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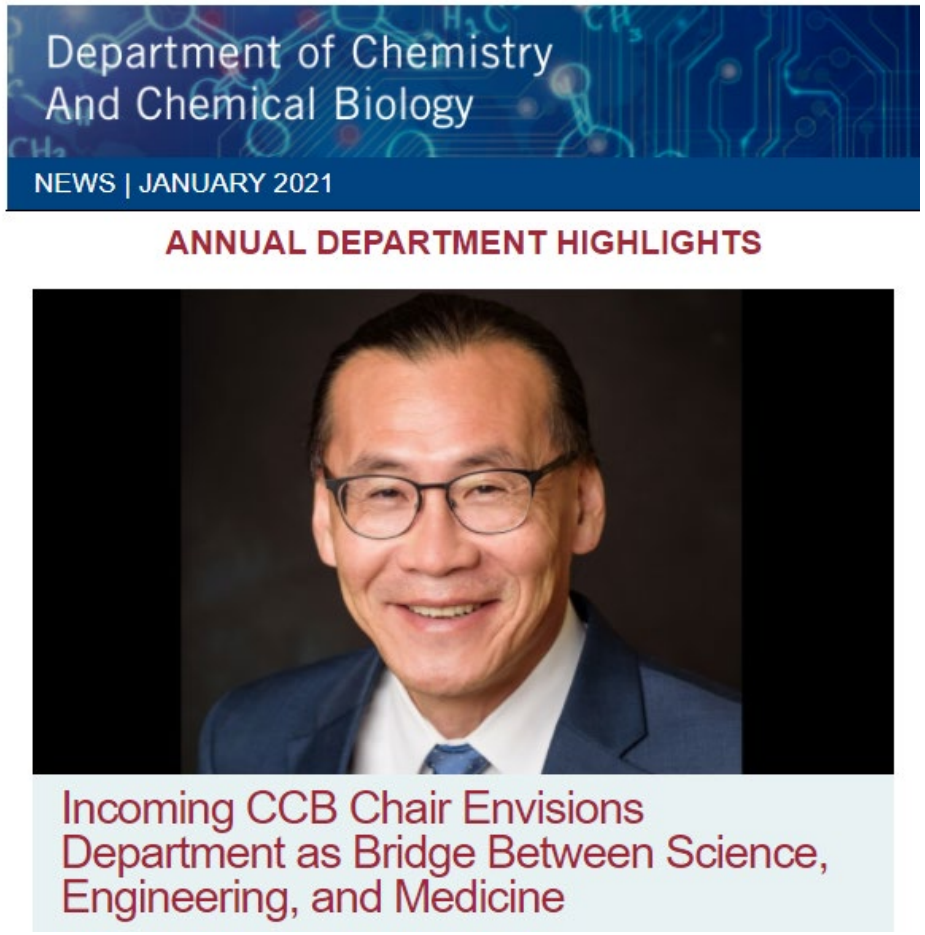
Strategic Plan of the Department

May 2021

Department of Chemistry and Chemical Biology (CCB)
Schaefer School of Engineering and Science
Stevens Institute of Technology

Chair's Perspective on Strategic Planning



- Explore new opportunities, especially as the pandemic highlights the importance of CCB's mission and provides a historic occasion to project our future as a bridge between science, engineering, and medicine
- Empower our faculty, with professionally diverse backgrounds, for the shared vision of our future
- Engage students, adjuncts, administrators, alumni, advisors, and collaborators to help pursue our vision

References for Strategic Planning Framework

- 2013 Stevens 10-Year Strategic Plan
- 2018 SES 5-Year Strategic Plan
- 2019 SES PhD Programs Task Force Committee Report
- 2020 SES Masters Programs Task Force Committee Report
- 2018 CCB Self-Study Report
- 2019 External CCB Review Committee Report

2019 External CCB Review Committee – Recommendations

- Determine a vision for future
- Develop research foci in concert with engineering departments
- Emphasize hiring tenure stream faculty, while noting the importance of teaching faculty
- Support faculty as they apply for research grants
- Explore joint appointments in CCB and engineering departments to help build bridges
- Discourage a single focus on cancer biology as it is too limited for growth
- Invest in building infrastructure
- Innovate undergraduate and graduate programs
- Increase communication as one common theme we heard from undergraduates, graduate students and even faculty is that individuals feel “on their own”
- Encourage Chair, Dean, and Provost work together to develop a strong strategic vision for CCB and deal with some teaching problems

CCB Department – Vital Statistics

	2016F	2017F	2018F	2019F	2020F	
Total # of Students	138	146	132	160	175	
Total # of Students*	138	152	141	170	185	**34% ↑**
Total # of Credit Hours**	7547	7768	8728	8419	9167	**21% ↑**
Total # of TT/NTT Faculty	12	14	12	12	12	**0%**
Total # of Lecturers	3	3	3	5	5	
Office and Advising Staff	2	2	2	2	2	
Student*/Faculty Ratio	11.5	10.9	11.8	14.2	15.4	
Credit Hours/Faculty Ratio**	629	555	727	702	764	

*Including 1/2 of Bioengineering Masters
**Excluding 1/2 of Bioengineering Masters

Source: Office of Institutional Research and Effectiveness

Vision

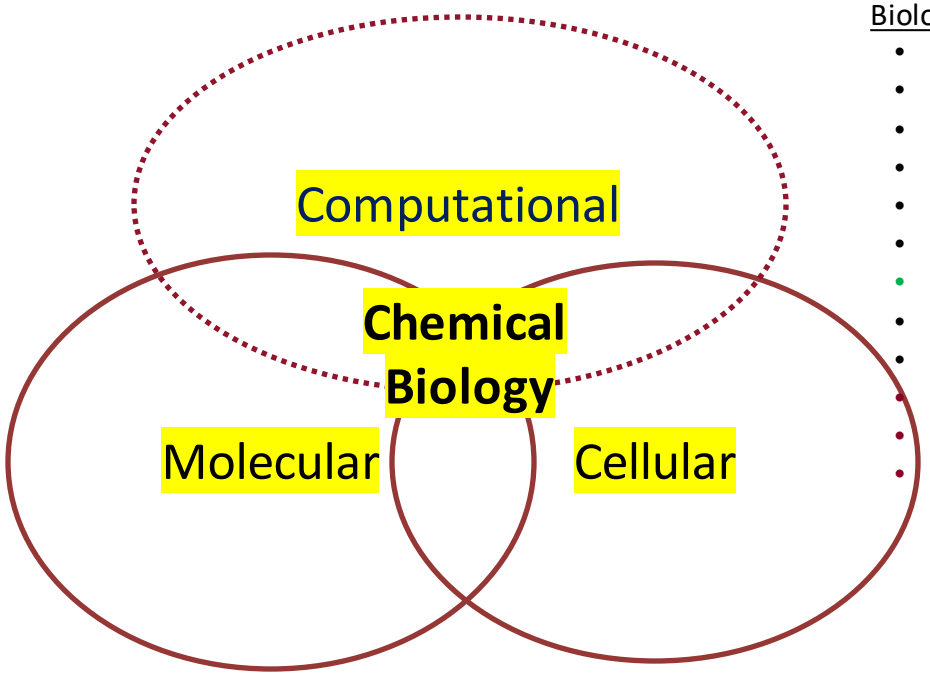
The CCB Department will be a community of researchers with molecular, cellular, and computational minds, dedicated to educating the next generation of science leaders and innovators and exploring transformative scientific ideas for global societal impact.

Computational Chemistry & Biology

- Faith Kim (Bioinformatics)
- Miguel Menendez Polanco (Computational Materials Science)
- Kenny Wong (Big Data & Drug Discovery Biology)
- Yong Zhang (Physical & Computational Chemistry)
- "…" (Computational Biology)
- "…" (Data Science)
- "…" (Artificial Intelligence)
- Simon Podkolzin (Computational Materials Science, CEMS)

Impact Areas

- *Drug Discovery*
- *Precision Medicine*
- *Sustainability*



Chemistry Core

- Sesha Alluri (Organic Chemistry)
- Athula Attygalle (Analytical Chemistry)
- James Liang (Biochemistry)
- Patricia Muisener (Polymer Chemistry)
- Sunil Paliwal (Medicinal Chemistry)
- Abhishek Sharma (Organic Chemistry)
- Anju Sharma (Pharmacy)
- "…" (Inorganic Chemistry)

Biology and Tissue Engineering

- Paola DiMarzio (Virology)
- Marcin Iwanicki (Cancer Biology)
- Nuran Kumbaraci-Jones (Physiology)
- Woo Lee (Tissue Models)
- Ansu Perekatt (Cancer Biology)
- Brunella Taddeo (Virology)
- William Windsor (Biophysics)
- "…" (Induced Pluripotent Stem Cells)
- "…" (Immune System)
- Hongjun Wang (Tissue Engineering, BME)
- Xiaojun Yu (Tissue Engineering, BME)
- "…" (Quantitative Imaging, BME)

Current and Future Research Foci

Molecular

- Modulation of disease-relevant biological systems at molecular level
- Macromolecules for diagnostics, electronics, and photonics

Cellular

- Mechanisms of cancer initiation, progression, and therapy resistance
- Patient-derived organoids and models in cancer, inflammatory diseases, and infectious diseases

Computational

- High accuracy predictions of molecular structures and properties
- Quantification of molecular and biological processes using data science, machine learning, and artificial intelligence

Strategic Initiatives – Research

- ***Make a coherent effort to recruit three Assistant Professors***
  - New insights using data science, machine learning, and artificial intelligence
  - Collaborative opportunities with current faculty
  - Cultivate students' computational mindset

- ***Explore the possibility of establishing "Named Computational Chemistry & Biology Lab" through a major gift***
  - Collaboration hub to collectively study and solve complex chemical and biological problems
  - Pilot activities in AY21-22 with Schrödinger Maestro, Gaussian, ChemDraw, Scifinder, SNAPgene, etc.

- ***Establish "CCB Research Day" in conjunction with Stevens Expo Day***
  - Annual assembly as a community of researchers
  - Piloted with undergraduate senior research projects in Spring 2021
  - Research projects of graduating masters and doctoral students
  - Invite EAB members, alumni, science teachers, local ACS members, and students from other universities

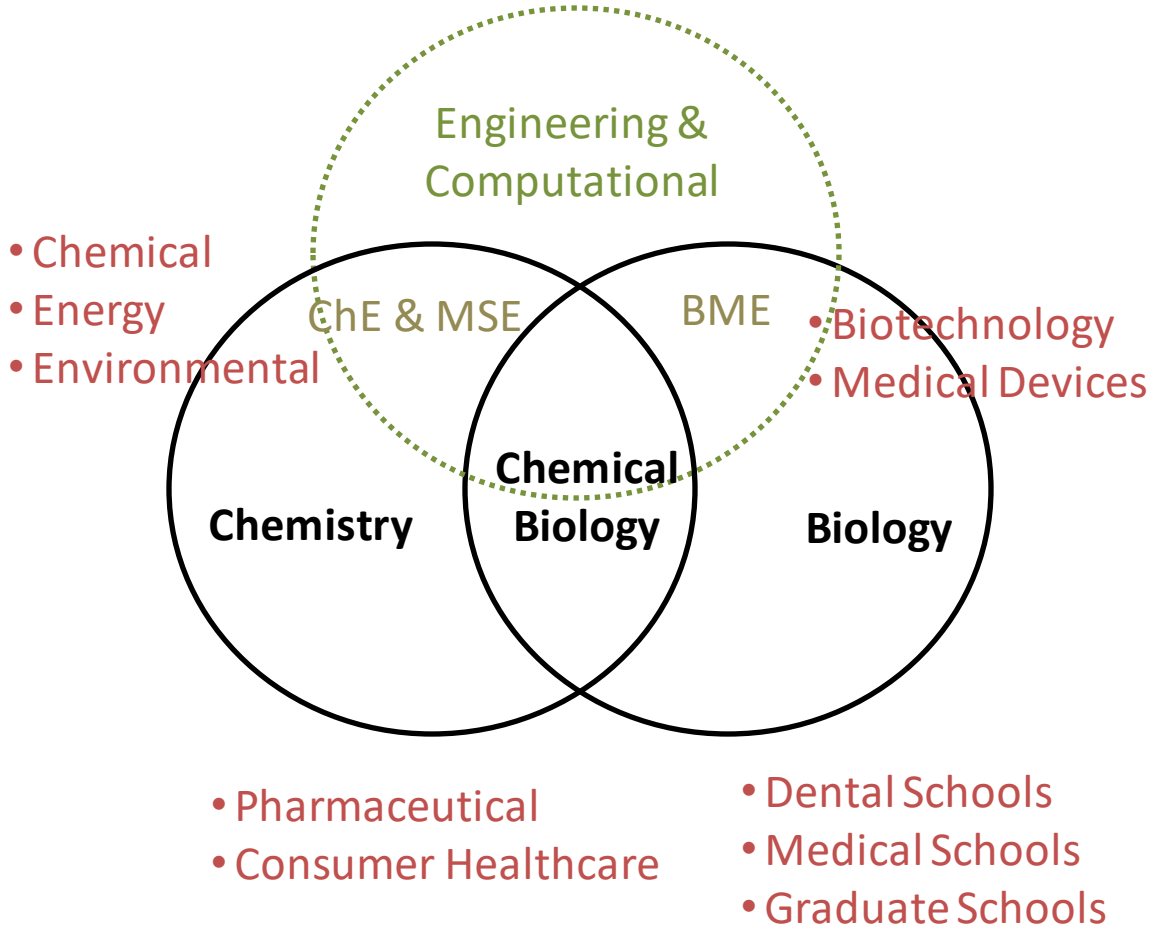
State of Undergraduate Programs

	Total	Biology	Chemical Biology	Chemistry
Seniors	23	9	11	3
Juniors	28	14	12	2
Sophomores	31	9	15	7
First Year	42	16	20	6
Totals	124	48	58	18

- Chemistry
  - Foundational ACS approved program
    - ACS certified B.S. degree
- Chemical Biology
  - Stevens' legacy in pioneering the interdisciplinary field in 1970's
  - ACS certified B.S. degree
- Biology
  - New program at Stevens since 2015

Innovate undergraduate curricula for distinguishing features

- ***Research spine*** *(first year-to-senior year) experience as the defining foundation of the Stevens science programs*
- ***Technology emphasis*** *(e.g., drug screening, computational chemistry, tumor models, gene editing, artificial intelligence)*
- ***Contemporary societal context*** *(e.g., pandemic, antibiotic resistance, cancer, sustainability)*



Research Spine

CH 189
Awareness of research in CCB and scientific literature in chemistry and biology

CH 301
Examine **ethical problems** that can be encountered in the practice of scientific research

CH 398 (NEW)
Plan your research for the following year, pick topic, and advisor. Write a research proposal

CH 498/CH 499
Capstone senior research project
- Molecular, cellular, and computational
- Collaborative & coordinated CCB activities as a research community

- **Augmented by research with faculty advisors, clinical experience, and industrial internship**
- **Sponsored by National Science Foundation (REU), National Institutes of Health (R15), and Jersey City Medical Center, etc.**

“Technology” Emphasis in Science Education

- Implement CRISPR-Cas genetic editing technology (2020 Nobel Prize in Chemistry) in Chemical Biology Lab (McLean 323) and create collaboration with engineering departments
- BIO381 selected as one of two courses on campus for piloting the use of virtual reality (VR) to help students visualize CRISPR-Cas technology in Fall 2021 and assess effectiveness in student learning
- Pilot computational chemistry and biology activities in AY21-22 with software such as Schrödinger, Gaussian, ChemDraw, Scifinder, SNAPgene, etc.
- High-throughput technology for drug discovery in Organic Chemistry Lab (McLean 219)
- Coordinated space designed for research with teaching faculty in Chemical Biology and Organic Chemistry Labs

Stevens Prehealth Program – Vision

- **Campus wide** targeting students interested in healthcare careers across **all majors,** starting AY2023-2024
- More students at Stevens pursue **health professional programs** upon graduation and are admitted and enroll in top tier schools
- New growth area with increasing the number of **high-quality students**

Stevens Undergraduates

- Chemical Biology
- Biology
- Biomedical Engineering
- Chemical engineering
- Mechanical Engineering
- Business Technology
- Science Technology and Communications
- Philosophy
- Other majors, e.g., Physics, Computer Science, Quantitative Finance, Chemistry, Music Technology, etc.

Health Professional Programs

- Medical Doctor (MD)
- Doctor of Osteopathic Medicine (DO)
- Dentistry
- Pharmacy
- Physical Therapy
- Optometry
- Physician's Assistant
- Veterinarian
- Chiropractic

Health Professional Schools
Stevens Graduates have Matriculated in last 5 years

2021 (3), 2020(1),2017(1)

2020(1), 2018 (2), 2017(1)

2020(2), 2019 (2), 2018 (1)

2020(1)

2020(1): MD/PhD

2021(1)

2020(1)

2020(1)


2019 (1)

2019 (1)

2018 (1),MD/PhD

2018 (1)

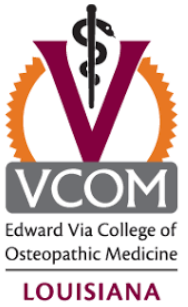
2018 (1)

2018 (1)

2017 (

2016 (1)

2019(1)



2021(1)

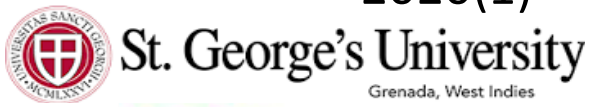
2016 (1)

2020(1), 2019(1)

2019(1)

2019(1)

2020(1)



2020(1)

2019(1), 2016 (1)

2020 (1)

2020(1), 2019 (2),

2020(1)

2021(1)

2018 (1)

2019 (1)

Modernize, Invigorate, and Formalize Prehealth Program
(per Criteria for National Ranking of Premed Programs)

1. **Prehealth advising** throughout four or five years
   - Create a formal advising program
   - Formalize Health Professions Advisory Committee (HPAC)
   - Appoint Interim Director of Prehealth Program and Chair of HPAC

2. **Research** and **publication** opportunities
   - Provide research experience with realistic chance for students to publish (e.g., "Research Spine" initiative for CCB majors)

3. **Clinical experience** opportunities
   - Develop partner relationships with local medical centers (e.g., New Jersey Medical Center, Hackensack Meridian Health)

4. **Rigorous curriculum**

SES Pilot Activities (AY21/22 & AY22/23)

Responsible Partners

Chemistry & Chemical Biology

- Prehealth prerequisite courses
- Bridge between Stevens and Healthcare Science

Office of Undergraduate Academics

- Multilayered advising support from first year to senior year

Other Academic Departments

- Math, Physics, Arts and Letters
- Availability of prerequisite courses
- Study sessions for entrance exams

Pilot HPAC-Led Activities →
Leading to Campus Wide Prehealth Program
Staffed with Director and Advisor by AY23/24

External Partners

- Clinical experience

Campus Wide Partners

Precollege Programs

- Summer precollege and bridge programs

Admissions Office

- High-quality student recruitment

Learning Technology

- Learning environment for visualization & computation intensive courses

Student Organizations

- Stevens Health Professions Club
- Alpha Epsilon Delta

Library

- Entrance exam study resources
- Research publications

Writing Center

- Personal statements
- Applications

Career Center

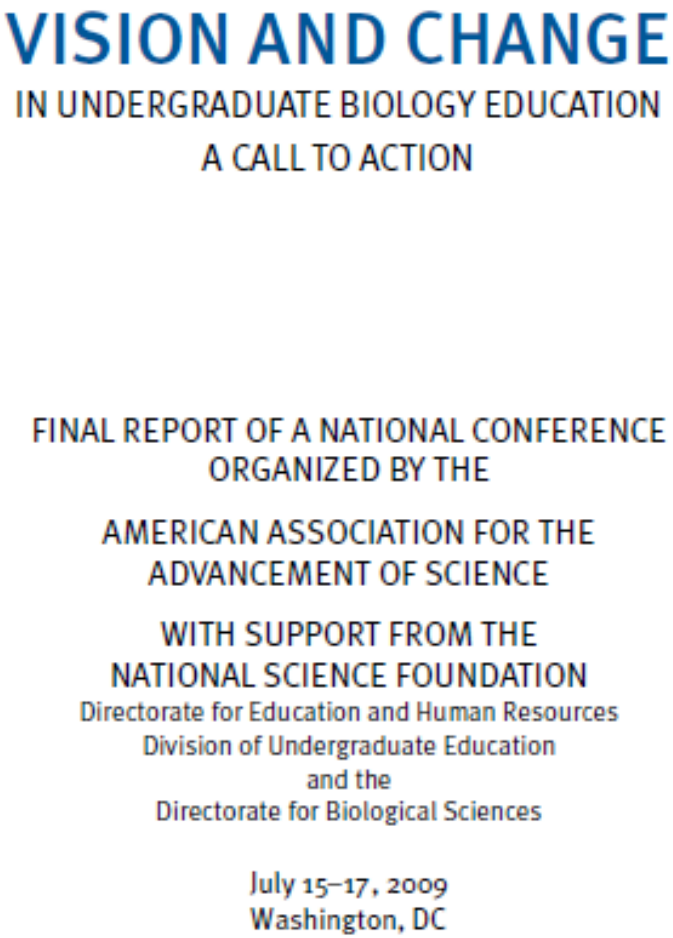
- Resume writing
- Interview skills
- Clinical experience opportunities

Long-Term Planning & Questions

- Formalize and assess undergraduate curricula by mapping student, program, and course outcomes
  - Next ACS Program Review, 2023

- What is the future of Chemical Biology and the best way to brand and promote the degree?

- How to redesign and possibly rename Biology undergraduate program to be more focused and in line with expected resources?



State of Graduate Programs

Spring 2021	Total	Bio-engineering*	Chemical Biology	Chemistry	Computational & Medicinal Chemistry
Masters	54	17	15	17	5
PhD	23		12	11	

*Collaboration with BME

Source: Census Information from SES Associate Dean for Graduate Education

Master's Programs

- Strategic Goal
  - Innovate graduate curricula to equip master's students with tailored foundational and interdisciplinary knowledge and skills for professional development and career success

- Strategic Initiative
  - Architect the overall framework of CCB MS and certificate programs per the SES Master Task Force Recommendation
  - Review and revise core courses
  - Develop certificates (i.e., concentrations) that capture regional, institutional, and CCB strengths

Modular Masters Structure

OPTIONS: Master's Thesis (6 credits required)
Research project (Special topic course, 3 credits)
CPT courses / internship
Ramp courses (for students with missing background)

Allows student to specialize on a specific area after taken the core courses
Optimum: aligned with ongoing research directions / industrial outreach
(1:1 mapping towards research involvement – if desired)
Leverage on interdisciplinary offerings (courses from other departments / schools)
Set of courses can be a Graduate Certificate

Core courses deliver **core skills and knowledge** a student needs to be successful in his future career
Specific skills can be delivered through combination of 1-credit skill focused courses as well as standard 3-credit courses

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- Core courses for skill building (4 courses)
- Elective courses (4 to 6) in focused certificates
- Master' thesis or special problems for research skills (2)

Master's Programs Updated for AY21/22

Chemistry (Core Courses)
- CH 520 Advanced Physical Chemistry
- CH 610 Advanced Inorganic & Bioinorganic Chemistry
- CH 640 Advanced Organic & Heterocyclic Chemistry
- CH 662 Separations in Analytical/Organic Chemistry

Chemical Biology (Core Courses)
- BIO 586 Immunology
- BIO 687 Molecular Genetics
- BIO 690 Cellular Signal Transduction
- One Advanced Chemistry Course

Analytical Chemistry (Certificate)
- CH 561 Instrumental Methods of Analysis
- CH 660 Advanced Instrumental Analysis
- CH 662 Separations in Analytical Chemistry
- CH 666 Modern Mass Spectrometry

Computational Chemistry & Biology (Certificate)
- CH 520 Advanced Physical Chemistry
- CH 664 Computer Method in Chemistry
- CH 669 Applied Quantum Chemistry
- BIO 568 Computational Biology

Drug Discovery (Certificate)
- BIO 690 Cellular Signal Transduction
- CH 685 Medicinal Chemistry

Choose two of the following
- CH 582 Biophysical Chemistry
- BIO 684 Molecular Biology Lab Techniques
- BIO 682 Biochemical Lab Techniques
- CH 800 Special Problem
- BIO 800 Special Problem

- Opportunities for DS, AI, and ML?
- High-quality fully online Chemical Biology Master's program in post-pandemic era?

MS in Data Science
Led by Math

MS in Machine Learning
Led by CS

MS in Applied AI
MS in Robotics
Led by ECE/ ME

Strategic Initiatives for Doctoral Education

- Revised the Ph.D. qualification process during AY20/21 to be research-oriented and consistent with the overall framework of CCB MS programs
  - Discarded theoretical and subject-based tests
  - Evaluate student's skills in interpreting and analyzing current scientific literature and proposing and defending a research hypothesis

- Provide competitive research training by:
  - Fostering collaboration at the intersection between molecular, cellular, and computational research clusters
  - Building bridges for collaboration with other departments and external collaborators

- Use fellowship and teaching assistant resources more effectively to enhance the recruitment of high-quality doctoral students, especially to support tenure track faculty

Infrastructural Challenges

- New confocal laser scanning microscope under a service contract starting Spring 2021
- Explore the possibility of consolidating analytical capabilities in the Center for Mass Spectrometry (McLean 409 and 408) and the Instrumental Analysis Teaching Lab (Mclean 423-429) as an SES User Center with focus on supporting lab courses and campus-wide analytical chemistry needs
- Acquire modern NMR instrument (at least 500 MHz)
- Recruit and develop Ph.D. level bench scientists with responsibilities to
  - Maintain facilities and equipment
  - Train users of major instruments
  - Administer shared use for our equipment campus wide

Governance & Culture

- Structured the governance of CCB through standing committees during AY20/21
- Obtain, assess, and address stakeholder's feedback
  - Undergraduate Students Advisory Board
  - Graduate Students Advisory Board
  - External Advisory Board
- Establish an inclusive culture by providing equal voting privileges for all full-time faculty members on academic matters
- Increase diversity in future faculty hires in partnership with the Stevens Advance program
- Promote inclusivity and diversity in the undergraduate and graduate classroom through both existing and new strategies

Communication

- Use CCB webpage as a front gate of communicating with prospective students and parents, alumni, friends, collaborators, and sponsors

- Publicize major faculty and student accomplishments
  - New stories
  - Annual CCB Newsletters, e.g., Inaugural 2021 CCB Annual Newsletter
  - CCB Research Day

- Build strategic partnerships with prestigious regional institutions

- Strengthen our connection to the ACS NY Section and faculty advising of ACS Student Chapter

- Created Make a Gift as a means of cultivating donors for CCB-specific initiatives such as research spine implementation during AY20/21

External Advisory Board Members

- Dr. Lance Bruck, MD, Vice President and Chairman, Department of Obstetrics, Gynecology & Women's Health, Jersey City Medical Center.
- Dr. Nicholas DePinto, DMD, Associate Professor and Dental Director, Rutgers School of Dental Medicine (Stevens Alumnus, BS 2003).
- Dr. Simarna Kaur, PhD, Research Manager and Ageless Platform Lead, Johnson & Johnson (Stevens Alumnus, BS 2002, MS 2004, PhD 2008).
- Ms. Nadia Makar, BS, STEM Supervisor, Jose Marti Stem Academy.
- Mr. Joshua Ross, New York University, Medical School (Stevens Alumnus, BS 2018).
- Dr. Ben Tycko, MD, PhD, Senior Scientist, Center for Discovery and Innovation and Co-Director of the Institute for Cancer and Infectious Disease, Hackensack Meridian Health.

EAB is charged with reviewing CCB programs and providing counsel and advocacy to CCB's mission and strategic plan. EAB members serve on a three-year basis. We plan to add more EAB members over the next two years.

CCB Faculty

- Administrative Leadership
  - Woo Lee, Professor and Chair
  - Patricia Muisener, Teaching Associate Professor and Associate Chair for Undergraduate and Graduation Education
  - Kenny Wong, Teaching Associate Professor and Biology Program Director

- Tenure Stream
  - James Liang, Professor
  - Yong Zhang, Professor
  - Nuran Kumbaraci-Jones, Associate Professor
  - Abhishek Sharma, Assistant Professor
  - Marcin Iwanicki, Assistant Professor
  - Ansu Perekatt, Assistant Professor

- Teaching Track
  - Athula Attygalle, Teaching Professor
  - Anju Sharma, Teaching Associate Professor
  - Sunil Paliwal, Teaching Assistant Professor
  - Sesha Alluri, Lecturer
  - Paola DiMarizo, Lecturer
  - Faith Kim, Lecturer
  - Miguel Mendez Polanco, Lecturer
  - Brunella Taddeo, Lecturer

CCB Adjunct Instructors

- Dr. Michael Cutrera, Scientific Consultant and most recently at Bristol-Myers Squibb
- Dr. Dolores Kowalski, Cellular and Molecular Pathologist, Stonybrook and Montclair
- Dr. Gary Martin, Retired from Merck and Co-Editor-in-Chief of “Magnetic Resonance in Chemistry” Journal
- Dr. Nicholas Murgolo, Currently with Merck
- Dr. Sheo Singh, Retired from Merck
- Dr. Laura L. Rokosz, Owner of EGGLRock Nutrition and Formerly with Merck
- Dr. Wolfgang Ruettinger, Currently with BASF
- Dr. Rahul Khade, Postdoctoral Fellow, Stevens
- Dr. William Windsor, Retired from Merck

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