General Education Course Information Sheet

Please submit this sheet for each proposed course

Department & Course Number	Life Sciences Core Curriculum/ LS 7A
Course Title	Cell and Molecular Biology
Indicate if Seminar and/or Writing II course	Seminar

1 Check the recommended GE foundation area(s) and subgroups(s) for this course

Foundations of the Arts and Humanities	
• Literary and Cultural Analysis	
• Philosophic and Linguistic Analysis	
• Visual and Performance Arts Analysis and Practice	
Foundations of Society and Culture	
• Historical Analysis	
• Social Analysis	
Foundations of Scientific Inquiry	
• Physical Science	
With Laboratory or Demonstration Component must be 5 units (or more)	
• Life Science	X
With Laboratory or Demonstration Component must be 5 units (or more)	

2. **Briefly describe the rationale for assignment to foundation area(s) and subgroup(s) chosen**.
The course is designed to provide a strong background in the scientific process. The student-centered classroom will encourage students to both understand and apply the scientific process to hypotheses of their own creation, to choose appropriate techniques to evaluate their hypotheses, and to critically consider the validity of their hypotheses based on examples given throughout the course. In addition, students will learn how to evaluate different forms of data (discipline specific to cell and molecular biology), recognize limitations that may exist with methods generating the data, and then draw conclusions based on the data. Utilization of the scientific process will be woven throughout the course with general course content in cell and molecular biology.

3. "List faculty member(s) who will serve as instructor (give academic rank):
Debra Pires, Ph.D. is the confirmed instructor for the first offering (Fall 2016), however, additional faculty will also contribute, including the following.

Campbell, David, Professor……...Pires, Debra, Academic Administrator
Lin, Chentao, Professor ……..…..Pyle, April, Associate Professor
Pfluegl, Gaston, Academic Administrator ……...Smale, Steve, Professor
Pham, Hung, Lecturer ……..…Tamanoi, Fuyu, Professor

Do you intend to use graduate student instructors (TAs) in this course? Yes X No ____

If yes, please indicate the number of TAs 1-8

4. Indicate when do you anticipate teaching this course over the next three years:

2015-16	Fall		Winter		Spring	
	Enrollment		Enrollment		Enrollment	
2016-17	Fall	X	Winter		Spring	X
	Enrollment	48	Enrollment		Enrollment	48
2017-18	Fall	X	Winter	X	Spring	X
	Enrollment	720	Enrollment	720	Enrollment	720

5. GE Course Units

Is this an ***existing*** course that has been modified for inclusion in the new GE? Yes ___ No X

If yes, provide a brief explanation of what has changed. _____

Present Number of Units: _____ Proposed Number of Units: 5

6. Please present concise arguments for the GE principles applicable to this course.

❑ General Knowledge	Discussion of scientific concepts and technologies is pervasive in the world today, from newspapers and magazines, with numerous important political and medical decisions contingent upon such knowledge. This course will provide basic general knowledge in the fields of cell and molecular biology. General concepts of cell form and function, the central dogma, and regulatory pathways of cell physiology will be covered in the course. In addition, focus on how genes are expressed, regulated and duplicated in the context of scientific experiments will be covered with focus on how scientists approach learning about the molecular world which cannot be seen by eye (or microscope).
❑ Integrative Learning	Students will be exposed to classic experiments in the field to not only inspire fruitful discussion of the scientific process but also to show how modern studies use the same techniques to test new hypotheses. Moreover, modeling the classic experiments in class will provide students with examples to draw on when they are asked to conceive of their own testable hypotheses and how various techniques discussed in class can be used to test those hypotheses. Additionally, the course frequently draws on examples from other fields such as Medicine and Biotechnology to integrate with the foundations of Molecular and Cell Biology and demonstrating relevance to everyday life.
❑ Ethical Implications	Throughout LS7A, students explore issues with important and difficult ethical implications. While not a focus of the course, discussions of cancer, stem cells, and CRISPR system allows for discussions of the ethical considerations that are part of current considerations for research. These considerations will be discussed after students have read science news articles separate from their assigned textbook reading. During discussion sections there will be opportunity for groups to debate the topics and their arguments must be written up in a formal document and properly cited from literature searches.
❑ Cultural Diversity	An important component of our discussions relates to the evaluation of the amounts of within-population variation and between-population variation, which helps shed light on issues surrounding cultural and racial diversity, and the difficulty in categorizing individuals. Understanding the basis for genetic diversity provides the student with the background knowledge necessary to explore the nature vs nurture question. As classic and groundbreaking experiments are presented in this class, a number of researchers and their contributions are introduced to the class. Great care is taken in selecting a diverse set of scientists and to highlight the contributions of women and researchers from different ethnic backgrounds or countries of origin.

❑ Critical Thinking	Critical analysis is a critical component of LS7A. At the core of LS7A lies the process of hypothesis-testing and the analysis of experimental observations in order to draw conclusions (and estimate our confidence in such solutions). From the use of statistical analyses to the examination of data in light of competing explanations to the generation of experimental predictions about novel situations, students spend significant time learning and using critical thinking skills. Each class meeting there are 3-5 clicker questions that are based on the evaluation of data from various sources. After being provided general content related to the data, students are led through a series of clicker questions related to the data. Once that is completed, students then work in groups to make predictions and give rough representations of how the data would change with perturbations to the system.
❑ Rhetorical Effectiveness	Essay questions on the midterms and final exam in LS7A require students to analyze experimental results and to use their analyses to form persuasive arguments about the genetic mechanisms responsible for the observed patterns. Students are asked to share their reasoning process and scientifically argument with their classmates during clicker questions. This helps them develop critical skills in communicating their findings and scientific discourse. Furthermore, students are frequently asked to share their reasoning with the whole class. During discussion sections, students work in groups which are highly interactive and communicative. At the end of each activity, each group report their findings and reasoning to the class, further practicing the construction of scientific arguments, effective communication, and public speaking.
❑ Problem-solving	Throughout the course, and especially on exams, students are required to use problem-solving skills to interpret experimental data and come up with an appropriate model. The clicker questions and discussion section activities are largely focused on problem solving as it relates to the interpretation of experimental data. The questions also frequently ask students to predict outcomes of hypothetical scenarios, which forces students to integrate their knowledge, and apply it to effectively solving the problem.
❑ Library & Information Literacy	Throughout the course, students are required to utilize information from their textbook and from the internet (both primary source papers and digital information). There are both group and individual written assignments throughout the quarter that will require accurate citations from the scientific literature.

(A) STUDENT CONTACT PER WEEK (if not applicable write N/A)

1.	Lecture:	**3**	(hours)
2.	Discussion Section:	**1.5**	(hours)
3.	Labs:	**N/A**	(hours)
4.	Experiential (service learning, internships, other):	**N/A**	(hours)
5.	Field Trips:	**N/A**	(hours)

(A) TOTAL Student Contact Per Week **4.5** **(HOURS)**

(B) OUT-OF-CLASS HOURS PER WEEK (if not applicable write N/A)		
1. General Review & Preparation:	**3**	(hours)
2. Reading	**1.5**	(hours)
3. Group Projects:	**0.5**	(hours)
4. Preparation for Quizzes & Exams:	**4**	(hours)
5. Information Literacy Exercises:	**0.5**	(hours)
6. Written Assignments:	**1**	(hours)
7. Research Activity:	**N/A**	(hours)

(B) TOTAL Out-of-class time per week	**10.5**	**(HOURS)**
GRAND TOTAL (A) + (B) must equal at least 15 hours/week	15	**(HOURS)**

UCLA MEMORANDUM

FACULTY EXECUTIVE COMMITTEE
College of Letters and Science

A265 Murphy Hall
Box 951571
Los Angeles, California 90095

To: Frank Laski, Chair, Life Sciences Core

Fr: Joseph Bristow, Chair, College Faculty Executive Committee

Date: March 8, 2016

Re: **Life Sciences Core Proposal (dated March 1, 2016)**
Final approval terminates with the Undergraduate Council

On behalf of the College Faculty Executive Committee (FEC), we thank you for presenting your proposal at our meeting on March 4, 2016. I am pleased to inform you that the FEC unanimously approved the request to create a new 3-quarter series of courses called Life Sciences 7A, 7B, and 7C to replace the current Life Sciences 1-4 series (6 approve, 0 oppose, 0 abstain). The effective date of the FEC approval is Fall 2016.

We support the gradual transition from the current series to the new sequence by limiting enrollments to 50 students during the first year, with the goal of full implementation in the 2018-2019 academic year. The members were impressed to learn about the highly consultative process of developing this curriculum and the care taken to ensure that, even in these large courses, opportunities for active learning was emphasized.

Thank you for your leadership and dedication to improving and strengthening the Life Sciences Core curriculum. We share your optimism that the new curriculum will improve learning and produce students with a high degree of mastery of these essential concepts. Furthermore, we are hopeful these steps will help improve time to degree and increase retention of students who have declared life science majors.

We would be most grateful if you could present a report to the College FEC in two years' time so that the membership can assess the progress that you and your colleagues have made in phasing out Life Sciences 1-4.

By way of this letter, I am forwarding your request to the Undergraduate Council for final approval. They will inform you of their decision at the conclusion of the approval process. In the meantime, you are welcome to contact me at jbristow@humnet.ucla.edu with questions. Mitsue Yokota, Academic Administrator, is also available to assist you and she can be reached at (310) 794-5665 or myokota@college.ucla.edu.

cc: Kim Alexander, Articulation Officer, Undergraduate Admissions and Relations with Schools
Lucy Blackmar, Assistant Vice Provost, Undergraduate Education Initiatives
Luisa Crespo, Interim Policy Analyst, Undergraduate Council
James Gober, Chair, Undergraduate Council
Corey Hollis, Director, College Academic Counseling
Nancy Jensen, Principal Policy Analyst, Undergraduate Council
Robert Kilgore, Manager, Degree Audit System, Registrar's Office

Tracy Knox, Manager, Life Sciences Core
Claire McCluskey, Associate Registrar, Registrar's Office
Linda Mohr, Chief Administrative Officer, Academic Senate
Victoria Sork, Dean, Division of Life Sciences
Kyle Stewart McJunkin, Director, Academic Initiatives
Blaire Van Valkenburgh, Associate Dean, Division of Life Sciences
Lily Yanez, Student Affairs Officer, Life Sciences Core

Attachment: Proposal

UNIVERSITY OF CALIFORNIA, LOS ANGELES UCLA

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DEPARTMENT OF LIFE SCIENCES CORE CURRICULUM
COLLEGE OF LETTERS AND SCIENCE
Hershey Hall, Room 222
Terasaki Loading Dock
610 Charles E. Young Drive, East
LOS ANGELES, CA 90095-7246
PHONE: (310) 825-6614
Fax: (310) 825-8290

March 1, 2016

To: Professor Joseph Bristow, Chair, College FEC

Fr: Frank Laski, Chair, Life Sciences Core Curriculum

Re: Curricular changes to the Life Science core curriculum

Dear Professor Bristow:

I would like to request consideration in approving a revised LS Core curriculum. After two years of active discussion among the Life Sciences (LS) departments, Chairs, and faculty, we have concluded that a curricular change of the current 4-quarter format to a 3-quarter model will be an effective approach to teaching the required LS Core courses. The proposal is designed to change the current offerings of LS1-4 to a 3-quarter model. This new series will place much of the material found in LS1-3, and some of the introductory material of LS4 (genetics) into 3 courses (LS 7A, 7B, and 7C). The goal of this new format is aimed to not only to help students in the LS Major to *time to degree,* but also to focus on increasing retention rates in LS majors (see Appendix B for more details). The Core will ease into this new format by keeping the current offerings of LS1-4 as we transition into the new model with limited enrollments in Fall 2016.

We are proposing for this transition to begin in the Fall 2016 and reach completion by the 2018-19 academic school year. The revised curriculum comprises of the following proposals:

Proposal A: Revise LS1, LS2, LS3 courses to a 3-quarter series that will be listed as LS7A, 7B, and 7C

Proposal B: Move LS4 (genetics) to an upper division genetics course and re-number to LS107

These changes will affect 17 majors. These proposed changes were reviewed by faculty in the following majors (departments) that use the Life Science Core curriculum during 2015-16 academic year and approved for implementation, effective Fall 2017. Supporting letters can be found in the appendix.

- Anthropology, B. S. (Anthropology)
- Biochemistry (Chemistry & Biochemistry)
- Bioengineering (Engineering)
- Biology (Ecology and Evolutionary Biology)
- Chemical Engineering (Engineering)

- Computational & Systems Biology (Computational & Systems Biology)
- Ecology, Behavior and Evolution (Ecology and Evolutionary Biology)
- Human Biology and Society B.A. (Interdepartmental Program)
- Human Biology and Society B.S. (Interdepartmental Program)
- Marine Biology (Ecology and Evolutionary Biology)
- Microbiology, Immunology, & Molecular Genetics (MIMG)
- Molecular, Cell Developmental Biology (MCDB)
- Neuroscience (Neuroscience)
- Physiological Science (Integrative Biology and Physiology)
- Psychobiology B.S. (Psychology)
- Psychology, B. A (Psychology)

At the time of submission of this proposal, we have not received an official reply from the following departments:

- Earth and Environmental Science (Earth, Planetary, and Space Sciences)
- Geology B.S. (Earth, Planetary, and Space Sciences)
- Nursing (Nursing)

Yours,

Frank Laski
Professor, MCDB Department and MBI
Chair, Dept. of Life Sciences Core Curriculum
Terasaki Life Sciences Bldg, UCLA
Los Angeles, CA 90095-7239

I approve of and support this request:

Victoria Sork, Ph.D.
Dean, Division of Life Sciences, College

Proposal A
Revise LS1, LS2, LS3 into a 3-quarter model (LS7A, 7B, and 7C)

The current LS Core courses are listed in Table 1, along with the number of units, chemistry requisites, and length of discussion sections. A description of these courses can be found in Appendix A. Discussion among the LS departments and faculty led to the decision that the 20-year old LS Core curriculum requires revision.

To address these problems, the LS Departments decided to create a revised LS Core curriculum to include the following characteristics:

1. The curriculum will be reduced from 4 quarters to 3 quarters.
2. Incoming freshman LS students will be able to start taking the series in their freshman year and the vast majority of students will finish the series by the end of their sophomore year.
3. The courses will be at an introductory level using a single introductory textbook for the series.
4. The vast majority of LS transfer students will be able to place out of the series and immediately begin upper division courses in their major upon arrival at UCLA.

The proposed revised LS Core curriculum will contain a 3-quarter series of courses that will be listed as:

LS7A, (Cell and Molecular Biology), LS7B (Genetics, Evolution and Ecology), and LS7C (Physiology and Human Biology). These courses involve a reorganization of the content covered in LS1, LS2 and LS3, with the addition of three weeks of Genetics content from LS4. The LS7ABC courses will be taken in order and are listed in Table 2 (see Appendix C for additional details and suggested catalogue listings for these courses). The numbering indicates that we do not consider these to be three separate courses but rather a single integrated course taken over a one-year period. Table 3 shows a weekly topics list for these courses. A more detailed list of weekly student learning objectives is found in Appendix D. Each course will be five units and will meet three hours per week in lecture and an additional 75 minutes in discussion section, with the exception of LS7B that will have 110 minute discussion sections to accommodate additional labs/demos. The implementation schedule for these changes is described in Appendix E.

Proposal B
Move LS4 (genetics) to an upper division genetics course and re-number to LS107

Reorganizing the LS Core curriculum to a 3-quarter series requires the LS4 genetics course moving to an upper division course. This course will be listed as LS107. The placement of the introductory genetics course in the upper division is similar to what is found at most universities. This adjustment makes sense given that the current LS4 courses used upper-division textbooks and will places the introductory genetics course back to where it was before the formation of the LS Core, when it was listed as Bio108.

TABLE 1. LS1-4 Curriculum

Course #	Name	Units	Chemistry requisites	Disc. section time/week
LS1	Evolution, Ecology, and Biodiversity	5		110 min.
LS2	Cells, Tissues and Organs	4	14a or 20a	75 min.
LS3	Introduction to Molecular Biology	4	14c or 30a	75 min.
LS4	Genetics	5	14a or 20a 14c or 30a	75 min.

TABLE 2. LS7A, 7B, and 7C Curriculum and LS107

Course #	Name	Units	Chemistry requisites	Disc. section time/week
LS7A	Cell and Molecular Biology	5		75 min.
LS7B	Genetics, Evolution and Ecology	5		110 min.
LS7C	Physiology and Human Biology	5		75 min.
LS107	Genetics	5	14a or 20a 14c or 30a	75 min.

TABLE 3. Weekly Topics for LS 7A-C Curriculum
LS 7A-Cell and Molecular Biology

Week	Topic
1	Energy, Equilibrium, Kinetics
2	Nucleic Acids, Transcription
3	Protein Structure, Translation
4	Membranes and Cell Structure
5	Cell Communication, Cell Form and Function
6	Control of Gene Expression
7	DNA Manipulation and Genomes
8	Cell Division, DNA Replication
9	Mutation, and DNA repair
10	Cell cycle control, cancer

LS 7B-Genetics, Evolution and Ecology

Week	Topic
1	Meiosis, Mendelian Genetics
2	Chromosomal Theory of Inheritance (linkage, sex-linkage)
3	Genetic and Environmental Basis of complex traits
4	Population genetics
5	Speciation, Adaptation, Coevolution
6	Phylogenies, Macroevolutionary Patterns
7	Tree of Life, Patterns of Biodiversity
8	Species Interactions, Communities and Food webs
9	Biodiversity, Biogeography, and Biomes
10	Global cycles and global change

LS 7C– Physiology and Human Biology

Week	Topic
1	Carbon cycling, Energy conversion pathways
2	Cardiovascular, Respiratory Systems
3	Kidney/water ion balance
4	Nervous System
5	Endocrine, Reproduction
6	Muscles, Skeletal
7	Immunology, Gut Microbiome
8	Genomics, Bioinformatics
9	Genome Manipulation
10	Human Genetics

Appendix A. Current LS Core Curriculum

A.1. Description of Current LS Core Curriculum

The LS Core Curriculum includes a series of lower division biology courses, as listed in Table 1, which are required for most LS majors as well many students in other divisions.

TABLE 1

Course #	Name	Units	Chemistry requisites	Disc. section time/week
LS1	Evolution, Ecology, and Biodiversity	5		110 min.
LS2	Cells, Tissues and Organs	4	14a or 20a	75 min.
LS3	Introduction to Molecular Biology	4	14c or 30a	75 min.
LS4	Genetics	5	14a or 20a 14c or 30a	75 min.
LS23	Introduction to Laboratory and Scientific Methodology	2		3 hours

Each course is taught a minimum of eight times per year (two offerings each Fall, Winter, and Spring plus one offering each in Summer sessions A and C). Approximately 2000 students take each course per year. LS1-4 are lecture courses with three hours of lecture and 110 minutes (LS1) or 75 minutes (LS2-4) of discussion every week. The extended discussion time for LS1 accommodates laboratory exercises and demos. Lectures are taught by faculty and lecturers, while discussion sections are led by teaching assistants. Approximately 20 faculty from six departments (Ecology and Evolutionary Biology; Integrative Biology & Physiology; Microbiology, Immunology & Molecular Genetics; Molecular, Cell & Developmental Biology; Psychology; Life Sciences Core Curriculum) teach these courses.

LS2, LS3 and LS4 must be taken in order and have the Chemistry requisites shown in Table 1. Because Chemistry 14c has its own course requisites, students are required to pass three chemistry courses and at least one mathematics course (dependent on high school preparation) before enrolling in either LS3 or LS4. LS1 has no requisites and can be taken at any time relative to the other courses. LS23 is a lab course that is taken concurrently with either LS3 or LS4.

Both LS1 and LS2 are GE Scientific Inquiry-Life Science courses. LS1 also fulfills the GE lab/demo requirement. Consistent with their GE designation and their role as introductory courses, LS1 and LS2 typically use introductory level biology textbooks such as Freeman's *Biological Science* or Sadava's *Life: The Science of Biology*. By contrast, LS3 and LS4 typically use more advanced textbooks more commonly associated with upper division courses. LS4 instructors typically choose Hartwell's *Genetics: From Genes to Genomes*, while LS3 instructors have recently used Alberts' *Molecular Biology of the Cell*, Watson's *Molecular Biology of the Gene,* and Cox's *Molecular Biology: Principles and Practice*.

A.2 Catalogue Listings For LS1-4 and LS23

LS1. Evolution, Ecology, and Biodiversity. (5) Lecture, three hours; laboratory, two hours; one field trip. Introduction to principles and mechanisms of evolution by natural selection; population, behavioral, and community ecology; and biodiversity, including major taxa and their evolutionary, ecological, and physiological relationships. P/NP or letter grading.

LS2. Cells, Tissues, and Organs. (4) Lecture, three hours; discussion, 75 minutes. Enforced requisite: Chemistry 14A or 20A. Introduction to basic principles of cell structure, organization of cells into tissues and organs, and principles of organ systems. Letter grading.

LS3. Introduction to Molecular Biology. (4) Lecture, three hours; discussion, 75 minutes. Enforced

requisites: course 2, and Chemistry 14C or 30A. Corequisite: course 23L (students must take 23L concurrently with course 3 if they do not plan to take course 4). Introduction to basic principles of biochemistry and molecular biology. Letter grading.

LS4. Genetics. (5) Lecture, three hours; discussion, 75 minutes. Enforced requisites: courses 2, 3, Chemistry 14A (or 20A), 14C (or 30A). Enforced corequisite: course 23L. Principles of Mendelian inheritance and chromosomal basis of heredity in prokaryotes and eukaryotes, recombination, biochemical genetics, mutation, DNA, genetic code, gene regulation, genes in populations. Letter grading

LS23L. Introduction to Laboratory and Scientific Methodology. (2) Laboratory, three hours; discussion, one hour. Enforced requisite: course 2. Must be taken concurrently with either course 3 or 4. Introductory life sciences laboratory designed for undergraduate students. Opportunity to conduct wet-laboratory cutting-edge bioinformatics laboratory experiments. Students work in groups of three conducting experiments in areas of physiology, metabolism, cell biology, molecular biology, genotyping, and bioinformatics. Letter grading

Appendix B. Reasons Requiring Change to LS Core Curriculum

Reasons LS Core Curriculum Requires Revision

The main reasons for revising the LS Core Curriculum is to decrease the time to degree for Life Science majors and increase retention rates in STEM majors. Out of all of the aspiring LS majors entering UCLA from 2005 to 2008, nearly one-third (31%) switched into Humanities, Arts, and Social Sciences (HASS) before completing their degrees within a 6-year period (UCLA Office of Analysis and Information Management). This LS attrition rate was disproportionately high for under-represented minority (URM) students, only 37% of which completed their intended LS degree.

Reasons for attrition from STEM disciplines have been studied, and some of the most important factors that lead to switching majors from a STEM subject to a HASS subject include negative experiences such as academic challenges related to grades and coursework, feelings of not belonging in the major, and logistical concerns regarding time-to-degree or course availability[1,2]. These published findings are mirrored by the responses of graduating UCLA students who switched from LS to HASS majors.

While there are several factors that can influence students' decisions to leave STEM, 28.6% of 2013 and 2014 UCLA Senior Survey respondents reported some kind of negative experience in their STEM major that "pushed" them toward HASS (BIC 2015 Report, Appendix H).

We propose that a revised introductory LS series will help address the retention and time-to-degree problems currently experienced among LS majors. Specifically, the proposed curriculum will:

- Make introductory LS courses more accessible so that LS majors can take more LS courses in their first year at UCLA.
- Facilitate entry into upper-division major courses by the start of students' third year.
- Reduce time-to-degree for freshman-admit students and facilitate entry into major courses earlier in their academic careers.
- Promote success of transfer students by reducing the number of lower-division courses that must be taken at UCLA before advancing to major courses.

B.1. Providing Access to Introductory LS Courses

- *Problem*: Traditionally, 40% or fewer intended biological sciences majors do not take a single LS course until their second year or later due to the high number of prerequisite courses. This decreases overall morale and may increase attrition from LS / STEM majors to other HASS disciplines.
- *Goal*: Facilitate enrollment of all LS majors enrolled in an LS course during their first year through waving the chemistry prerequisites.

B.2. Reducing Time-to-Degree.

- *Problem*:
    - Most of the life science majors don't finish their lower division courses until their junior year (18% of Biological Science majors take LS3 in their 3rd year or later; 59% take LS4 in their 3rd year or later). This makes graduation within 4 years at UCLA very difficult to achieve. Part of the reason for this is that we have a 4-quarter lower division curriculum rather than the 3-quarter curriculum typically found at most universities.
    - In addition, LS3 requires Chem 14c which delays our students' entry into LS3. Our students are spending much of their first two years on campus taking lower division courses in math, physics and chemistry rather than courses in the life sciences.
    - Considering this, it is important to note that the later a student takes LS3 or LS4, the higher the likelihood is that this student will fail the class and will have to repeat it. This

leads to a greater difficulty in completing the degree requirements in time as both LS3 and LS4 are prerequisites for many upper division courses.

- *Goal*: Enable students to fulfill degree requirements on time by facilitating taking the LS series in the first or second year at UCLA and reducing the number of lower division LS courses from 4 to 3 as seen in most other universities.

B.3. Promoting Success of Transfer Students

- *Problem*: The current LS Core series poses a unique challenge to transfer students, who often fail to gain equivalency for LS3 and LS4. Among all transfer students entering UCLA as biological sciences majors over the past few years, approximately 57% and 72% were required to take LS3 and LS4, respectively. This puts transfer students at a disadvantage compared to their freshman-admit peers, as nearly 80% of freshman-admit biological sciences majors have completed LS3 by the end of their second year. As a result, many transfer students do not take LS4 until the winter quarter of their third year and are therefore likely to be at least a full quarter behind their freshman-admit peers in entering their upper-division major courses. It also means they have only four quarters to finish their upper-division major if they are to graduate in four years.
- *Goal*: Facilitate direct entry into upper division courses for most transfer students. Though rigorous, the proposed revised LS series will be composed of introductory level courses, in contrast to the existing LS3 and LS4 courses that are taught at a more advanced level. This will allow more transfer students to use their community college biology education to articulate out of the full LS series.

References

1. Thoman, D. B., Arizaga, J. A., Smith, J. L., Story, T. S. & Soncuya, G. The Grass Is Greener in Non-Science, Technology, Engineering, and Math Classes Examining the Role of Competing Belonging to Undergraduate Women's Vulnerability to Being Pulled Away From Science. *Psychol. Women Q.* **38,** 246–258 (2014).
2. Beasley, M. A. & Fischer, M. J. Why they leave: the impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Soc. Psychol. Educ.* **15,** 427–448 (2012).

Additional Details and Proposed Catalogue Listings for LS7a, LS7b, LS7c, LS23L and LS107

C.1. Additional Details. The revised LS Core curriculum will contain a three-quarter series of courses called LS7a, LS7b, and LS7c, as listed in Table 2. The numbering indicates that we do not consider these to be three separate courses but rather a single integrated course taken over a one-year period. Each course will be five units and meet three hours per week in lecture and an additional 75 minutes in discussion section with the exception of LS7b. LS7b will have 110 minute discussion sections to accommodate additional labs/demos.

TABLE 2. LS7abc Curriculum and LS107

Course #	Name	Units	Chemistry requisites	Disc. section time/week
LS7a	Cell and Molecular Biology	5		75 min.
LS7b	Genetics, Evolution and Ecology	5		110 min.
LS7c	Physiology and Human Biology	5		75 min.
LS107	Genetics	5	14a or 20a 14c or 30a	75 min.

There will be no prerequisites for this series, except that LS7b will require LS7a and LS7c will require LS7b. All background chemistry necessary for this course will be taught in the course. This will allow life science majors to start the LS7abc series during their freshman year and finish the series by the end of their second year on campus. The topics covered in this series are similar to what is taught in many California Community Colleges, which will allow most life science transfer students to pass out of this series and immediately be able to start their upper division courses upon arrival at UCLA.

Each course will be taught as a highly-structured flipped classroom, which have been shown to increase learning gains for all students and reduce the achievement gap between advantaged and disadvantaged students in an introductory biology class. The students will watch professionally made videos of animated lectures before attending class where active learning and problem solving will be emphasized. A single textbook will be used throughout the three-course series. A faculty committee will choose this textbook at a later date, though *Biology: How Life Works* by Morris, Hartl, Knoll and Lue is an example of an appropriate textbook based on its introductory level and emphasis on concepts rather than detailed facts. Even though an introductory textbook will be used, we expect that faculty will go into greater depth than the book on many subjects, supplementing the material with lectures, videos, animations, and additional readings.

We will continue offering the lab course LS23. Modifications to the lab will be made to facilitate alignment with the new LS7 curriculum. We recommend that students take LS23 simultaneously with LS7c.

LS7b will contain three weeks of genetic material from LS4. This is a sufficient amount of introductory genetics to prepare students for many upper division courses that require Mendelian genetics, but it is not sufficient for it to be called a "Genetics" course. The LS7 series therefore requires that an upper division Genetics course be created to replace LS4. This is similar to what is found at many universities: often an introductory course that includes a genetics survey component is offered in the lower division and is followed by an upper division course dedicated solely to genetics. This upper division genetics course will be called LS107. LS107 will review the Mendelian genetics material covered in LS7B and then continue with more advanced topics, most of which are currently being taught in LS4. LS107 will be a five unit class with three hours of lecture and 75 minutes of discussion per week. It will be taught as a highly-structured flipped classroom making use of professionally made high-quality videos. LS107 will maintain the Chemistry requisites (14a or 20a and 14c or 30a) that currently belong to LS4.

Dedicated teachers from the Life Sciences Core Department as well as faculty and lecturers from the major Life Science Departments (Ecology and Evolutionary Biology; Integrative Biology & Physiology; Microbiology, Immunology & Molecular Genetics; Molecular, Cell & Developmental Biology; Psychology) currently participate in teaching the LS1-4 courses. These five Life Science Departments contribute faculty at a rate roughly proportional to their size. This will continue with the LS7 series as well as LS107: the departments will contribute to the faculty teaching these courses using the proportionality rules currently in use for the LS1-4 series.

Considering its introductory nature and lack of requisites, we will propose to the GE Governance Committee that LS7A be designated a GE Scientific Inquiry-Life Science course.

C.2. Proposed Catalogue Listings.

LS7a. Cell and Molecular Biology (5 Units)

Lecture, three hours; discussion 75 minutes. Enforced requisite: none. Introduction to basic principles of cell structure and cell biology, basic principles of biochemistry and molecular biology. P/NP or letter grading.

LS7b. Genetics, Evolution and Ecology (5 Units)

Lecture, three hours; discussion 110 minutes. Enforced requisite: LS7a. Principles of Mendelian inheritance and population genetics; Introduction to principles and mechanisms of evolution by natural selection; population, behavioral, and community ecology; and biodiversity, including major taxa and their evolutionary, ecological and physiological relationships. Letter grading.

LS7c. Physiology and Human Biology (5 Units)

Lecture, three hours; discussion 75 minutes. Enforced requisite: LS7b. Organization of cells into tissues and organs, and principles of physiology of organ systems. Introduction to human genetics and genomics. Letter grading.

LS23L. Introduction to Laboratory and Scientific Methodology (2 Units)

Laboratory, three hours; discussion, one hour. LS7c is a requisite or must be taken concurrently. Introductory life science laboratory designed for undergraduate students. Opportunity to conduct wet-laboratory cutting-edge bioinformatics laboratory experiments. Students work in groups of three conducting experiments in areas of physiology, metabolism, cell biology, molecular biology, genotyping, and bioinformatics. Letter grading.

LS107. Genetics (5 Units)

Lecture, three hours; discussion 75 minutes. Enforced requisite: Chem14a or 20a; Chem14c or 30a; LS7c and LS23L. Advanced Mendelian genetics, recombination, biochemical genetics, mutation, DNA, genetic code, gene regulation, genes in populations. Letter grading.

Appendix D. Learning Objectives for LS7A-C

LS7A

Week 1: Energy, Equilibrium, Kinetics
Learning Goal: Understand the applicability of the laws of thermodynamics as they relate to chemical reactions and the function of cells.
Students will be able to…

- Define different types of chemical bonds and how they are formed
- Explain the first and second laws of thermodynamics.
- Predict whether a specific reaction will be exergonic or endergonic.
- Discuss how an energetically favorable reaction can be "coupled" to and drive a separate energetically unfavorable reaction.
- Explain what is meant by the term "equilibrium."
- Differentiate between anabolic and catabolic processes.
- Predict the favorable direction of a reversible reaction based on the relative concentrations of products and reactants.

Learning Goal: Understand how enzymes modulate the rate of chemical reactions to regulate cellular processes.
Students will be able to…

- Differentiate between thermodynamics (direction of a reaction) and kinetics (rate of a reaction).
- Explain the effect of enzymes on the thermodynamics and kinetics specific to any reaction.
- Describe different levels of protein structure
- Predict favorability, effect of coupling, and relative rates of reactions based on free energy diagrams.
- Discuss the different levels of protein structure and how they relate to the "native state" and function of a protein.
- Evaluate the effects of environment (pH, temperature, substrate concentrations) on enzyme catalyzed reaction rates
- Predict changes in reactivity based on regulatory (activation or inhibition) molecules

Week 2: Membranes and Cell Structure
Learning Goal: Understand the relationship between structure and function as a selectively permeable barrier for cell and organelle membranes.

- Describe basic lipid structure and how that contributes to the structure and fluidity of membranes.
- Evaluate how changing factors such as temperature and lipid content will affect membrane fluidity.
- Predict the permeability of a molecule based on its chemical properties.
- Use Fick's Law to describe the net movement of molecules down a concentration gradient.
- Predict the net movement of water and solute molecules across cell membranes in the absence or presence of transporters.

- Relate the diffusion of molecules to changes in free energy.
- Define the term "osmolarity" and explain how this influences the process of osmosis.
- Interpret experimental data about the mechanisms by which different molecules cross a semipermeable membrane.

Learning Goal: Students will appreciate the role of membrane-bound organelles and the endomembrane system as they relate to basic cellular functions.

- Compare and contrast the general organization of prokaryotic/eukaryotic cells and plant/animal cells.
- Identify the location of translation and track the trafficking of a protein based on its function (i.e., is it secreted, cytoplasmic, membrane-bound, inside another organelle, etc.)
- Evaluate the consequences of adding a drug or inducing a mutation that alters protein trafficking through the endomembrane system.
- Compare and contrast the processes of endocytosis, pinocytosis, and phagocytosis.
- Relate the structure of different membrane-bound organelles to their function (i.e., lysosomes as digestive organelles).
- Describe the evolutionary origins of chloroplasts and mitochondria.

Week 3: Nucleic Acids, Transcription

Learning Goal: Identify the relationship between structure and function in nucleic acids, and how genetic information moves from DNA to RNA

- Diagram the central dogma, and name specific events that occur during each process
- Explain how the properties of different chemical bonds govern the composition and 3-D structure of biological molecules
- Describe the structure and organization of DNA
- Discriminate between the major and minor groove and provide rationale for why they exist
- Differentiate DNA from RNA
- Explain why the structure of DNA allows for the storage of genetic information
- Given a sequence of DNA provide the complementary sequence
- Apply the concept of hybridization to molecular analytical methods i.e. FISH, Southern Blot
- Predict and analyze experimental results from FISH and Southern Blot

Learning Goal: Describe how information in DNA is transcribed into RNA

- Explain the basis of RNA tertiary structure and how this impacts RNA function
- Differentiate between template and non-template / coding strand
- Describe the process of transcription initiation, elongation, and termination

- Compare and contrast prokaryotic and eukaryotic transcription (including modifications to mRNA)
- Predict the effect that loss of function in different components of the transcription machinery may have on transcription
- Interpret experimental results from Northern blots

Week 4: **Protein Structure and Translation**
Learning Goal: Describe how RNA messages are translated into protein, and how the amino acid composition in proteins is important for determining levels of protein structure and function.

- Describe different levels of protein structure
- Differentiate ribozymes from other RNAs and RNA containing molecules
- Compare and contrast prokaryotic and eukaryotic translation (you should be able to attribute some of these differences to differences between prokaryotes and eukaryotes)
- Predict the effect mutations in various components of the translation machinery could have on translation
- Given the final location of a protein, predict its site of synthesis
- Predict the effect posttranslational modifications have on characteristics of a protein
- Predict the effect of amino acid substitutions on protein structure
- Select a suitable purification method for a given protein or experimental question
- Interpret results from SDS-PAGE and Western Blot experiments
- Describe the basic structural features of antibodies and how are they used as tools in molecular biology.
- Relate the process of ribosome assembly to the initiation of translation and the facilitation of peptide bond formation during translation.
- Define each of the following as they relate to the genetic code: degeneracy, wobble pairing, open reading frames.

Week 5: Cell Communication, Cell Form, Function
Learning Goal: Appreciate cellular diversity and the ways that individual cells come together to form a multicellular organism.

- Explain why diffusion and surface area limit cell size and its implications for large, multicellular organisms.
- Predict the primary function of a cell or tissue based on its cellular composition (i.e., organelle abundance) and vice versa.
- Evaluate how changing components of the cytoskeleton would change cell structure (shape) and/or function (i.e., motility).
- Explain how cell-cell junctions and the extracellular matrix (ECM) contribute to cells' abilities to form tissues and organs.
- Describe the different types of cell-cell junctions.
- Evaluate the effect of modifying cell-cell junctions or ECM components on tissues structure and function.

Appendix D. Learning Objectives for LS7A-C

Learning Goal: Understand how cells communicate with their external environment and respond to change.

- Predict changes in cellular responses based on changes in the environment.
- Explain how proteins can act as "molecular switches" (particularly G proteins and transmembrane receptors).
- Predict the effect of altering part of a signal transduction pathway, and/or evaluate data related to signal transduction pathways.
- Explain how a signal transduction pathway can be turned off.
- Describe the mechanism of each type of signaling pathway.
- Distinguish between second messengers and other components of signal transduction pathways.
- Interpret data related to different types of cell signaling pathways.

Week 6: Control of Gene Expression

Learning Goal: Describe various mechanisms that affect levels of gene expression in prokaryotes and eukaryotes.

- Contrast the differences between positive and negative forms of regulation
- Be able to interpret data as it relates to the *lac* operon and other similar methods of regulation
- Predict whether gene expression will occur given specific environmental conditions in prokaryotes
- Explain the process of attenuation, and why this results in transcriptional regulation for prokaryotes
- Identify changes in gene expression based on the haplotypes found in the cell (i.e. using partial diploids)
- Explain how the action of activators and co-activators interacts with chromatin modifications and regulates gene expression
- Predict the effect of mutations in gene regulatory systems on gene expression
- Predict which genes will be regulated by enhancers given a diagram
- Evaluate the effect of different chromatin modifying enzymes on gene expression
- Relate the role of activators, repressors, looping, chromatin remodelers, and histone modification to the regulation of gene expression.

Week 7: DNA Manipulation and Genomes

Learning Goal: Describe genome structure in prokaryotes and eukaryotes and different methods of describing and manipulating the genome.

- Describe the different techniques used in genome-wide analysis

- Relate the role of restriction enzymes to their role in molecular biology
- Given a plasmid vector, devise a cloning strategy for a gene and how to identify the correct clone
- Determine from which type of library a given sequence / gene can be cloned
- Explain the key components of a cloning plasmid and their functions
- Differentiate between genomic and cDNA libraries and relate how/why they provide different information
- Compare and contrast the differences in genome organization between prokaryotes and eukaryotes.
- Define some of the sources of variation in genomes (gene duplication, gene families, LINES, SINES, SNPs, microsatellites, mutation)

Week 8: Cell Division, DNA Replication
Learning Goal: Relate the process of DNA replication to events in the cell cycle

- Explain the mechanism of action of the replication machinery
- Predict the potential experimental outcomes of the three models of DNA replication (i.e. what would the banding pattern look like for each model)
- Provide experimental data to support the proposed pattern of DNA replication
- Differentiate between the leading and lagging strand during DNA replication, and explain why there are differences for the two strands
- Describe the regulation of initiation of replication in eukaryotes
- Relate events in the process of DNA replication to stages in the cell cycle
- List factors that contribute to the "end replication problem"
- List the major events at each stage of cell division and the role MTOC play in cell division
- Describe how changes in local concentrations of cyclins and cdks are altered during the cell cycle

Week 9: Mutation and DNA Repair
Learning Goal: Understand the process of mutation and their effect from the cellular to the organismal level.

- Define the term mutation, and the different classes of mutations
- Define mutagen and explain how chemical modification of bases leads to mutations, and alterations of DNA sequence
- Given a specific mutation, predict what the outcome will be in terms of transcription and translation for that gene
- Differentiate between DNA repair mechanisms and how mechanisms of detection differ for each repair pathway
- Describe how duplications, deletions, inversions, and translocations can affect gene function, gene expression, and genetic recombination.*
- Describe the same for transposable elements.*
- Describe how mutations arise and how environmental factors can increase

mutation rate.*
- Interpret results from experiments to distinguish between different types of DNA rearrangements.*

Week 10: Cell Cycle Control
Learning Goal; Understand how cells regulate their own growth and division throughout the cell cycle.

- Describe the stages of the eukaryotic cell cycle, mitosis, and meiosis.
- Explain how regulatory factors such as CDK, cyclin, APC, and separase regulate the progression of the cell cycle and cell division.
- Predict how changes in cell signaling pathways and cell cycle regulatory mechanisms (checkpoints) will affect cell growth and division.
- Compare and contrast mitosis and meiosis.
- Evaluate the consequences of altering microfilaments and microtubules on the process of cell division.
- Relate changes in cell cycle regulation to the development of cancer.