



BOARD OF ADMISSIONS AND RELATIONS WITH SCHOOLS (BOARS)

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Assembly of the Academic Senate

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July 17, 2017

JAMES A. CHALFANT
CHAIR, ACADEMIC COUNCIL

Re: Proposed Revisions to Senate Regulation 424.A.3 (Area D)

Dear Jim:

In January 2017, the Board of Admissions and Relations with Schools (BOARS) charged a faculty working group with proposing revisions to the area “d” (laboratory science) requirement, to align UC’s subject area expectations more closely with the new expectations for high school science curricula based on California’s adoption of the Next Generation Science Standards (NGSS) for K-12, which include four science categories: Physical Sciences, Life Sciences, Earth and Space Sciences, and Engineering, Technology and Applications of Science.

The University Committee on Committees populated the working group with UC faculty from all ten campuses who represent a broad range of science and science education disciplines. (The full working group roster is attached.) The working group met four times in spring 2017 and ultimately recommended revisions to Senate Regulation 424.A.3 that require approval by the greater UC Academic Senate. At its July 7, 2017 meeting, BOARS unanimously approved the proposed revisions and requests a systemwide Senate review. A full explanation of and justification for the proposed changes is attached.

The key revisions to Senate Regulation 424.A.3 include:

- 1) Increasing the minimum area “d” requirement from 2 units (3 recommended) to 3 units, while continuing to require 2 units of coursework that “provide basic knowledge in at least two of the fundamental disciplines of biology, chemistry, and physics.” One unit is equivalent to a year-long course.
- 2) Changing the name of the area “d” subject requirement from Laboratory Science to Science.

Expanding the Science Requirement to Align with the NGSS Course Models

The Next Generation Science Standards (NGSS) reframe high school science curriculum into four core categories — Physical Sciences, Life Sciences, Earth and Space Sciences, and Engineering, Technology and Applications of Science. The California implementation of the NGSS provides high schools with three possible course models. Many schools may choose the integrated three-course model, which incorporates Earth and Space Science into each of three years of Biology, Chemistry, and Physics. Alternatively, the NGSS four-course model is a single-discipline model that adds a year of Earth and

Space Science on top of three years of Biology, Chemistry, and Physics. Finally, the three-course “Every Science, Every Year” model allows for full integration across the core disciplines (Biology, Chemistry, and Physics).

Based on a recommendation from the work group, BOARS is proposing a revision to Senate Regulation 424.A.3 to increase the minimum area “d” requirement from 2 units (3 recommended) to 3 units. The policy will continue to require 2 units of coursework that “provide basic knowledge in at least two of the fundamental disciplines of biology, chemistry, and physics.” The changes will align UC’s expectation with the NGSS and expand UC’s science expectation to a third year in a way that could help better prepare students for a variety of college and career pathways.

The work group discussed a proposal to include language “recommending 4 units,” but was concerned that UC recommendations are often interpreted by students, high school counselors, and school districts as *de facto* requirements that could reduce students’ flexibility to explore other disciplines and disadvantage students in under-resourced schools, although currently 95% of UC applicants already take more than the two required years of area “d” science.

Expanding Science Course Options

BOARS also approved the work group’s recommendation to broaden options for science disciplines that can fulfill the third year area “d” requirement, so that in lieu of taking a third course from among the three core disciplines (biology, chemistry, physics) listed in the regulation, students could select a third course from other disciplines reflected in the NGSS, including earth and space sciences, interdisciplinary sciences, computer science, engineering, and applied sciences. The A-G Guide (<http://www.ucop.edu/agguide/a-g-requirements/d-lab-science/index.html>) will include specific examples of courses that could fulfill the requirements not explicitly mentioned in the Senate regulations. The changes will align the requirement with NGSS language that defines student performance expectations not only around laboratory science practices but also around scientific and engineering practices that emphasize critical thinking and the acquisition of skills.

The work group reviewed examples of how high schools might implement each of the three possible NGSS-aligned course models approved by California (detailed in the attached chart), and how their mode of implementation could affect how students fulfill a new three-year area “d” requirement. High schools are expected to concentrate on implementing the NGSS to meet state accountability standards, so at least at first, most high school students are likely to follow their school’s chosen course model in year one, two, and three, leaving students to pursue a course outside of the three- or four-course model in year four of high school, if at all. A three-year area “d” requirement would not prevent a school from implementing a four-course model, but it may make it less likely that students will select the third science course from outside the three core disciplines.

To be clear, BOARS does not support adding any other discipline to the Senate regulation as an additional core science discipline alongside biology, chemistry, and physics, believing that the two years of core area “d” science continue to provide the strongest possible foundation. However, BOARS also believes that additional science courses will also help prepare students for college-level work, and additional flexibility around the third science course will make the third year as broadly inclusive of other disciplines as possible, while ensuring that such courses meet UC faculty’s criteria of a science course that can fulfill the area “d” requirement.

To this end, BOARS supports maintaining the requirement that area “d” courses include a laboratory component. In other words, **all area “d” approved courses must include authentic investigations consistent with the practices of the scientific field.**

Importantly, any area “d” course, including options for the third year of science, will be required to meet the nine specific UC faculty-approved course criteria and eight NGSS science and engineering practices articulated in the A-G Guide (<http://www.ucop.edu/agguide/a-g-requirements/d-lab-science/index.html>). Those criteria expand on the basic language in the Senate regulation to provide specific guidance to schools about acceptable disciplines and course content. High schools and districts refer to them when developing a course for possible area “d” approval, and UCOP analysts consult the criteria when reviewing course submissions. In other words, UCOP does not judge a course by its title, but by applying the criteria established by the faculty. It would be up to high schools to provide evidence that their proposed area “d” course aligns with UC’s criteria.

Moreover, BOARS understands that the definition of “laboratory” has evolved such that computer science and engineering curriculum can be framed in the context of current area “d” criteria that are based in experimentation and the scientific method. So for example, specific computer science and engineering courses that incorporate NGSS concepts and performance expectations could be considered and approved for area “d.” UCOP currently accepts courses based on an integrated science curriculum and approves them for area “d” if they meet the faculty’s current course criteria. UCOP would expect the high school curriculum designer to indicate whether they are following an integrated science model or a single-discipline model.

Name of Area D Requirement

BOARS endorsed the work group’s recommendation to change the name of UC’s area “d” subject requirement from “Laboratory Science” to “Science.” BOARS based this in part on a recommendation from Stanford Professor Emeritus Helen Quinn, who chairs the California Science Curriculum Framework Committee for K-12, who noted that the term “laboratory” is outdated in the context of the NGSS and should be broadened to better reflect the four core NGSS categories — Physical Sciences, Life Sciences, Earth and Space Sciences, and Engineering, Technology and Applications of Science. The more general title of “Science” covers a broader range of NGSS-aligned science fields rather than only traditional laboratory bench science, and provides greater clarity to course designers and UCOP analysts seeking to certify that a given course meets the area “d” criteria.

However, there was some difference of opinion on BOARS about the proposed title for area “d.” Some members preferred “Science and Engineering” instead of “Science.” BOARS took a separate vote on this specific question and the recommendation for the title “Science” passed by a narrow margin.

BOARS believes these revisions will go a long way to connect the University’s academic preparation expectations much more closely with the curriculum reform efforts of California high schools given the new direction K-12 science curriculum is taking under the NGSS. We look forward to reviewing the results of the systemwide review.

Sincerely,



Henry Sánchez
BOARS Chair

Encl:

cc: BOARS

Proposed Revisions to Senate Regulation 424.A.3 (Area D)
Board of Admissions and Relations with Schools (BOARS)
July 2017

Proposed Area D Policy Revisions

UC Senate Regulation 424.A.3

<http://senate.universityofcalifornia.edu/bylaws-regulations/regulations/rpart2.html#r424>

424. Candidates applying for freshman admission on the basis of a transcript of record from a secondary school in California must satisfy the course work requirements specified in this regulation. (Am 2 Jun 77; Am 26 May 82; Am 3 May 90; Am 24 May 00) (Am 17 June 2009)

A. Course Requirements

1. Unit Requirements

For the purpose of this Regulation, a unit consists of a year-long college preparatory course approved by the University at the applicant's high school, in one of the following subject areas: History/Social Science, English, Mathematics, ~~Laboratory~~ Science, Language Other Than English, Visual and Performing Arts, and College-Preparatory Electives. A minimum of 15 units must be completed in grades 9-12 as specified in paragraph C of this Regulation. However, courses in Mathematics and Language other than English taken in grades 7 and 8 may be included in the required 15 units if the courses are accepted by the applicant's high school as equivalent to high school courses that meet the a-g requirements of SR.424.A.3. At least 7 of the 15 required units must be completed during the applicant's last two years in high school. A minimum of 11 units must be completed before the end of grade 11. (Rev 4 May 1995) (Am 17 June 2009) (Am June 2013)

2. Exception to the Unit Requirements

Notwithstanding Paragraph A.1 of this Regulation, a campus may elect to admit an applicant who does not present the required minimum 15 units prior to high school graduation, provided that the applicant has completed 11 units before the end of the grade 11, including those specified in Paragraph A.3 of this Regulation. Campuses should exercise this option sparingly, and only when an applicant presents a strong overall record of academic achievement that is at least comparable to the records of other applicants admitted to the campus. (Am 17 June 2009) (Am June 2013)

3. Specific Subject Requirements

The following subject requirements must be satisfied through the completion of approved courses of study as provided in Bylaw 145.B.5.

- a. History/Social Science, 2 units. One unit of world history, cultures, and historical geography; and, one unit of US History or one-half unit of US

History and one-half unit of Civics or American government. (Am 17 June 2009)

- b. English, 4 units. College-preparatory English composition and literature. (Rev 4 May 1995) (Am 17 June 2009)
- c. Mathematics, 3 units. Four are recommended. Must include the topics covered in elementary and advanced algebra and two- and three-dimensional geometry. (Am 17 June 2009)
- d. ~~Laboratory s~~Science, ~~2~~ 3 units. ~~Three are recommended.~~ Must provide basic knowledge in at least two of the fundamental disciplines of biology, chemistry, and physics. (Am 17 June 2009)
- e. Language other than English, 2 units. Three are recommended. Both units must be in the same language. (Am 17 June 2009)
- f. Visual and performing arts, 1 unit. Must be a single, year-long course in dance, drama/theater, music, or visual art. (Am 17 June 2009)
- g. College preparatory elective, 1 unit. Additional approved a-f courses beyond the minimum required, or courses that have been approved specifically in the 'g' subject area (Am 17 June 2009)

Proposed Revisions to Area D Goals and Course Criteria & Guidance

<http://ucop.edu/aguide/a-g-requirements/d-lab-science/index.html>

Laboratory Science ("d")

~~Two-Three~~ **units** (equivalent to ~~two three~~ years or ~~four six~~ semesters) of ~~laboratory~~ science are required (~~three units are strongly recommended~~), providing ~~fundamental basic~~ knowledge in at least two of the following ~~fundamental~~ disciplines of biology, chemistry, and physics:

- ~~• Biology~~
- ~~• Chemistry~~
- ~~• Physics~~

~~A~~ Yearlong courses in a core discipline (biology, chemistry, or physics) or integrated science can meet the first two years of this requirement, as long as the course meets the goals and criteria of area "d." The third year of the requirement can be met with a yearlong course in any one of the following: interdisciplinary, or integrated, or earth and space science course can meet one year of this requirement.

- Core discipline (biology, chemistry, or physics)
- Integrated science
- Interdisciplinary science
- Earth and space sciences
- Computer science
- Engineering
- Applied sciences
- Honors science (including Advanced Placement or International Baccalaureate courses)

Goals of the requirement **[Revisions appear in red below]**

The overarching goal of the subject requirement in **laboratory** science is to ensure that entering college freshmen are adequately prepared to undertake university-level study in any scientific or science-related discipline. The term “**laboratory** science” is intended to signify an empirical basis of the subject matter, as well as inclusion of a substantial experimental and/or observational activity in the course design. The requirement emphasizes biology/life sciences, chemistry and physics/**physical sciences** because these subjects are preparatory to university-level study in all science-based disciplines. However, coverage of these foundational subjects in suitable breadth and depth can potentially be found in a wide range of science courses, including those with an **integrated/**interdisciplinary, engineering, **computer science**, or a career technical education focus, provided the courses conform to the criteria described in the Course Criteria & Guidance section below.

All courses approved in the **laboratory** science subject area should be designed with the explicit intention of developing and encouraging scientific habits of mind important for university-level studies, and aligned with the eight practices of science and engineering identified by the National Research Council Framework and detailed within the [Next Generation Science Standards](#):

1. **Asking questions (for science) and defining problems (for engineering).** Students should develop a perception of science or engineering as a way of understanding the world around them, not as a collection of theories and definitions to be memorized.
2. **Developing and using models.** Students should understand that scientific models are useful to represent phenomena in the physical world, and should routinely develop or use multiple representations and models to solve scientific problems and to communicate science concepts. They should appreciate that models and theories are valuable only when rigorously tested against observation.
3. **Planning and carrying out investigations.** Students should emerge from high school embracing an ease in using their scientific knowledge to perceive patterns and regularity, make predictions, and test those predictions against evidence and reason.
4. **Analyzing and interpreting data.** This includes developing and maintaining openness to using technological tools appropriately, including graphing calculators and computers, in gathering and analyzing data. Students should be aware of the limitations of these tools, and should be capable of effectively using them while making sound judgments about when such tools are and are not useful.
5. **Using mathematics and computational thinking.** In particular, students should recognize that measurements and observations are subject to variability and error, and that these must be accounted for in a quantitative way when assessing the relationship between observation and theory.
6. **Constructing explanations (for science) and designing solutions (for engineering).** Students should recognize that abstraction and generalization are important sources of the power of science.
7. **Engaging in argument from evidence.** Students should understand that assertions require justification based on evidence and logic, and should develop an ability to supply appropriate justifications for their assertions. They should habitually ask “Why?” and “How do I know?”
8. **Obtaining, evaluating, and communicating information.** Student should be able to read a variety of domain-specific scientific and technical texts and to write using the language conventions of scientific discourse, including but not limited to laboratory reports. Useful guidelines for promoting scientific literacy can be found in the [Common Core State Standards for Literacy in History/Social Studies, Science and Technical Subjects](#) [PDF].

Course criteria & guidance **[Revisions appear in red below]**

Regardless of the scientific subject, all courses approved for the “d” subject area are expected to satisfy these criteria:

1. Courses will be consistent with and illustrate the goals described above. Courses that integrate these eight practices of science and engineering with course content will be taking a substantial step toward achieving these goals.
2. Courses will provide rigorous, in-depth treatments of the conceptual foundations of the scientific subject studied. ~~based on the appropriate underlying biological, chemical and physical principles.~~
3. Courses will afford students opportunities to participate in all phases of the scientific process, including formulation of well-posed scientific questions and hypotheses, design of experiments and/or data collection strategies, analysis of data, and drawing of conclusions. They will also require students to discuss scientific ideas with other students and teachers, differentiate observations from interpretations, engage in critical thinking and write clearly and coherently on scientific topics.
4. Courses will specify, at a minimum, elementary algebra or its equivalent as a required prerequisite or co-requisite, and will employ quantitative reasoning and methods wherever appropriate.
5. All courses will include teacher-supervised, hands-on laboratory activities that are directly related to, and support, the other class work, and that involve inquiry, observation, analysis and write-up of authentic investigations consistent with the practices of the scientific field. Teacher supervision may be synchronous or asynchronous, depending on whether the learning environment is classroom-based, fully online, or a hybrid. These hands-on inquiry-based activities will constitute a significant portion of the instruction and account for at least 20 percent of class time. It is recommended that at least one scientific investigation conducted in the field or laboratory per unit/year be a student-designed project involving a tested hypothesis (project must be approved and supervised by the instructor). Hands-on laboratory activities must explicitly address safe and ethical practices with respect to experimenters, society and the environment.
6. Courses will be explicit about the formative and summative assessment practices that will be used throughout to assess student development of deep content understanding as well as mastery of scientific practices and skills. Courses will include a variety of assessments to ensure the teacher is able to determine that the course learning objectives have been met, as well as challenge students to defend their ideas and conclusions and demonstrate higher-order thinking skills. These measures could include, but are not limited to, multiple choice, short answer, laboratory reports, essay, projects, poster presentations and videos.
7. Courses will include culturally relevant topics and activities, real-world problems and applications that are appropriate for the context of the school community and the course content. The activities should be aimed at engaging all students in science learning and understanding the role of science in their lives.
8. Courses will include the use of technology to increase access and computer-based skills for students. This could include visualization programs that provide scientific animations and 3-dimensional modeling; data collection and analysis tools; graphing calculators and other tools for mathematical representations; a variety of digital tools for encouraging multiple verbal and visual representations of scientific phenomena; and computer coding exercises. Courses that give students the opportunities to experience learning in evidence-based, non-traditional ways such as a flipped classroom are encouraged.

9. The content for biology/life sciences, chemistry and physics/[physical sciences](#) courses in grades 9 through 12 will generally be drawn from [the Science Content Standards for California Public Schools \[PDF\]](#), the [Next Generation Science Standards](#) and the [Common Core State Standards for Literacy in History/Social Studies, Science and Technical Subjects](#) [PDF]. For success in college, secondary science teachers should help students learn to assimilate the major ideas and principles that encompass the standards rather than explore the breadth of all the standards. Equally important to the topics covered, or to the skills directly used in class, are the more general abilities and attitudes gained through the effort of mastering the course content. These general abilities and attitudes are outlined in the goals section above.

Options for Satisfying the New Science Requirement				
	3 Years of Science	CA NGSS 3-Course Model*	CA NGSS Every Science, Every Year Integrated Model*	CA NGSS 4-Course Model*
1 Year	Core discipline course OR Integrated science course	The Living Earth (integrating Biology and Earth Science)	Integrated Science 1	Life Science/Biology
1 Year	Core discipline course OR Integrated science course	Chemistry in the Earth System (integrating Chemistry and Earth Science)	Integrated Science 2	Chemistry
1 Year	Core discipline (biology, chemistry, or physics) OR Integrated science OR Interdisciplinary science OR Earth & space sciences OR Computer science OR Engineering OR Applied sciences OR Honors science (including Advanced Placement or International Baccalaureate courses)	Physics in the Universe (integrating Physics and Earth & Space Science)	Integrated Science 3	Physics
1 Year	Not applicable	Not applicable	Not applicable	Earth & Space Sciences
		<p>*Note: California has approved three high school course models that are aligned to the new Next Generation Science Standards (NGSS) for K-12. The courses in each model are not required to be taught in a specific sequence. The current listings in the shaded columns provide examples of how a particular course model might be implemented at a school site, which in turn, provide examples of how students might fulfill the new area “d” requirement for UC freshman admissions.</p>		

**Systemwide faculty work group to examine the UC's laboratory science ("d")
undergraduate admissions requirement**

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Area D Addendum: Q&A

1. *What are the Next Generation Science Standards, and who decided on these standards for California?*

In September 2013, the State Board of Education voted unanimously to adopt the [Next Generation Science Standards for California Public Schools](#), Kindergarten through Grade 12. California’s Next Generation Science Standards (CA NGSS) present a unique opportunity for the California Department of Education, K-12 schools/districts, and community stakeholders to reset science education to more effectively prepare students with the knowledge and skills they need to understand and shape our increasingly technology-driven world. The state’s implementation plan will update K-12 curriculum and equipment to match the latest scientific knowledge and technology. From incorporating science and engineering practices into instruction, to using project-based learning and other instructional strategies, the aim is to achieve dramatic and necessary transformations in how science is taught in every California public school to prepare students for college and future careers.

2. *What are the state’s expectations behind implementing new science curriculum aligned to CA NGSS?*

Despite California’s current minimum high school graduation requirement of two years of science, the K-12 science curriculum framework adopted by the State Board of Education in 2016 provides high schools with the options of implementing a [3-course model](#) or a [4-course model](#). Furthermore, the framework includes guidance on the accountability of schools, through their [assessments of student learning](#), to teach high school science across more than just two years. Because California’s high schools operate largely under local control, science course offerings and the sequence of those courses are district-level decisions. Many districts across the state align their local high school graduation requirements with the “a-g” requirements to position as many students as possible for success in college.

3. *What might be the resource impact on high schools to shift from two to three years of required science for area “d”?*

Based on recent data, 97% of the high schools (public and private) from which UC undergraduate applicants are graduating offer three or more area “d” courses. For public high schools in particular, California’s new [Local Control Funding Formula](#) (LCFF) provides baseline funding to all schools. Supplemental funding is granted to high schools with more than 75% of students who are English learners, eligible for a free or reduced-price meal, or identified as foster youth; these are known as “LCFF plus” (LCFF+) schools. The LCFF+ funding benefits will provide many previously under-resourced high schools with a possible means to offer multiple NGSS-aligned courses if they do not already. Also, the availability of nearly 2,000 UC-approved online area “d” courses may further support schools in their efforts to teach high-quality science classes.

4. *How might students be affected by the shift from two to three years of required science for area “d”?*

Recent data show that 95% of UC undergraduate applicants already take three or more area “d” courses (63% take four or more). Of the applicants who complete only two area “d” courses ($n = 5,032$), about 60% are underrepresented minorities, raising questions about potential differential access to area “d” course offerings. To address such concerns across a range of demographics – including race, ethnicity, gender, and socioeconomic status – the state’s science curriculum framework includes [specific guidance](#) to educators about critical actions that can ensure equity and access to science learning for all students. These include building and expanding technology resources and network infrastructures to increase access to online learning opportunities, online learning communities, virtual laboratories, and other digital resources.

5. How will the new policy affect student eligibility for UC or CSU admissions?

Given the statistics referenced above, a three-year science requirement will not dramatically affect UC admissions eligibility. The California Science Teachers Association has also found that 80 to 90 percent of California public school students take at least three science courses during high school. To determine the possible effects on the California State University system, BOARS has presented UC's proposal to relevant CSU Senate leaders and faculty for their feedback.

6. What is the rationale behind the name change for the new area "d" requirement?

Changing the name of the subject requirement from "Laboratory Science" to "Science" brings area "d" more directly in line with CA NGSS by using a broad umbrella term to cover the diverse range of science disciplines – from the core disciplines of biology, chemistry, and physics, to the more integrated or interdisciplinary sciences such as earth and space sciences, environmental sciences, and marine science. This alignment between area "d" and the new science standards also invites K-12 to develop or expand high school course offerings in engineering, computer science, technology, and applications of science.

7. UC currently does not allow earth and space sciences to fulfill the two years of area "d," so why would it be an option under the new Science requirement?

In the past, the state did not provide standards or a curriculum framework to shape the design of high school courses in earth and space sciences. With the transition to new science standards, high schools are guided by and held accountable to the higher teaching and student learning standards established by the CA NGSS.

Both of the [3-course models](#) specified in the new K-12 science curriculum framework are integrated models, with one integrating each of the core disciplines (biology, chemistry, physics) with earth and space sciences. The [4-course model](#) specifies earth and space sciences as one of the four distinct courses, along with the three core disciplines of biology, chemistry, and physics. See summary chart on page 3 for details.

8. If the new science requirement is approved, when will it go into effect?

If the proposed area "d" policy change is approved by the Assembly of the Academic Senate, UC Undergraduate Admissions will implement the policy effective with the UC freshman class entering UC in Fall 2023. The anticipated implementation schedule is as follows:

2018-19: Statewide communications campaign for K-12 awareness of UC's policy change for area "d"

2019-20: Incoming high school freshmen are held to completing three years of science in high school

2020-21: High school sophomore year

2021-22: High school junior year

2022-23: High school senior year

2023-24: Incoming UC freshmen have completed three required years of high school science aligned to CA NGSS