West Point Department of Chemistry and Life Science: Strengthening Army Medicine through Leadership and Research

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INTRODUCTION

With the transition from a multi-decade focus on low-intensity counterinsurgency operations to the prospect of near-peer competitor high intensity conflict in multiple theaters, the Army has a critical need for high quality physician-leaders. The continued evolution of the Defense Health Agency (DHA) and the military's increasing dependence on civilian medical providers further highlight the need for deployable uniformed physicians. Ensuring the health of our Soldiers and their families throughout the Army's global footprint is essential for a ready fighting force prepared for any contingency. Current operations in the Russo-Ukraine conflict remind us of the grim realities that combat brings to bear on those fighting on the front lines, as well as the varied nature of the threats and nature of casualties they inflict. This is especially important for chemical, biological, radiological, nuclear and explosives (CBNRE) threats.[1–5] Further, adaptive medical leaders with critical thinking, problem-solving skills, and organization leadership that transcend technical expertise are essential in fielding the leaders in the Medical Corps of the future.[6,7]

Army physicians usually enter military service through direct commission or a scholarship program, such as the Health Professionals Service Program (HPSP) or the Army Medical Department's Long-Term Health Education Training (LTHET).[8] While each of these options reliably supports the DoD's requirements for licensed military physicians, the United States Military Academy (USMA) at West Point is also a robust undergraduate source for future Medical Corps (MC) officers. In fact, USMA graduates routinely matriculate into many of the nation's top medical schools, such as Harvard, Yale, Stanford, and Columbia. While West Point only provides approximately 20 graduates each year to the MC pipeline, its graduates represent an extraordinary talent pool of scientific and leadership expertise, in part because of their experience in the Department of Chemistry and Life Science (CLS).

West Point provides a comprehensive 47-month experience in which military education, leadership, academics, and character development are intricately interwoven, as well as planned and executed by Army officers and civilian faculty. West Point faculty also either enhance their professional careers within the AMEDD or otherwise contribute to the medical mission during or following their teaching assignment. In this article, we describe how CLS supports the AMEDD officers through its faculty development, undergraduate education program, and teaching and leadership through research.

USMA DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

West Point was founded in 1802 to provide the Army and Nation officers and engineers to defend and expand the country's infrastructure.[9] While serving as the Superintendent of the United States Military Academy, Colonel Sylvanus Thayer saw the need for cadets to understand the basic sciences, to include chemistry and biology. He solicited help from the Surgeon General of the Army to develop courses and form a department to teach them. In 1820, a Department of Chemistry and Mineralogy was established, and the Head position was initially filled with the post surgeons, James Cutbush and James Percival. In 1838, the name changed to the Department of Chemistry, Mineralogy, and Geology, and was initially led by 2LT Jacob Bailey. The Department of Chemistry, Mineralogy, and Geology maintained its name for over one hundred years until it became the Department of Chemistry and Electricity in 1943. In 1946, the department name changed again to the Department of Chemistry and Physics. The department was ultimately renamed the Department of Chemistry and Life Science in 2002.

Today, the Department of Chemistry and Life Science teaches courses in Chemistry, Chemical Engineering, and Life Science and serves as the proponent for USMA's Premedical Scholarship Program. The mission of CLS is: *To educate cadets with a firm foundation in the fields of*

chemistry, life science, and chemical engineering so that each graduate is a commissioned leader of character who can leverage their understanding of science to implement solutions using appropriate problem-solving skills; and to inspire cadets to a career in the United States Army and a lifetime of personal growth and service to the nation.[10] In addition to offering three academic majors – American Chemical Society (ACS) accredited Chemistry, Accreditation Board for Engineering and Technology (ABET) accredited Chemical Engineering, and Life Science – CLS also offers a supplemental three-course Bioengineering track. The Department provides instruction in four core curriculum courses: CH101 General Chemistry I, CH151 Advanced General Chemistry I, CH102 General Chemistry II, and CH275 General Biology. CLS is also a member of the Photonics Research Center (PRC), along with the Departments of Physics and Nuclear Engineering (PANE) and Electrical Engineering and Computer Science (EECS), which conducts basic and applied research and support to the Army and DoD in the areas of lasers and photonics, giving future physicians research opportunities to understand and apply laser and imaging instrumentation. Collectively, the programmatic interdisciplinary nature of the Department is uniquely conducive to academically supporting top-tier premedical experiences.

With 25 military faculty, 10 civilian faculty, 13 administrative and laboratory staff, and numerous staff scientists and postdoctoral researchers, CLS serves the Academy, the Army, and the Nation by providing its graduates with a fundamental understanding of basic science and an advanced ability to solve complex problems. CLS maintains collaborative relationships across the DoD's science and technology research enterprise, including the Defense Threat Reduction Agency (DTRA), the Defense Advanced Research Projects Agency (DARPA), multiple entities of the U.S. Army Combat Capabilities Development Command (DEVCOM), the Chemical and Biological Center (CBC), the Army Research Laboratory (ARL), and multiple institutes of the Medical Research and Development Command (MRDC). The Department also hosts an Annual Microbiology Symposium, featuring renowned microbiologists from military and civilian research institutes and universities, and supports West Point's annual Summer Leaders Experience, a weeklong program that provides an immersive academic, military, physical, and social experience to high school juniors who will apply to become USMA cadets.

Table 1. USMA Table of Distribution and Allowances (TDA) Medical Service Corps authorizations for the Department of Chemistry & Life Science

Line	Position	Grade	Position Code	Degree
08	Instructor/ Researcher	O5	67B00	Ph.D.
13	Instructor/ Researcher	O5	67B00	Ph.D.
14	Instructor/ Researcher	O5	67B00	Ph.D.

CLS FACULTY IN THE AMEDD

Military faculty of CLS include permanent USMA professors, senior rotating faculty with PhDs, and junior rotating faculty with master's degrees.[11,12] AMEDD officers have fulfilled positions in all three categories.

CLS Academy Professors serve as tenured program and department leaders. Upon their selection, these officers become Functional Area 47 officers. Two recent Medical Service Corps (MSC) officers have received this distinction and served within CLS. COL Jason Barnhill, formerly a 71A Microbiologist, served as the Life Science Program Director. BG (Ret) Leon Robert, formerly a 72B Entomologist, rose through the academic ranks and retired as the Department Head, CLS. Both distinguished AMEDD faculty members were Adjunct Professors in the Uniformed Services University of the Health Sciences (USUHS) with multiple overseas and operational tours.

AMEDD Officers most commonly serve in CLS as senior rotating faculty, both due to medical-focused experience and by virtue of their doctoral degrees. The Tables of Distribution and Allowances (TDA) personnel authorizations for CLS currently includes three positions for AMEDD Laboratory Science (67B) officers with PhDs (Table 1) in topics relevant to biology and chemistry courses taught in the Department. These positions have historically been filled by 71A Microbiologist and 71B Biochemist officers, with one from each specialty filling at least one slot. Additionally, O1A branch immaterial positions are now able to be filled with other Areas of Concentration (AOC), such as 72B Entomologists or Veterinary Corps (VC) officers.

The junior rotating faculty is comprised of department-level committee-selected senior company grade and junior field grade officers who have received 2-year thesis-based Master's degrees in various chemistry, biology, and bio/chemical engineering programs through the Advanced Civil Schooling (ACS) program. While assigned to CLS, these officers serve as Instructors and Assistant Professors for the Department's core courses. Many junior rotators work closely with AMEDD officers assigned to CLS, and similarly lead and mentor premedical students. In some cases, these professional relationships inspire junior rotating faculty to subsequently pursue PhDs and return to USMA as senior rotators, either within their branch or as Functional Area 52 Nuclear and Countering Weapons of Mass Destruction (CWMD) officers. Two recent rotating USMA officers pursued professional degrees and

branch-transferred to the AMEDD, with one becoming a Microbiologist (COL Barnhill) and the other becoming a Dermatologist (LTC Ford Lannan).

Regardless of faculty type, CLS officers serve in various leadership roles. Each academic course has a Course Director (CD), responsible for course content and assessment plans. Each academic program – Chemistry, Life Science, and Chemical Engineering – has a Program Director and Deputy Program Director, who are responsible for resourcing with guidance, staffing, space, and materials. Research within CLS, the Center for Molecular Science, is also managed and led by a Program Director. Many of these roles are filled by senior rotator AMEDD faculty.

Both AMEDD and non-AMEDD officers contribute to Army medicine while serving as CLS faculty. West Point cadets and faculty regularly present basic and applied research at international meetings and conferences hosted by organizations such as DTRA, the American Society for Microbiology, and the American Chemical Society. CLS faculty also serve on review panels, boards, and advisory councils relevant to AMEDD's clinical and operational missions.[11,12] During the COVID-19 pandemic, AMEDD officers assigned to CLS served in staff roles at USMA and deployed as subject matter experts. Finally, following their respective tenures with CLS, AMEDD officers have completed fellowships and served in drug laboratories, MRDC laboratories, and Medical Centers. Two CLS faculty, LTC Erin Milner and COL (Ret) Norman Waters, later served as the Deputy Consultant and Consultant to the U.S. Army Surgeon General for Biochemistry and Microbiology, respectively.

CLS GRADUATES IN THE AMEDD

Education is critical at all levels in the career development of AMEDD officers, which starts with undergraduate programs and progresses through advanced military and civilian schooling. Chemistry, Life Science, and Chemical Engineering graduates support the AMEDD in wide ranging capacities. In part based on their passion for lessons learned throughout their CLS programs of instruction, these graduates align well with the AMEDD's mission of "ready and sustained health services support and force health protection in support of the Total Force."[13]

West Point alumni are represented in nearly all components of the AMEDD, including the Medical Corps, Nurse Corps, Dental Corps, Veterinary Corps, Medical Service Corps, Medical Specialist Corps, and Civilian Corps. Cadets interested in healthcare-related career fields are authorized to enter the MSC directly from West Point, but must first serve in a different branch before transferring to the other AMEDD branches. West Point graduates serve as MSC officers in wide-ranging roles, from medevac pilots and laboratory scientists to managers of the U.S. Army's health service. An additional cohort of West Point graduates temporarily joins the MSC when they are accepted into medical school following graduation, before transitioning to the Medical Corps after receiving their M.D. or D.O. degrees. There are additional paths for West Point graduates to join the other AMEDD branches. In many cases, West Point graduates apply as junior officers for release from their branch to enter professional schooling prior to completing their Active-Duty Service Obligation (ADSO). In other cases, graduates complete their ADSO, earn their professional degree, and return to active duty. Regardless, rooted in their 47-month leadership and character development experience at USMA, graduates bring a wide range of experiences, highly desirable qualities, and valuable leadership skills to the AMEDD.

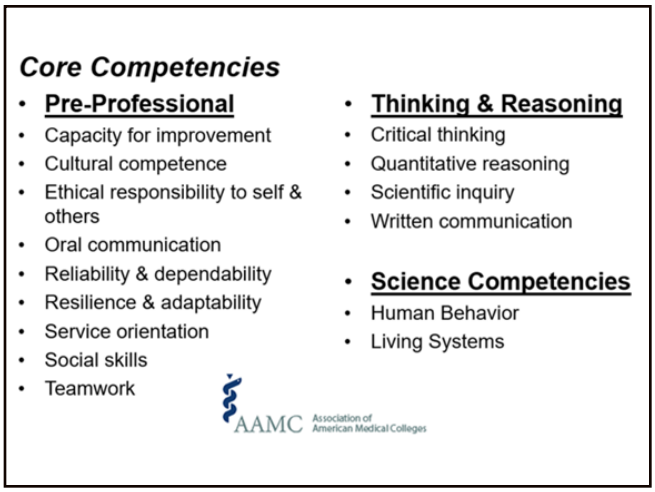
West Point's premedical program has a long history. The first West Point graduate to attend medical school, Dr. Dorsey Mahin (West Point, 1945), was commissioned as an engineer, graduated from the Columbia College of Physicians and Surgeons in 1955, and retired as a colonel in 1972. He was required to resign his commission to attend medical school, a practice that continued for a decade. Later, Doctors John Fegin and Pauk Lenio (West Point, 1955) helped change the path to medicine for subsequent generations. As Lieutenants, these industrious officers presented their case to the Army Chief of Staff, GEN Maxwell Taylor, who reportedly said, "If you can make it work for the Army – do it."[14] Joined by classmate Preston Mayson, the three aspiring physicians attended medical school while on leave without pay. They all completed their residency training at Walter Reed Army Medical Center, then volunteered to serve in Vietnam.14 Army Regulation (AR) 601-112, which was first approved in 1968 as the Program for Medical, Dental, and Veterinary Education for Regular Army Officers, and subsequently amended to include Osteopathic education, allowed qualified officers to attend professional schools with government funding after serving a minimum of two years in the combat arms.15 Subsequently, members of the Class of 1970 were the first West Point graduates to receive permission to enter medical school directly from the academy.[14]

Since 1979, West Point cadets have attended medical school immediately following graduation from West Point in accordance with AR 601-141, which states: "The Superintendent, U.S. Military Academy (USMA) is responsible for preliminary selection of cadet applicants for HPSP participation and notification of selected cadets to USAREC for processing. DOD guidance permits only two percent of each academy graduating class to attend medical school under military sponsorship, effective 19 August 1978."[16] Thus, the DoD currently permits two percent of each West Point graduating class to attend medical school under military sponsorship. Many additional West Point graduates attend medical school following a period of service in the MSC or a branch outside the AMEDD. In recent years, between 75% and 100% of cadets aspiring to directly attend medical school upon graduation have majored in CLS, and overwhelmingly

in Life Science. Those cadets who select majors in other departments must take a heavy load of chemistry and biology classes (General Chemistry II, Organic Chemistry I, Organic Chemistry, II, Advanced Biology, Human Physiology, and Biochemistry), in addition to their academic major requirements, to meet medical school prerequisites.

West Point cadets bring highly desirable qualities and attributes to the medical school application process, aligning extremely well with the fifteen core competencies established by the American Association of Medical Colleges (Figure 1).[17] In addition, cadets perform exceptionally well throughout the medical school application process (Table2). Their acceptance rate over the past six years has averaged 95% and they have attended a wide range of medical schools, including Federal, state, and private institutions (Table 3). Approximately 98-99% of West Point graduates complete their residency training in the military graduate medical education system.

Figure 1. American Association of Medical Colleges core competencies



In all, 1168 USMA graduates have served as military physicians.[1] West Point alumni have become leaders in all aspects of medicine, both military and civilian. They have served as department chairs in prestigious universities and senior executives in healthcare organizations. Fourteen USMA graduate physicians have become General Officers, including three who attained the rank of Lieutenant General (LTG): former Surgeons General of the Army, LTG James Peake (WP'66) and LTG Nadja West (WP'82), and the current Director of the Defense Health Agency, LTG Telita Crosland (WP'89). Finally, six physicians have earned West Point's Distinguished Graduate Award (Table 4), which is conferred upon individuals whose "character, distinguished service, and stature draw wholesome comparison to the qualities for which West Point strives, in keeping with its motto: "Duty, Honor, Country."[18]

In addition to service as MSC officers and physicians, West Point CLS graduates have made significant contributions throughout the AMEDD. USMA graduates have earned professional degrees as dentists (n=23), veterinarians (n=7), and doctorate level physical therapists (n=15) between 1990 and

Table 2. Medical school acceptance data for West Point graduates, 2018 – 2023

	2018	2019	2020	2021	2022	2023
Applied	15	20	20	16	15	16
Accepted	14	19	20	15	13	16
Life Science Majors	8	13	17	12	11	15
Other Majors[a]	7	7	3	4	4	1
Total interviews	26 (1.7)	91 (4.55)	103 (5.2)	84 (5.3)	74 (4.9)	114 (7.1)
Total acceptances	19 (1.3)	55 (2.75)	61 (3.1)	52 (3.3)	46 (3.1)	65 (4.1)
USU interviews	13 (0.87)	20 (1.0)	20 (1.0)	16 (1.0)	15 (1.0)	16 (1.0)
USU acceptances	12 (0.8)	16 (0.8)	14 (0.7)	12 (0.75)	12 (0.8)	14 (0.9)
Civilian interviews	12 (0.87)	71 (3.6)	83 (4.2)	68 (4.3)	59 (3.9)	98 (6.1)
Civilian acceptances	7 (0.47)	39 (1.95)	47 (2.4)	40 (2.5)	34 (2.3)	51 (3.1)

[a]Other majors: Chemistry, Chemical Engineering. Kinesiology, Psychology, Environmental Science, Mechanical Engineering, Mathematical Science, Foreign Language, Interdisciplinary Science, Nuclear Engineering

Total numbers in black. Average numbers per cadet in blue. USU – Uniformed Services University.

Table 3. Medical Schools attended by West Point graduates, 2018 – 2023

Brown University
Southern Illinois University
Case Western Reserve University SOM
St. Louis University
Columbia University
Stanford University
Cornell University
Texas A&M University
Dartmouth College
Tufts University
Drexel University
UCLA
Georgetown University
Uniformed Services University
Harvard University
University of Arizona - Phoenix
Louisiana State University, New Orleans
University of North Carolina
Mayo Clinic
University of Oklahoma HSC
Medical College of Wisconsin
University of Texas, Houston
Medical University of South Carolina
University of Texas HSC
Michigan State CHM
University of Virginia
Michigan State COM
University of South Carolina Greenville
Morehouse SOM
Vanderbilt University
Nebraska – UNMC
Wake Forest University
Nova Southeastern COM
Washington State University
Penn State University
Yale University
Rocky Vista University COM

CHM – College of Human Medicine; COM – College of Osteopathic Medicine; HSC – Health Science Center; SOM – School of Medicine; UNMC – University of Nebraska Medical Center; UCLA – University of California Los Angeles

2020.[2] Thus, West Point graduates bring their military experience, unparalleled leadership education and training, and character development to classmates in professional schools and colleagues throughout the military. The lessons learned during CLS courses in Bartlett Hall's classrooms and laboratories, as well as mentorship from members of the CLS staff and faculty, provide the backbone for exceptional careers of service in the AMEDD.

CLS LEADS PREMEDICAL TRAINING

Although only a small percentage of Army physicians and other supporting officers are West Point graduates, they nonetheless distinguish themselves through their undergraduate experience of integrated leadership development in military, physical, character, and academic instruction. As the USMA proponent for the premedical program, CLS specifically strengthens the AMEDD through cultivation of undergraduates and career professionals via military medicine-tailored academics, premedical club coordination, summer internships, and teaching through research.

LIFE SCIENCE PROGRAM: ACADEMICS AND ASSESSMENT

Most West Point graduates who become physicians, either directly following graduation or later during their Army

Table 4. Physician recipients of the West Point Distinguished Graduate Award

Thoralf M. Sundt Jr. WP'52
John A. Feagin, WP'55
James B. Peake, WP'66
Victor F. Garcia, WP'68
Frederick C. Lough, WP'70
Nadja Y. West, WP'82

careers, major in Life Science. Between 2018 and 2023, 74.5% (76 of 102) direct medical school attendees majored in Life Science (see Table 2). Except for Physics, CLS teaches all science courses that are required for premedical students: Biology, Organic Chemistry, Human Physiology, and Biochemistry (Table 5), and each of these courses is also required for the Life Science major.

CLS courses are taught and/or directed by MSC Officers, who provide rigor and mission-specific applicability that is unique among the typical American undergraduate STEM experience. The Human Anatomy class has been taught by a physician from Keller Army Community Hospital (KACH). Furthermore, the Biotechnology capstone course for Life Science majors has been designed and executed in conjunction with USUHS faculty, which further highlights the strong connection between CLS and Army medicine.

CLS offers its robust Life Science academic major at near-capacity, with enrollment of approximately 40 cadets per year. Simultaneously, many non-Life Science majors take several upper-level courses to meet or otherwise supplement medical school applications. The Life Science program is strengthened by its diversity of military and civilian faculty. Military faculty represent non-AMEDD branches, such as Signal Corps, Military Intelligence, Chemical Corps, and FA52 Nuclear and CWMD, as well as AMEDD branches, such as VC and MSC (71A Microbiologists, 71B

Biochemists, and 72B Entomologists). Civilian faculty, with and without military backgrounds, have PhDs in fields such as microbiology, biochemistry, and neuroscience.

The Life Science course sequence (Table 6) begins in the fall semester of a cadet's sophomore year with Advanced Biology, followed by Genetics in the spring. In their junior year, Life Science majors take Cell Biology in the fall and both Biochemistry and Human Physiology in the spring. Either during their junior year spring semester or immediately following the conclusion of the spring semester, premedical cadets take the Medical College Admission Test (MCAT). Upon returning to USMA from summer military training, Life Science seniors take Microbiology in the fall and a capstone Biotechnology course in the spring. In addition to this biology-focused course sequence, Life Science majors also take one full year each of General Chemistry and Organic Chemistry. With the exception of Genetics, all these courses have coupled laboratory programs, ensuring that cadets gain practical knowledge of chemical and biological instrumentation and experimental techniques. Life Science majors also complete two required elective courses, which commonly include Human Anatomy, Advanced Techniques in Light Microscopy, or Biological Psychology. Recently, CLS has added a three-course bioengineering track of instruction, consisting of Biomedical Engineering, Bioprocess Engineering, and Bioengineering Modeling, Analysis, and Design, which has begun to enhance the undergraduate experience of several premedical Life Science majors.

As the centerpiece for the Department's support of not only premedical cadets, but many of the Academy's future MSC officers, the Life Science program is a remarkably effective product of its civilian and medically oriented military faculty. Within the Life Science Program, its students are assessed using externally derived direct evidence from three standardized tests:

- Medical College Admission Test (MCAT), taken by 30 – 50% of Life Science majors in the spring of junior year,
- American Chemical Society (ACS) Biochemistry Exam (one semester course), taken by all Life Science and all Chemistry majors, typically during spring of junior year, and

Table 5. CLS courses that are required for West Point's Premedical Scholarship Program, and their status within each CLS major

Course Designation	Course Title	Life Science	Chemistry	Chemical Engineering
CH102	General Chemistry II	Required	Required	Required
CH383	Organic Chemistry I	Required	Required	Required
CH384	Organic Chemistry	Required	Required	Not required
CH375	Advanced Biology	Required	Elective	Not required
CH387	Human Phisiology	Required	Elective	Not required
CH473	Biochemistry	Required	Required	Not required

Figure 2. Life Science performance on the ETS Major Field Test for Biology, 2021 – 2022

ETS Major Field Test AY21

Assessment Indicator Title	USMA Mean Percent Correct	USMA Percentile	National Mean Percent Correct	National Percentile
Biochemistry and Cell Energetics	53%	91st	43%	45th
Cellular Structure, Organization, Function	56%	89th	44%	43rd
Molecular Biology and Molecular Genetics	53%	89th	42%	47th
Diversity of Organisms	62%	86th	53%	40th
Organismal - Animals	53%	94th	41%	45th
Organismal - Plants	42%	74th	38%	51st
Population Genetics and Evolution	50%	85th	41%	44th
Ecology	62%	99th	46%	44th
Analytical Skills	56%	93rd	44%	45th
Average	**54%**	**89th**	**44%**	**45th**

	USMA Average Score	USMA Percentile	National Average Score	National Percentile
Subscore 1: Cell Biology	61	92nd	51	43rd
Subscore 2: Molecular Biology and Genetics	62	93rd	52	45th
Subscore 3: Organismal Biology	60	91st	51	41st
Subscore 4: Population Bio, Evolution, Ecology	62	95th	50	40th
Total Score	162	93rd	152	48th

ETS Major Field Test AY22

Assessment Indicator Title	USMA Mean Percent Correct	USMA Percentile	National Mean Percent Correct	National Percentile
Biochemistry and Cell Energetics	57%	97th	43%	45th
Cellular Structure, Organization, Function	62%	98th	44%	43rd
Molecular Biology and Molecular Genetics	58%	97th	42%	47th
Diversity of Organisms	61%	83th	53%	40th
Organismal - Animals	54%	96th	41%	45th
Organismal - Plants	43%	78th	38%	51st
Population Genetics and Evolution	51%	87th	41%	44th
Ecology	64%	99th	46%	44th
Analytical Skills	60%	98th	44%	45th
Average	**57%**	**93rd**	**44%**	**45th**

	USMA Average Score	USMA Percentile	National Average Score	National Percentile
Subscore 1: Cell Biology	64	98th	52	50th
Subscore 2: Molecular Biology and Genetics	65	97th	53	49th
Subscore 3: Organismal Biology	60	91st	52	49th
Subscore 4: Population Bio, Evolution, Ecology	63	97th	51	47th
Total Score	165	98th	152	46th

Table 6. Recommended CLS course sequence for West Point Life Science majors

Sophmore		Junior		Senior	
Fall	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**
CH375 Advanced Biology	CH388 Genetics	CH385 Cell Biology	CH387 Human Physiology	CH457 Microbiology	CH479 Biotechnology (Capstone)
CH383 Organic Chemistry I	CH384 Organic Chemistry II	N/A	CH473 Biochemistry	N/A	N/A

- Educational Testing Services (ETS) Major Field Test (MFT) in Biology, taken by all Life Science majors during their spring of senior year.

The Biology MFT is the best holistic assessment of the program, since all Life Science majors take this exam just prior to the conclusion of their 47-month West Point experience. The Biology MFT provides a broad-based assessment of the academic program as well as a benchmark against a national standard, either on a student or institutional level. From 2018-21, 24,092 seniors at 403 U.S. institutions took the Biology MFT. West Point's Life Science majors averaged a total score Biology MFT in the 93rd percentile, compared to the 48th percentile national average (Figure 2). Thus, USMA Life Science cadets outperform the Biology MFT national average by >45 percentile points (162 v. 152 raw score). Furthermore, USMA cadets consistently scored significantly higher than the average in all categories: Cell Biology, Molecular Biology/Genetics, Organismal Biology, and Population Biology/Evolution/Ecology.

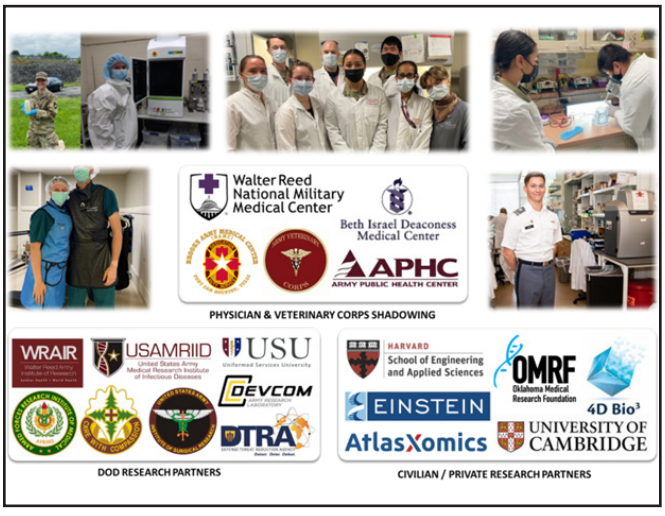
CLS LEADS THE WEST POINT PREMEDICAL SOCIETY (WPPMS)

In addition to academically supporting premeds through the Life Science major, a Microbiologist, Biochemist, or Veterinarian in CLS serves as the Officer-in-Charge of the West Point Premedical Society (WPPMS). The WPPMS supports the AMEDD mission, to "provide ready and sustained health services support and force health protection in support of the Total Force to enable readiness and to conserve the fighting strength while caring for our People and their Families,"[13] by creating opportunities for prospective cadets with a passion for pursuing a career in military medicine. The club strives to inform and advise members on such opportunities afforded to them in pursuit of preserving the fighting strength. In addition, the club exposes cadets to research, clinical, and community service practices to develop a medical professional that embodies Duty, Honor, and Country.

Cadet leadership of WPPMS is a hallmark of the premedical experience, in keeping with USMA's status as the world's premiere leadership institute. WPPMS provides leadership opportunities for cadets who are dedicated to the medical profession. Cadet leadership roles include President, Vice President, Secretary/Shadowing Coordinator, Public Affairs Officer, Treasurer/Concessions, and Volunteer Coordinator. Cadets who serve in these leadership roles, typically during their junior year, routinely earn numerous academic awards and matriculate at top-tier medical schools.

The cadets who lead WPPMS plan and execute many activities for its members during the academic year, focused on volunteering (selfless service), physician shadowing, evening seminars, book club, basic medical training events, fundraisers through USMA athletics concession sales, and trips to medical schools. In one annual event, Army 68K medics provide hands-on basic medical school training to club members, including basic suture skills labs, cardiopulmonary resuscitation techniques, and basic life support training. Other major club events include an annual Medical School Celebration to honor cadets who attend medical school

Figure 3. Representative summer research and physician shadowing internships offered by the Life Science program within the Department of Chemistry & Life Science



immediately following graduation, and a Medical Scholars Retreat for cadets who apply to West Point's internal medical school selection board. The cadet Volunteer Coordinator plans and executes monthly trips to the Food Bank of the Hudson Valley. Typically, 12 cadets are authorized to volunteer during each session, accruing hours towards selfless service, which is a key component of medical school applications. The cadet Secretary/Shadowing Coordinator works with KACH to schedule physician shadowing excursions for club members. Currently, shadowing during the academic year occurs bimonthly in all major KACH Departments. In 2022, the Veterinary Treatment Facility (VTF) on West Point also volunteered to provide VC Officer shadowing opportunities to club members who may also be interested in pursuing a future career in veterinary medicine. Finally, the cadet President of WPPMS coordinates recurring evening seminars, bringing in various speakers from across Army Medicine. These guest speakers share their respective professional journeys and are a great resource for club scholars as they forge their own paths to medical school.

The WPPMS cadet President works with the OIC to plan and execute an annual trip section, giving club members the opportunity to travel outside West Point. In 2022, WPPMS brought cadets to the National Capital Region, where they visited three medical schools, the Uniformed Services University School of Medicine, Georgetown University School of Medicine, and George Washington Medical School, and met with medical students who will enter the Army upon graduation. Through such trips, aspiring future physicians from West Point directly compared their options of attending the DoD's military medical school or a civilian medical school. Cadets also met with active-duty physicians with various specialty certifications from Walter Reed National Military Medical Center (WRNMMC) and learned more about their respective career paths.

CLS ACADEMIC INDIVIDUAL ADVANCED DEVELOPMENT PROGRAM

In addition to its oversight of WPPMS, CLS coordinates and offers summer physician shadowing and research opportunities to further enhance the undergraduate premedical experience. Funded largely by DEVCOM, DTRA, and West Point's Association of Graduates, the Department sends approximately 50 cadets each summer to various Academic Individual Advanced Development (AIAD) internships that are managed and offered respectively by the Chemistry, Chemical Engineering, and Life Science programs. CLS summer internships with DoD and civilian partners fall into two broad categories: medical shadowing and research (Figure 3).

Medical shadowing AIADs, which are predominately physician shadowing but may also include veterinarian shadowing, are key developmental opportunities for cadets to interface with Military Medicine and various clinical disciplines. These programs also enable premedical cadets to log as many as 120 hours of shadowing time, which are critical for their medical school applications. Physician shadowing AIAD opportunities are the largest block of Life Science offerings, with ~20-25 cadets participating each summer. In addition to previous opportunities at Landstuhl Army Regional Medical Center and Madigan Army Medical Center, physician shadowing AIADs annually occur at WRNMMC and Brooke Army Medical Center (BAMC), where cadets shadow in numerous medical departments, such as general and orthopedic surgery, neurology, pediatrics, endocrinology, and emergency medicine.

Often, cadets shadow physicians at local Army clinics and civilian hospitals when participating in research AIADs, which provide cadets with dedicated time to hone their ability to ask critical questions, analyze data, and conduct experimentation through research. Like physician shadowing, research experiences are also crucial aspects of medical school applications. Furthermore, research AIADs closely align with West Point's Academic Year 2024 theme of the exploration of innovation and technology and how it shapes warfare and the national defense strategy. The Disease Biophysics group at Harvard University hosts 3-4 cadets as part of an interdisciplinary research study with CLS majors, most of whom are premedical students, in the Department's Multifunctional Materials Laboratory. Cadets also conduct research in DoD laboratories, such as USAMRIID, WRAIR, and ARL (see Figure 3), which provides them with unique real-world experiences of working alongside DoD scientists to address DoD problems. Although many cadets participating in research AIADs choose careers outside medicine, they nonetheless develop their ability to work in complex environments and adapt rapidly to an increasingly technological battlespace. Thus, the Department's research internships align with the Army Modernization Strategy and the Secretary of the Army's 2nd objective, "to ensure the Army becomes more data-centric and can conduct operations in contested environments, which will enable our ability to prevail on the future battlefield."[19]

Nearly all members of the West Point Classes of 2018 through 2023 who attended medical schools and/or become Army physicians participated in shadowing or research AIADs coordinated through CLS. Crucially, many of the research AIADs provided by CLS are also tied to ongoing research within the Department, wherein cadets expand on the depth and breadth of their undergraduate research experience.

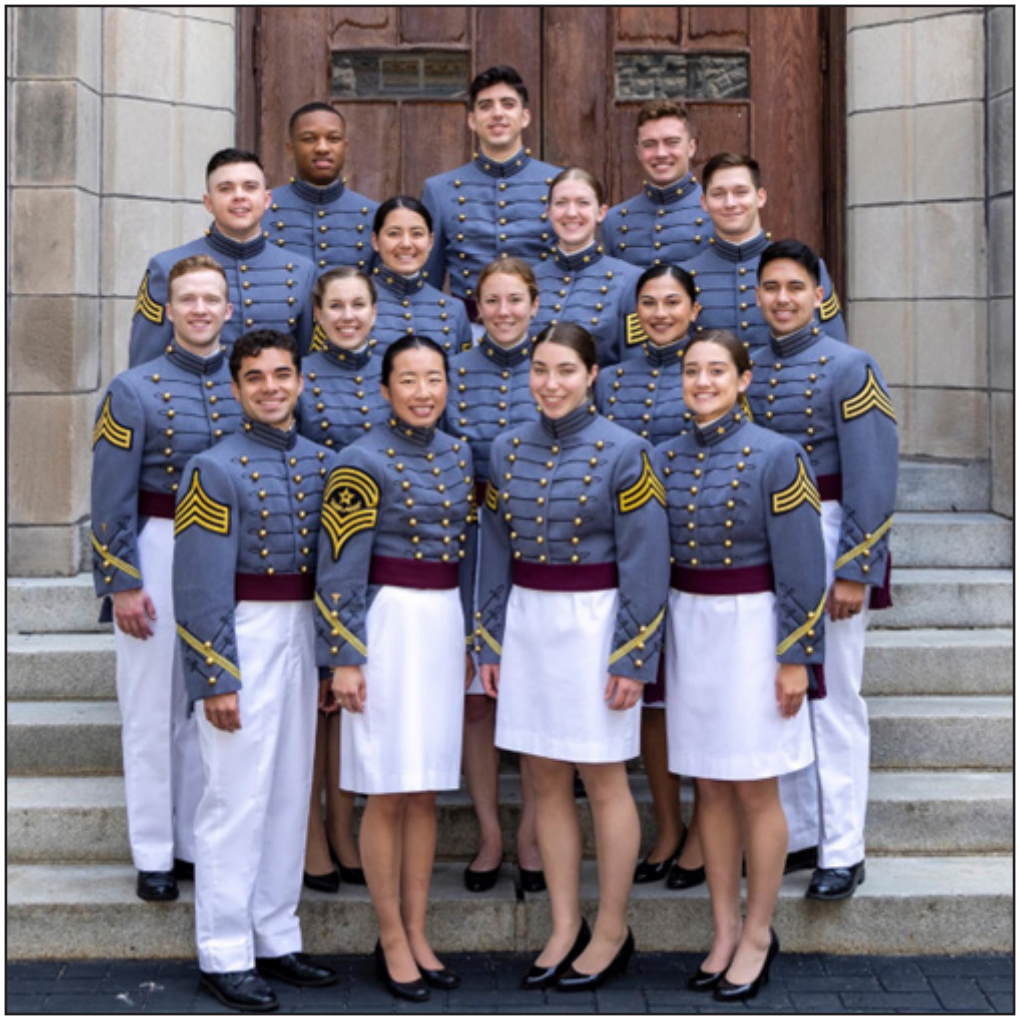
CLS TEACHES THROUGH RESEARCH

In addition to providing required courses, leadership, mentorship, and internship, CLS leads West Point in providing year-round research opportunities for its students to successfully begin their journeys towards careers in

medicine. "Teaching through research" explains undergraduate research as a critical component of USMA's leader development model and its core mission "to educate, train, and inspire". Recognizing the value and benefits of an undergraduate research experience (URE) is not unique to West Point; peer-reviewed educational research consistently affirms the numerous benefits of an URE. As a brief summary of broad research studies, college graduates who participate in UREs report higher self-evaluation of their skills in communication, research, critical thinking, and leadership.[20–22] Additionally, completing an URE increases student interest in research and likelihood to complete a STEM Ph.D. or other graduate program.[23–25] Furthermore, students who publish as undergraduates are more likely to publish a greater number of articles, and in higher impact journals after graduation.[26] Life science students who continue in an URE typically report positive experiences and enjoy both the culture and everyday tasks of research laboratories.[27] Finally, formally designed and funded summer UREs significantly increase the outcomes of Ph.D. completion, publication output, and encouragement of underrepresented groups to choose careers in STEM.[28]

These same outcomes have been strikingly evident in the past few years since CLS formally implemented a research course sequence, which is taken by nearly all premedical students. Cadets can enroll in 200, 300, and 400-level research courses at 1, 2, and 3 credit hours, respectively. As early as freshman fall semester, cadets meet with CLS faculty members and upper-class research students to discuss potential topics of

Figure 4. USMA Class of 2023 recipients of medical school scholarships. Each graduate majored within the CLS Department. Top row: Gerald Moore, Honors, 11 research credit hours, Morehouse; Dalton Ennis, 9.5 research credit hours, St. Louis University; William Rankin, Honors, 13 research credit hours, Mayo Clinic Arizona. Second row: Riley McHale, 8.5 research credit hours, Michigan State COM; Malina Hatton, Honors, 15.5 research credit hours, Harvard; Erika Rapp, Honors, 11.5 research credit hours, Michigan State CHM; Liam Sasser, Honors, 11.5 research credit hours, Cornell. Third row: Alex Burgess, Honors, 11 research credit hours, Stanford; Aidan Wright, Honors, 14 research credit hours, Dartmouth; Alicyn Grete, Honors, 10.5 research credit hours, USUHS; Sophia Mckenzie, Honors, 11 research credit hours, USUHS; Dagan Herring, 3.5 research credit hours, USUHS. Fourth row: Anthony Amaru, Honors, 11.5 research credit hours, Georgetown; Victoria Lam, Honors, 9.5 research credit hours, North Carolina; Abigail Graham, Honors, 9.5 research credit hours, Columbia; Taylor Miller, Honors, 11.5 research credit hours, Dartmouth



interest. During freshman spring semester, cadets enroll in a 200-level research course, which requires cadets to conduct at least 2.5 hours of research per week throughout the semester. During this time, students are typically trained by upper-class cadets enrolled in 300-level (≥five research hours per week) and 400-level (≥7.5 research hours per week) research courses. Chemistry and Life Science majors who complete two semesters of 400-level research may graduate with honors, depending on their grade point average. Most cadets who begin as freshmen continue research with the same mentor and team until they graduate, enabling a multi-year URE that results in learning, communication, advanced STEM training, and leadership outcomes consistent with the literature. The Department's research partnerships and collaborations dovetail with three-to-four-week research AIADs, wherein cadets apply their skills in a DoD-affiliated or university collaborator's laboratory during the summer.

West Point's multi-year URE leverages a leadership development model to develop future Army officers as leaders in medicine or science and technology. Within CLS, established principal investigator's (PI) laboratories are largely run by upper-class cadets, with each PI mentoring and leading the upper-class students with the support of postdoctoral researchers and staff scientists. Summarily, upper-class cadets lead, train, and mentor under-class students. This model for undergraduate research provides several advantages: faculty time is conserved, upper-class cadets develop vital leadership experience in a technical environment, and under-class cadets are optimally positioned to assume leadership roles, thereby creating a sustainable model. Additionally, multi-year research projects engage and develop cadets' scientific foundations, critical thinking, and problem-solving skills far beyond the capacity of other 3.5-hour academic courses. Thus, teaching through research is a large component of the CLS mission and its vital contributions to the Army of 2030 and beyond.

Cadets who complete multi-year research experiences in CLS are afforded significant opportunities for academic competitions, conference presentations, and peer-reviewed publications. Unsurprisingly, these myriad accomplishments routinely enable CLS majors to win highly competitive graduate scholarships, which include attendance at medical schools, further developing high-quality officers and validating USMA as a top-tier undergraduate institution (see Table 3 and Table 7). The consistency with which CLS cadets win these scholarships is in part due to the Department's URE model. Cadets share their results and conclusions as speakers and poster presenters at national conferences and co-author peer-reviewed publications. Between 2018-2022, approximately 30% of publications by staff and faculty in CLS featured cadets as co-authors (Table 8). Thus, the Department's teaching through research model directly supports Army medicine through inspiring premedical cadets to pursue careers in medicine, facilitating their competitiveness for top-tier medical school admittance. See Figure 4 for a summary of the Class of 2023 medical school attendees.

Both medical and non-medical research within CLS broadly enhance problem skills and strengthen medical school applications. By design, departmental research is often multidisciplinary or interdisciplinary due to the innate overlap of chemical and biological sciences with engineering. Research within CLS generally supports the Army in one of four areas: Materials, Protection, Energy, and Leadership, with efforts frequently bridging these areas (Figure 5). As an example of non-medical research, a collaboration on metal organic frameworks features two different research groups in CLS and one with the DEVCOM CBC. This research focuses on developing new materials for the purpose of chemical warfare agent degradation or a hasty gas mask. Additionally, CLS has long-term partnerships with DEVCOM Army Research Laboratories and DEVCOM Armaments Center for evaluating energy systems modeling, energy storage, and batteries. This research has gained partnerships with both the Sustainable Infrastructure, Resilience, and Climate Consortium and Special Operations Command (SOCOM), spanning both Energy and Protection. As an example of medical research, CLS has collaborated with USU's 4D Bio^3 Laboratory on developing new biomaterials for military medical applications and protection. The Department also works closely with DTRA on microbiological research, exploring detection and therapeutic options against Bacillus

Table 7. Cadet nationally competitive undergraduate and graduate scholarship winners with CLS affiliation, 2019 – 2023

	2019	2020	2021	2022	2023
Medical school attendance	19	20	15	15	16
Rhodes scholar	0	0	0	1	0
Undergraduate scholarships	2	3	9	7	6
Graduate scholarships	5	6	3	9	4

Undergraduate – Stamps, Goldwater, Truman

Graduate – National Science Foundation, GEM fellowship, Rotary, Lincoln Labs, Draper, Fulbright, Southampton, Purdue Military Research Institute

Table 8. CLS peer-reviewed publications, 2018 – 2022

	2018	2019	2020	2021	2022	Total
Total Publications	25	40	51	53	37	206
w/Cadet Co-Authors	6	9	14	19	13	61
%Cadet Co-Authors	24.0%	22.5%	27.5%	35.8%	35.1%	29.6%

anthracis and multidrug resistant organisms. Finally, CLS cadets and faculty study biomarkers related to ACL injuries as part of a clinical study with KACH and other stakeholders.

CLS AND THE FUTURE OF ARMY MEDICINE

In conclusion, the Department of Chemistry and Life Science at West Point contributes to Army medicine on multiple time scales through scientific and leader development. In the near term, graduates immediately serve in the Medical Service Corps; in the mid-term, graduates completing their medical training serve as Army physicians and AMEDD officers return to the force from West Point faculty assignments; in the long term, both graduates and faculty alum contribute as AMEDD senior leaders. This pipeline of talent results from the synergy between academic courses, laboratory research, summer internships, club activities, and the Premedical Scholarship Program, all preparing cadets and faculty to solve the Army's most demanding medical challenges. Teaching through research serves as the integrating activity that holistically leverages these synergistic activities to provide a competitive edge, not only for medical school admission, but for a career of AMEDD service. With the continued evolution of military medical care and geo-political threat landscape driving operations, West Point provides a unique and critical role in supporting Army medicine no matter what the future may bring.

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