Changes to introductory Yale chemistry courses starting fall 2015

A new general chemistry curriculum is to be adopted in the fall semester of 2015 in response to changing student demographics, learning styles and programmatic needs. The current courses CHEM 112, CHEM 113, CHEM 114, CHEM 115 and CHEM 118 will be discontinued. Courses in the organic, inorganic and physical chemistry curriculum will remain unchanged, although a number of new courses will be added and some renumbered. Freshmen will continue to have a number of ways to accelerate.

New general chemistry courses

Introductory chemistry for most students will be offered in a pair of new sequences. All sequences fulfill medical school requirements for general chemistry, the general chemistry requirement in any Yale major, and as the prerequisite to organic chemistry. Students will be placed into all courses, and enrollment in any will be by departmental permission only. All courses will continue to be keyed.

CHEM 161 and CHEM 165 – General Chemistry I and II. An introductory university level course. This course is intended as a first university course in chemistry. Students taking this course may be taking chemistry for the first time, perhaps took chemistry as a high school sophomore, or may even have taken AP chemistry but not fully mastered the subject at that level. Students with more extensive chemistry preparation will be guided into CHEM 163 and CHEM 167 instead.

CHEM 163 and 167 – Comprehensive University Chemistry I and II. A more advanced general university chemistry course for students with previous exposure to chemistry and science in high school. Most students taking this course will have more recently completed a year or two of chemistry in high school, although motivated students may have last taken chemistry as a high school sophomore if they have a strong math and physics background.

These should be viewed as new sequences. Neither is a direct replacement for any of the previous offerings. The subject matter will be very similar to that covered in CHEM 112/113 and CHEM 114/115, although at different levels. The interleaving of the course numbers is intentional.

Acceleration options

Highly motivated and qualified students will be able to accelerate by placement directly into CHEM 167, earning 1 acceleration credit if completed in the freshman year. Students who perform well on the department placement exam will still be offered the option to enroll in organic chemistry, either as CHEM 174a/CHEM 175b Freshman Organic Chemistry (currently numbered as CHEM 124a/CHEM 125b) or CHEM 220a/CHEM221b. In addition a new freshman inorganic course will be offered, CHEM 185b. This course will also result in the award of an acceleration credit if completed in the freshman year. Students with superior math skills will continue to be offered admission to physical chemistry, CHEM 332/CHEM 333.

Course combination	Acceleration awarded for	Acceleration lost by later completing
CHEM 167	1 for equivalent of CHEM 163	Any course lower than CHEM 167
CHEM 167 + higher course	1 for equivalent of CHEM 163	Any course lower than CHEM 167
2 courses higher than CHEM 170	2 for equivalent of CHEM 163+167	Each course lower than CHEM 170

Freshman only courses

The freshman organic course will continue to be restricted to freshmen only, with the motivation to create special 1st year experiences for potential STEM majors. A new freshman inorganic course, CHEM 185b, will also be offered as a means of accelerating in the chemistry major and is intended to follow CHEM 167a.

Placement in general chemistry courses

Suggested initial placement into either CHEM 161 or CHEM 163, or acceleration into CHEM 167 will be made on the basis of admissions and math and science survey data. Students with 2 or more years of chemistry and evidence of mastery such as a 5 on the AP exam will not be permitted to enroll in CHEM 161/165. Those students will have the option of beginning in CHEM 163 or accelerating into CHEM 167, or taking the placement exam to earn admission to a higher level course.

New advanced chemistry laboratory course

Starting spring of 2016 a new chemistry laboratory course will be offered that may be of interest to advanced engineering or life science students, CHEM 335Lb Materials and Biophysical Chemistry Laboratory. This lab will cover physical methods and chemical synthesis in materials and biophysical chemistry. Examples of techniques students will be exposed to will include solution phase synthesis, solid state synthesis, UV-Vis, fluorescence, optical microscopy, SEM, STM, single molecule fluorescence, and optical trapping methods. If enrollment pressure is not too high the course will be open to accelerated freshmen who have completed CHEM 167a as well as students completing or concurrently enrolled in CHEM 333b.

Module 1: Preparation of graphene oxide nanosheets by chemical exfoliation of graphite. Chemical oxidation of graphite with $KMnO_4$ and H_2SO_4, exfoliation of oxidized graphite to prepare graphene oxide nanosheets, characterizations with optical microscope and UV-vis.

Module 2: Solution phase growth of Co_3O_4 nanocrystals on graphene sheets. Solution phase synthesis of Co_3O_4 nanoparticles on graphene oxide with subsequent characterization by SEM and STM.

Module 3: Solid-state synthesis of terbium doped lanthanum oxysulfide (La_2O_2S:Tb) fluorescent material. Co-precipitation of metal precursors, solid state synthesis, characterization of fluorescence properties of product.

Module 4: Microscopy and Image Resolution. This module will review geometric optics, Fourier transform relationships between image and aperture planes, and resolution as they pertain to microscopy. Students will build a microscope, characterize its resolution and image abberations, write software to process images, and learn about different image collection modalities.

Module 5: Optical Trapping. In this module, students will learn the principles behind the optical trapping methods that underlie single molecule force manipulation techniques. They will construct an optical trap and calibrate its force generation. The effects of laser wavelength, particle diameter, and medium viscosity on the trapping stiffness will be characterized. Finally, students will measure the compliance of bacterial flagella motors.

Module 6: Single Molecule Fluorescence. This module introduces students to single molecule fluorescence using semiconductor nanoparticles (quantum dots). Basic solid state theory and quantum models of semiconductor structure will be discussed. Students will characterize the electronic structure, photoluminescence, blinking behavior of quantum dots, and relaxation mechanisms of excited electronic states. Applications of quantum dots as specific and size-tunable fluorescence markers will be discussed.