Origins of Life in the Universe

Interim Evaluation

2013-14
(029:040:001-002)

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January 22, 2014

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A student’s response after NASA geochemist, David Des Marais, described the many worlds that researchers are investigating as potential homes for life in the Universe during his classroom visit: “[The Origins course] completely broadened my view of the possibility of life, but it was the class in which we talked to David Des Marais where he showed an image (Kepler Orrey) with many different planets light-years away that have the [potential] ingredients to create life that helped me understand what it is we would be looking for when searching for life in space.”
Abstract

This report reviews the assessment strategy implemented in the Fall 2013 semester of the interdisciplinary science course, *Origins of Life in the Universe*, to demonstrate the effectiveness of the TILE-Constellation vision and to provide a framework in developing improved teaching methods for the upcoming Spring 2014 semester. The work primarily utilizes Bloom’s Taxonomy to define learning objectives and to identify different levels of student proficiency. A discussion of the assessment items promoting an active, guided-learning environment is complemented by student responses to various feedback surveys given throughout the course. Sample student submissions serve as a visual reference to the efforts of this program.

**Key words:** Active learning, assessment, Bloom’s Taxonomy, classroom instruction, guided-learning, learning objectives

Acknowledgments

I would like to express thanks to Professor Cornelia Lang for the valuable opportunity in being part of the genesis of the *Origins of the Life in the Universe* course. Her contagious enthusiasm and teaching experience served as professional guidance in navigating the educational resources provided by the University of Iowa. Jean Florman and Wayne Jacobson, whose practical knowledge led to the development of the assessment strategy discussed here, also deserve special appreciation. Finally, I am grateful of the instructors, graduate students, and undergraduates involved in this course who accepted the work needed to make this project a reality.
Contributions to this Report

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I. Introducing the Pilot Program

Description of the Course

*Origins of Life in the Universe,* hereafter abbreviated as *Origins,* is designed as a pilot course in the new TILE-Constellation program funded for two years by the Office of the Provost at the University of Iowa under its Student Success Initiative*. *Origins* is being taught as a yearlong, interdisciplinary course that will satisfy the undergraduate Natural Sciences requirement of the General Education Program in the College of Liberal Arts and Sciences (CLAS). The course is comprised of six thematic units to investigate the discoveries provided by the disciplines of Astronomy, Chemistry, Biology, Geoscience, and Anthropology that elaborate upon our understanding of life in chronological order. Multiple faculty members and graduate students are involved in this project and their respective contributions have been noted on the previous page. *Fig. 1* illustrates the distribution of the major involvement of each discipline as outlined in the original proposal. The approach in teaching the first part of *Origins* from Units 1-3 (Fall 2013) will be described and a highlight of the course’s success will be summarized.

<table>
<thead>
<tr>
<th>Unit 1: Origin of the Universe</th>
<th>Unit 2: Origin of Life</th>
<th>Unit 3: Origin of Life on Earth</th>
<th>Unit 4: Evolution of Life on Earth</th>
<th>Unit 5: Origin of Humanity</th>
<th>Unit 6: Search for Life in the Universe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomy</td>
<td>Chemistry</td>
<td>Biology</td>
<td>Biology</td>
<td>Anthropology</td>
<td>Astronomy</td>
</tr>
<tr>
<td>Geoscience</td>
<td>Biology</td>
<td>Geoscience</td>
<td>Astronomy</td>
<td>Biology</td>
<td>Anthropology</td>
</tr>
</tbody>
</table>

Figure 1: From Professor Lang’s Student Success Proposal, “TILE Learning Across the Disciplines: Development of the First TILE-Constellation Course *Origins of Life in the Universe* (a Pilot Program).”

How old is the Universe? What is the nature of life? How has life evolved on Earth? What are our human origins? Are there other habitable planets in the Universe? These **Big Questions**, among others, prompt the starting point of and a student’s entryway into the *Origins* course. To find the answers, material from the different perspectives of the natural and social sciences are centered on humanity’s investigation of the unknown. The course (*Fig. 1*) is divided into units to be lead by expert faculty in a thematic approach that unifies content through the application of reoccurring scientific principles such as orders of magnitude, rates of change, and levels of complexity to name a few. Here, a **Constellation** of disciplines meets students in the *TILE* classroom (space to Transform, Interact, Learn, and Engage) to work directly with material through group-involved, guided activities utilizing the new instructional resources. Therefore,

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*See Student Success Proposals: [http://uc.uiowa.edu/student-success-proposals](http://uc.uiowa.edu/student-success-proposals)*, and Appendix A.

*Images of the classroom space can be found here: [http://tile.uiowa.edu](http://tile.uiowa.edu), along with other instructor’s teaching innovations.*
this course represents collaboration not only between a team of instructors, but also between teams of students working together to uncover new knowledge. The pedagogical goal of Origins in the TILE-Constellation vision is to build an effective foundation for future collaborations intended to promote recruited interest in the major disciplines and better retention of general education knowledge.

A key motive behind the development of novel teaching strategies is the enhancement of student progression toward the learning goals offered by and integral to the course. Assessment, the review of any items completed by students inside or outside of class, is utilized by the instructor as feedback to identify and improve students’ achievement of learning goals by modifying the working teaching methods in progress. Additionally, teaching can also be informed by the goals of the students themselves to work in tandem with the instructor’s own goals set out for the course. This evaluation aims to report an overview of the assessment used in the first part (Fall 2013) of Origins and a prescription for the revisions that may be implemented in the second part (Spring 2014) of the course in the interim between semesters.

Mo**des of Assessment**

A collaborative and interdisciplinary course requires a common language to communicate an approach unified toward student learning and success. This language makes transparent the learning goals of the course both to the instructors and to the students. In Origins, the framework provided by “Bloom’s Taxonomy” allows for the development of assessment items at the proper level of student learning. According to Bloom’s proposal, the measured outcomes of student learning can be stratified into different levels of proficiency. These levels are each associated with tasks (verbs) used to achieve the desired learning outcomes, answering the “students who take this course will be able to…” statement often found in syllabi. The following list defines and gives examples for the classification scheme of Bloom’s Cognitive Domain. In increasing level of proficiency:

- **Knowledge**: Ability to recall facts or concepts
  - Define, describe, identify, label, list, memorize, name, recite, select
- **Comprehension**: Ability to rephrase a concept into another mode of communication
  - Distinguish, explain, express, illustrate, interpret, match, restate, summarize
- **Application**: Ability to use facts in a concrete situation
  - Demonstrate, generalize, organize, prepare, produce, show, sketch, solve, use
- **Analysis**: Ability to break down material into parts and explain its relationships
  - Categorize, classify, compare, contrast, differentiate, infer, select, survey
- **Synthesis**: Produce new information by connecting and combining information

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6 *The Taxonomy of Educational Objectives: The Classification of Educational Goals* (1956), B. Bloom.
- Create, combine, compose, design, develop, formulate, hypothesize, plan, write
- **Evaluation**: Judge according to established criteria, verify accuracy of claim
  - Appraise, assess, consider, critique, judge, justify, recommend, review, support

In order to facilitate an active learning environment, the learning goals of the *Origins* course are presented as process-oriented **objectives** that use verbs (tasks) to identify the proper level of proficiency sought by a particular assessment item. This approach includes the writing of the course syllabus, which outlines the organization of content, resources, and assignments to be incorporated into the semester’s progress as well as the instructors’ expectations for the course. The two-part sequence of *Origins* necessitated the division of learning goals into a set of overarching yearlong objectives and a set of semester-specific objectives based on the curriculum content. These objectives are listed below as taken from the syllabus. Our approach towards meeting these objectives will be described in more detail in Part II of this report.

**Yearlong Course Objectives**: by participating in this TILE-Constellation course, students will be able to…

- Distinguish the parts of the **scientific method** (observation, hypothesis, experiment, and theory) and use these aspects to differentiate between science and pseudoscience.
- Interpret the **scale of a system** by the use of orders of magnitude and chronology to compare and contrast its various components (e.g. space and time, geologic time, reaction rates, branches of the evolutionary tree of life, and human history).
- Apply principles of **biological evolution** to understand the origin and the history of life on Earth and possibly beyond.

**Fall Semester Objectives**: by participating in Origins – Part 1, students will be able to…

- Breakdown the **structure and order** of the universe over its 13.7 billion year history to the present day solar system.
- Classify the **physical processes** that have occurred throughout the 4.6 billion year history of the Earth.
- Establish, apply, and outline the **biochemical origins** and early evolution of life on Earth.

These objectives guided the design of the course syllabus in both its content and the assessment items that were used to engage the material. The creation and organization of the syllabus as implemented in *Origins* followed an **assessment cycle** as sketched in Fig. 2.

Figure 2: To meet the process-oriented learning objectives set out for the *Origins* course, the execution of the syllabus followed a cycle centered on weekly meetings with the course instructors, teaching assistants, assessment coordinator, and consultant educators from the university. Once the team determined topics

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7 See Appendix B.
(1) for each class session of the semester schedule, individual learning objectives (2) were defined in order to construct and prompt in-class activities (3). Readings (5) of the assigned texts were chosen to complement each session topic, and in-class quizzes reinforced student preparation with the material. Selections from a popular science book were developed into concept mapping and writing assignments (7) that allowed further investigation by the student either through outlining, demonstrating, or elaborating upon a central theme. Lastly, results from these assessment items (2), (3), (6), and (7), including in-class exams (4), were incorporated as feedback for improvements made to the remaining instruction of the course.

A typical classroom session attempted to fully utilize the resources and space of the TILE-purposed room. Depending on the topic for that particular day (Tuesday or Thursday), the expert instructor presented, directed, or interspersed a mini-lecture to students before, during, or after they worked in groups of 3 at round tables of 9 seated peers to complete in-class activities. These activities were modeled, in part, after previously administered exercises from the Department of Physics & Astronomy’s Life in the Universe course, refined by contributions from each instructor, and conceptualized in comparison with the POGIL\(^8\) paradigm. POGIL (Process Oriented Guided Inquiry Learning) is an industrialized teaching strategy used by chemical educators directed to assist small student groups with individual roles through carefully designed classroom activities. The Origins format, however, follows a more fluid guided-learning, as opposed to guided-inquiry, strategy in which students operate in self-organized groups with no roles to work through models and examples in communication with several instructors and teaching assistants (TAs) moving throughout the decentralized floor plan of the TILE space. The main advantage, and departure from POGIL, of the TILE room is the capability for microphone-assisted, class-wide discussions to review and bring to closure the session’s material.

> “The biggest benefit [of the TILE classroom], I think, was the ability to use the different screens. At some point, notes would be displayed on the smaller screens, and demonstrations would be going on in others. It allowed me to compare both and, with many, connect the dots more efficiently” (Final Course Evaluation, Q19)

**Highlight of Results**

Over one year in development, Origins began first as a concept course for renewed teaching collaboration between instructors and students from different disciplines and majors. The proposed TILE-Constellation vision of this pilot program is unfolding in the first academic year of implementation after drawing on the expertise and past experiences of the involved faculty, the educational resources offered by the Center for Teaching and Office of Assessment at the university, and the testing of curriculum material by the graduate assistants. Funded in part by a grant intended to promote student success, the findings of this interim evaluation demonstrate an educational framework that can be used in Origins to improve its effectiveness through prioritized proficiency. That is, the explicit use of Bloom’s levels of proficiency (see Modes of Assessment) to answer the question: *What is most important for students to learn in this course?* Learning objectives do indeed provide a system to help identify learning outcomes designed as tasks by the instructor. However, because of institutional assessment items such as exams and grades, students tend to prioritize (or desire that) their learning efforts focus on what will be assessed. To put it differently, to what extent will a learning objective be assessed on the exam?

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\(^8\) See [https://pogil.org](https://pogil.org).
A simple addition to the course promoting a transparent assessment design is the emphasis on ascending tasks of difficulty for in-class activities. Each session topic could have different questions associated with different important proficiency tasks, such as: sketch (application) a timeline of at least 10 major events in the history of the Earth and argue (evaluation) why those events are significant to life on Earth today, and end with a question intended to assess the students’ achievement of the learning objectives prompting the activity, clearly marked as so.

“My biggest challenge so far was interpreting what exactly I needed to know for the exam. We are given so much information that when it comes to narrowing it down I either narrow points down too much or way over-review minimally important points” (Mid-semester Survey, Q2).

Successful advertisement led to a nearly full class size of 74 enrolled students completing the first semester (Fall 2013) of Origins. While the course is intended to appeal towards students seeking to satisfy the natural sciences requirement of their general education, a section of 20 spaces were reserved for an attached honors section of freshman students in conjunction with a specially paired rhetoric course. Fig. 3 indicates the difference between grade distributions of the honors section and those students enrolled under the general education program. Other demographic information, such as student major, could reveal the types of students choosing to enroll in this format of a course and those choosing to remain into the Spring 2014 semester. In terms of retention, 43 students have enrolled in the second part of Origins and 22 students from the previous semester indicating scheduling conflicts on the final course evaluation for Fall 2013. Origins owes its success largely to the diversity of instructors and students that have enthusiastically undertaken a novel teaching and learning experience.

“Even though it was a big class, it felt like a small one – we were given individual attention and forced to interact with each other to understand the material” (Final Course Evaluation, Q20).
II. Analyzing the Approach to Assessment

❖ Design of the Assessment Items

*Origins* is a learning objectives driven course. Following a compositional approach implies the division of instructional outcomes into a matrix of intermediate learning objectives that are applied across the assessment items of the course. These intermediate objectives then lend themselves towards processes (tasks) that can be made into activities following a fluid, guided-learning design. The distinction of content to be investigated over the entire year (themes) and that assigned to individual semesters (units) provided a framework from which to build the course. In this section, the components of the syllabus will be elaborated upon in reference to their application of learning objectives. The succeeding sections will highlight student work and provide their evaluation in terms of grades for the course.

The *Origins* team of faculty and graduate assistants sought out to answer Big Questions about the Universe with regards to life on Earth and potentially elsewhere. To facilitate the interdisciplinary environment necessary to address the Constellation of topics exposed by this line of thinking, a TILE Classroom and Student Lounge were chosen for all instructor-student interactions (course sessions and TA office hours). Therefore, the learning objectives established for the entire course over the year can be supported by the values of the Constellation project and the TILE space in collaboration. *Tbl. 1* identifies six different objectives enabled by these two teaching paradigms. The scientific method is first introduced by readings and writing assignments covering the assigned texts and then further reinforced by activities completed in-class. Models created and worked upon in those activities give memorable and tangible experiences for the retention of general scientific knowledge. Lastly, the focus of the course on life on Earth provides a center for the discussion of scientific discoveries.

<table>
<thead>
<tr>
<th>Constellation Project</th>
<th>TILE Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific Method</strong></td>
<td></td>
</tr>
<tr>
<td>Critique scientific arguments by identifying and challenging assumptions made by the author(s)</td>
<td>Facilitate collaborative group work by the division of labor (manager, recorder, skeptic) during in-class activities</td>
</tr>
<tr>
<td><strong>Scale of a System</strong></td>
<td></td>
</tr>
<tr>
<td>Integrate different perspectives of a system (eg. mass and energy, earth, life) with respect to an interdisciplinary context</td>
<td>Model a scientific problem through active learning exercises to retain both memorable experiences and practical knowledge</td>
</tr>
<tr>
<td><strong>Biological Evolution</strong></td>
<td></td>
</tr>
<tr>
<td>Employ basic scientific principles in the analysis of evidence</td>
<td>Contribute towards class-wide discussion to reach a consensus among the positions behind a topic</td>
</tr>
</tbody>
</table>

Table 1: A matrix showing the relation between content objectives set by the syllabus of *Origins*, and those supporting objectives facilitated by the TILE-Constellation Course vision.
Assessment items covering content objectives for the Fall 2013 semester of *Origins*, specifically, were delineated according to the levels of proficiency in Bloom’s Taxonomy as demonstrated by *Tbl. 2*. The amount of progression through each level was determined, in part, by the progress of the course during the semester and each student’s familiarity with the material. As the course developed, the opportunity to present the students with increasingly challenging tasks was met primarily through in-class activities.⁹ *Tbl. 3* lists the verbs contained in learning objectives prompting the activities supporting the three main semester outcomes of the course.

<table>
<thead>
<tr>
<th>Structure and Order of the Universe</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Synthesis</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Processes on Earth</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Biochemical Origins of Life</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Table 2: A chart of the levels of proficiency probed by the learning objectives of in-class activities of the course.

<table>
<thead>
<tr>
<th>Structure and Order of the Universe</th>
<th>Physical Processes on Earth</th>
<th>Biochemical Origins of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define, describe, distinguish, identify, observe, relate, report</td>
<td>Appreciate, compare, create, define, infer, know, learn, pose, re-familiarize</td>
<td>Apply, connect, define, describe, determine, distinguish, evaluate, examine, explore, identify, integrate, list, predict, research, recall, simulate, use</td>
</tr>
</tbody>
</table>

Table 3: A selection of distinct verbs used in the learning objective statements that open each in-class activity.

*Activities*

The in-class activities provided students with hands on interactive learning and the opportunity to engage with faculty experts leading the discussion of the material. Team based investigations usually involved a model that simulated general scientific principles. For example, students: counted galaxies in an image taken by the Hubble Space Telescope, used several balls of various sizes to construct the solar-system to scale, formed an arm-linked chain to feel the difference between seismic wave types, compared their finger nail growth to the movement of tectonic plates, used bags of differently popped corn to sample radioactive isotopes and their...

⁹ See Appendix C for a complete list of the Fall 2013 in-class activity titles for the course
half-life, determined whether or not an imperfectly self-replicating robot chicken could be considered alive, ate m&m’s to represent the effects of natural selection on a target population, set the parameters to an online simulation of a meteorite or asteroid impact with Earth, drew a “touchdown” timeline of the history of Earth to mark the number of yards for the appearance of each geologic event, handled fossils from the collection at the Department of Geology, and synthesized at the end of the semester an entire timeline of the history of the Universe from the perspectives of astronomy, geology, and biology. Moreover, Dale Stille of the Department of Physics & Astronomy provided instructional demonstrations for the course, including: samples of radioactivity, the greenhouse effect, and a Miller-Urey set-up.

Exams

Three exams, totaling 50% of the student’s final grade, were administered in the usual format featuring multiple-choice questions, matching diagrams, and short answer questions. Study guides for each exam were provided, outlining specific questions about the topic of each activity as well as recalling the relevant learning objectives and models investigated in class. Only the free response drew heavily from the activities, citing multiple part questions intended to elaborate upon the student’s prior work. These questions gave the students most trouble because their interpretation (application/analysis) of the information they could recall (knowledge) from the activities was usually flawed in a fundamental way (see Completed Grades and Statistics). It is suggested that the short answer questions more explicitly follow a progression through levels of proficiency so that students can “discover” connections they did not previously learn at a higher level of achievement and to reveal stumbling blocks in their knowledge. In Tbl. 4, the content of short answer questions for each exam are listed.

<table>
<thead>
<tr>
<th>Midterm Exam 1</th>
<th>Midterm Exam 2</th>
<th>Final Comprehensive Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Density of Earth’s interior layers</td>
<td>1. Definitions of life</td>
<td>1. Timeline of the Universe</td>
</tr>
<tr>
<td>2. An example of orders of magnitude</td>
<td>2. Biological family tree</td>
<td>2. Comparative planetology of Venus, Earth, and Mars</td>
</tr>
<tr>
<td>5. Age of the solar system</td>
<td></td>
<td>5. Rates of geologic processes and plate tectonics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Birth of the solar system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Biochemistry of life on Earth</td>
</tr>
</tbody>
</table>

Table 4: A listing of the topics addressed by short answer questions on each exam administered in the Fall of 2013. Review Fig. 1 for a comparison between the thematic units of the course and this table.
**Quizzes**

Readings for the course followed the topics outlined for each session and were based on two textbook resources and a supplementary popular science book (see syllabus). Multiple-choice quiz questions covering the assigned textbook readings were administered as a preparatory review for activities on the second day of class. First taken individually, students were then given the opportunity to collaborate with their group by recording answers on a scratch-off sheet. The number of attempts to determine the correct answer to a question, however, counted negatively to the overall score for the group of students.

**Writing Assignments**

In addition to the two textbooks assigned for the Origins course, students were also asked to read Neil Shubin’s short book, The Universe Within, as a complementary introduction to the genre of popular science writing. The text offers insight into how the human body, like a rock, carries a record of its origin and shaping. Shubin weaves together a narrative of his adventures as a geologist with the personal stories of the not-always-featured scientist who made important discoveries about milestones in the history of the Universe for life on Earth, such as: the Big Bang and our atomic composition, formation of the solar system and the presence of water on Earth, the diurnal motion of the Earth influenced by the hypothesized cataclysmic impact that formed the moon, the great oxidation of Earth’s atmosphere, the plate tectonics of continental drift, the catastrophes ending the reign of the dinosaurs and other early inhabitants of Earth, and the carbon cycle’s impact on global climate change. The purpose of the writing assignments, which covered this text as well as other topics discussed in class, was to give students an independent medium from which to work through course material alone and to have later as useful reference.

There were 5 different types of writing assignments that students completed in the Fall 2013 semester. A chart detailing the instructions and learning outcomes of each assignment can be seen in Tbl. 5.

<table>
<thead>
<tr>
<th>Description</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept Maps</strong></td>
<td>The desired format was not restrictive, so long as the students recorded multiple lines of evidence that linked together thought bubbles from the text in support of the central idea. A sample map for the first chapter was provided along with the instructions of the assignment for reference. To</td>
</tr>
<tr>
<td>For each chapter in the Shubin reading, students organized around 10 pieces of evidence supporting a central “Big Idea” that could be quoted as a thesis statement from the text. They provided reference page numbers and used the outlining concept map to summarize the chapter in a well-</td>
<td></td>
</tr>
</tbody>
</table>

“The reading quizzes... held me accountable”
(Final Course Evaluation, Additional comments)
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shubin Synthesis</td>
<td>After completing concept maps for the first 8 chapters of the Shubin text, the students wrote a short essay summarizing the purpose of the book and traced a recurring theme through several of the chapters using their concept maps as a reference. Lastly, they described their personal impressions of Shubin’s writing style. Students showed a keen interest in investigating further, in the style of Shubin, biological discoveries that were not presented in the text. They also found the rare glimpse of the personal side of science to be enjoyable, if not in correspondence, with the progress of the Origins course through surprising discoveries.</td>
</tr>
<tr>
<td>3 Surprising Facts</td>
<td>In the final weeks of the semester, prior to the Thanksgiving holiday, students were asked to recall 3 surprising concepts that they learned, to date, in the Origins course. They explained each concept with reference to specific sources from the activities, lectures, and readings. A fully written sample paragraph was provided to the students in order to facilitate grading review over a uniform range (formatting) of submissions. See Fig. X for a distribution of the mentioned facts.</td>
</tr>
<tr>
<td>Model Demonstration</td>
<td>Choosing from one of the facts they described in the previous assignment, the students were tasked over the Thanksgiving holiday with presenting a “model” of the concept to their family or friends using parts of the in-class activities and any other resources they found useful. Again, a template write-up was given to the students for their reports. Many novel models were presented to family and friends, and the students found that this activity generated a lot of discussion with those groups. They also had the opportunity to record questions asked about the concept that they could not answer.</td>
</tr>
<tr>
<td>Timeline of the Universe</td>
<td>For extra-credit, willing students were given a list of events obtained from the Shubin reading and in-class lectures to place on a timeline. The list was segregated into 3 categories so that they could choose a distribution of events to describe in detail. In addition, students wrote the names and discoveries of scientists for 6 events. Because of formatting issues, the timeline template was not drawn to scale and therefore students still had to rely on “calendar” analogies presented in the readings or in class to gain a concept of cosmic time. Around 50% of the students completed submissions to this assignment.</td>
</tr>
</tbody>
</table>

Table 5: A chart of the different writing assignments assigned in Origins during the Fall 2013 semester describing the specific instructions and goals for each.
**Sample Student Submissions**

Due to the novel design of many of the assessment items in the *Origins* course, a strict rubric for student submissions (excluding the templates and examples provided) was not created. The writing components of the course were instead judged according to a four-part scale with equal points assigned to the introduction, body, conclusion, and style of the piece. Concept maps submitted by students varied widely in format, so a general components requirement in addition to the example assignment was developed, *Fig. 4.*

**Figure 4:** The purpose of the concept mapping assignment was twofold: first, to assist the student’s ability to understand the author’s argument by organizing the evidence that supports a chapter’s main idea, and second, for the student to pose in writing their own reflection, which is part summary and ends in their own conclusion of the importance of the reading. Therefore, the assignment required a concept map centralized by the author’s Main Idea (MI), demonstrating at least 2 different branching Examples (X) of that idea, supporting the main idea with at least 2 layers of evidence (E), and exhibiting closure by at least 1 Interconnecting Statement (IS). The paragraph response introduced the author’s main idea as a thesis statement, was supported with at least 3 examples the student’s argument behind the thesis statement, and concludes with a highlighting example of the chapter.

Figures 5 and 6: (right and below) Student concept maps utilized both freehand and printed layouts, while both styles connect thought bubble with drawn lines indicating the verb or phrase that links together the intermediate ideas: which, caused, determined, based on, to form, etc. The quote is taken from a paragraph.

“I loved the concept maps. They were extremely helpful to review” (Final Course Evaluation, Additional comments)

“...you can visually show what Shubin does in writing” (Shubin Synthesis Essay)
Figure 7: A timeline from the extra-credit assignment unifying important cosmic and geologic events discussed in class and investigated through activities (bottom) and Shubin’s style of acknowledging the scientists responsible for discovering these events (top).

“Before our species were here on Earth, change took billions of years to transform the planet; now because of our biological inheritance (intelligence), change is driven by single ideas traveling at the speed of light” (3 Surprising Facts Essay)

From the “3 Surprising Facts” essay, a confirming even distribution of concepts were recalled by the students and elaborated upon through referenced activities, lectures, and readings. Fig. 8 shows the main categories of concepts that were discussed by the students, using the color scheme below to show each category’s association with the main disciplines (see Fig. 1) utilized by the Origins team of instructors.

- 26% ASTRONOMY
- 25% BIOLOGY
- 25% GEOSCIENCE
- 24% CHEMISTRY (Interspersed as biochemistry, chemical bonding, and reactions)
Completed Grades and Statistics

The first implementation (Fall 2013) of the *Origins* program challenged traditional avenues of teaching, including the delivery of a grade metric to the enrolled students as a report of their progress towards the learning objectives of the course. Graduate teaching assistants were responsible for all the grading of the course assessment items (Fig. 9), except for the final exam for which the lead instructor also reviewed a portion of the short answer questions. In-class activities served primarily as a completion and participation grade, because a lot of material was reviewed during class wide discussions. In class-quizzes, on the other hand, were graded for accuracy. Following the simplified grading scheme described in the previous section, the various writing assignments of the course were mainly graded in terms of the presentation of the material.

The following series of charts describes the grade outcomes of each assessment item recorded for *Origins* (Fall 2013) using the ICON (Iowa Courses Online) resources provided by the university. These charts detail the statistics and distribution of grades for each item serving as a final snapshot of the class of student’s level of progress.
### In-class Activities Class Statistics
- Number of submitted grades: 74 / 74
- Minimum: 89.5%
- Maximum: 100%
- Average: 98.9%
- Mode: 100%
- Median: 99.8%
- Standard Deviation: 2%

### Concept Maps Class Statistics
- Number of submitted grades: 74 / 74
- Minimum: 44.5%
- Maximum: 99.5%
- Average: 89.5%
- Mode: 96%
- Median: 93.3%
- Standard Deviation: 10.2%

### Individual Quizzes Class Statistics
- Number of submitted grades: 74 / 74
- Minimum: 48%
- Maximum: 98%
- Average: 83.1%
- Mode: 92%
- Median: 85%
- Standard Deviation: 10.2%

### Group Quizzes Class Statistics
- Number of submitted grades: 74 / 74
- Minimum: 67%
- Maximum: 100%
- Average: 94.1%
- Mode: 100%, 96%
- Median: 96%
- Standard Deviation: 6.5%

### Midterm Exam 1 Class Statistics
- Number of submitted grades: 74 / 74
- Minimum: 32.7%
- Maximum: 96.7%
- Average: 75.6%
- Mode: 81.3%, 89.3%, 68
- Median: 78.3%
- Standard Deviation: 15.3%
Notice that the first three assessment items (activities, writing assignments, and individual quizzes) have at least a 10% higher average than the midterm exams. However, the latter individual quizzes are possibly correlated with the student’s success on the final exam multiple-choice questions. A useful follow-up study at the year’s completion of Origins will be the comparison of grades between other general education science courses and this course, such as:

- 012:004 – Evolution and History of Life (geoscience)
- 029:053 – Life in the Universe (physics & astronomy)
- 113:013 – Human Origins (anthropology)
- 003:022 – Understanding Evolution (biology)
III. Breaking Down the Assessment Cycle

❖ Reliable and Valid Assessment

Not all assessment is created equally; like the results of a scientific experiment, the outcomes of an assessment item can be subject to bias and distortion. The terms, reliability and validity, are used to describe the degree to which the interpretation of an assessment item may be considered sound. Reliable assessment consistently produces the same outcome for students within some acceptable margin. For example, a science literacy pretest should indicate the level of preparedness of the class of students regardless of when such a test is administered; only the current ability of the students is desired, just as the current weight of an individual is measured consistently on a bathroom scale. Ideally, a science literacy posttest could then indicate the class of students’ level of improvement after an amount of instruction. This last statement refers to valid assessment in which the desired outcome is an accurate depiction of the class of students’ achievement. Thus, reliability implies the comparison between the same or multiple measures of assessment while validity implies an agreement between the assessment outcome and an instructional objective or criteria.

Following the assessment cycle (Fig. 2) used in Origins, the process of instruction incorporated various components of assessment, repeated each week for different topics, all at different levels of proficiency. Reviewing the total assessment carried out in the first part of the course uncovers opportunities to build credibility for the full completion of Origins. These suggestions are outlined in Tbl. 6.

<table>
<thead>
<tr>
<th>Type of Reliability</th>
<th>Did Complete</th>
<th>Can Implement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>Only the 4 Questions activity was repeated in this course. However, students also had the weekly opportunity to first complete an individual reading quiz in class before attempting the questions together in groups.</td>
<td>During the activities, the questions in the worksheet can be arranged in a pre-activity/post-activity format. Identifying these questions to the students also assists the TAs that are grading and checking for proficiency.</td>
</tr>
<tr>
<td>Alternate Form</td>
<td>All assessment items assigned to the students were uniform in task. It is also possible to hand out different activities to each student group seated at the team tables. For example, a discussion could follow from the comparison of a team’s model for the solar system, diagram of the distance to objects in the</td>
<td>In addition to spacing students apart when administering exams, the instructors could also distribute a Form A/Form B test in order to reduce the possibility of academic dishonesty, and further, to test potential questions (some may not even be graded) for future assessment items of this course.</td>
</tr>
</tbody>
</table>
Universe, and timeline of the history on Earth with respect to orders of magnitude in space and time. In fact, such an exercise has occurred previously in the *Life in the Universe* course (see previous section for course number).

<table>
<thead>
<tr>
<th>Internal Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No comprehensive review of the assessment material has yet occurred, although a few brief comments about the overall design of the activities will be discussed in this report.</td>
</tr>
<tr>
<td>In retrospect, multiple choice or short answer questions on the exams referring to different disciplines can be compared to see if students uniformly grasped the material. If not, the other assessment items of the course can be reviewed to note any difference in teaching strategies among the instructors.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
</tr>
<tr>
<td>The close correspondence between the Shubin text and the progress of session topics allowed students to construct a framework, through concept maps, of the content with which they worked in class activities.</td>
</tr>
<tr>
<td>Each exam serves to benchmark either unit learning or cumulative understanding. Thus, it follows that some questions on the midterm exams can be geared specifically towards specific semester based objectives of the covered content while the final exam can also address the yearlong objectives of the course.</td>
</tr>
<tr>
<td><strong>Criterion</strong></td>
</tr>
<tr>
<td>The charts in the previous section demonstrate that students did improve by a near 10% increase in the average quiz score when working in groups to select the correct answers as opposed to individually.</td>
</tr>
<tr>
<td>The results of final student grades and exam scores can be compared against other general education science courses offered at the university as described in the previous section.</td>
</tr>
<tr>
<td><strong>Construct</strong></td>
</tr>
<tr>
<td><em>Fig. X</em>, shows the distribution of final grades between students enrolled in the honors rhetoric section of the course and the rest of the class. The honors students constituted half of the top 10% achieving students. However, the majority of these students are not declared science majors.</td>
</tr>
<tr>
<td>A final survey of the students at the completion of <em>Origins</em> can indicate the necessity of a science literacy pretest to gauge the level of next year’s entering class. Affective responses such as, familiarity with the material, experience with science, and class year can be addressed.</td>
</tr>
</tbody>
</table>

Table 6: A chart of the attempted work done to demonstrate the effectiveness of the *Origins* teaching program.
Formative and Summative Assessment

There are many kinds of classroom assessment items that can be implemented into a course’s instructional strategy. Broadly speaking, these assessments facilitate improved progress towards course objectives by seeking to address the degree of student achievement and the degree of effectiveness of the applied teaching methods. This information can also be relayed back to the student, however, roughly separating assessments by the manner of delivery into two categories – formative assessments and summative assessments. Any on-going items, reviews, or observations intended to provide feedback to the instructor helping to modify the learning process is included in formative assessments. In Origins, the weekly organizational meetings for the faculty and graduate assistants also served as a forum to discuss the design of upcoming in-class activities, writing assignments, and other material to be presented in the classroom.

Summative assessments, on the other hand, typically evaluate the student’s learning at benchmarks assigned by institutional conventions, such as midterm and final exams or standardized tests. While the Origins course did not specifically align its learning objectives as a continuation of the K-12 Next Generation Science Standards[10] for high-school curricula, several topics from Units 2-3 (Fig. 1) do overlap with the defined Practices (process verbs), Core Ideas (content), and Crosscutting Concepts (interdisciplinary themes) of the standards. In this instance, the Origins team of instructors was able to provide content expertise and research experience in conjunction with the TILE classroom space for a new collaborative learning environment to reach these goals. A description of different assessment items used in Origins is presented according to the formative/summative distinction in Tbl. 7.

<table>
<thead>
<tr>
<th>Level of Proficiency</th>
<th>Formative Assessments</th>
<th>Summative Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Individual Quizzes</td>
<td>Group Quizzes</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Concept Maps</td>
<td>Matching Exam Questions</td>
</tr>
<tr>
<td>Application</td>
<td>4 Questions Worksheet</td>
<td>Order of Magnitude Example</td>
</tr>
<tr>
<td>Analysis</td>
<td>3 Surprising Facts Essay</td>
<td>Extra-credit Timeline Activity</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Model Demonstration</td>
<td>Shubin Synthesis Theme</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Shubin Synthesis Critique</td>
<td>Final Student Evaluations</td>
</tr>
</tbody>
</table>

Table 7: Examples of tasks at different levels of proficiency according to Bloom’s Taxonomy.

In-progress Student Feedback

In order to establish an operating framework, both in the instructors’ and students’ minds, for the implementation of the Origins course, several check-in surveys were carried out in the classroom to generate feedback. These surveys were given at the beginning, middle, and end of the semester in two categories – a pair of content focused and a pair of learning focused worksheets. The two content focused surveys are adapted from the suggestions of Jean Florman.

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[10] Finalized at the end of 2013, the standards are fully described here: [http://www.nextgenscience.org](http://www.nextgenscience.org). The Origins course design, however, instead followed the expertise of involved faculty members and institutional resources available at the University of Iowa including: Center for Teaching, Pentacrest Museums, departmental collections, and local state geology.
of the Center for Teaching, in which students were first tasked in the first week of the Fall 2013 semester to write individually, review as a team, and choose as a table the four most compelling questions that they should expect to answer during the course. At the end of the semester, the activity on the final day of class incorporated a pre-quiz that returned to the 4 Questions assignment and prompted four adapted questions from the original set that could be answered using knowledge gained in the first part of Origins. The selection included:

- A global definition of life is?
- Using the local definition of life, put these four lists of items in order of increasing complexity…
- According to David Des Marais (a NASA researcher who presented to the class), which of the following biosignatures is the most practical to observe and provides the best evidence for life as we know it on planetary bodies other than Earth?
- If found, why is extraterrestrial life or evidence of it more likely to be simple (i.e., single-celled) rather than complex (multi-cellular and beyond)?

After responding to these multiple-choice styled questions, the students worked again in teams to propose and select the most compelling question, out of four, to investigate further in anticipation of the Spring 2014 semester of Origins. A watermark collage of student responses to both activities can be found on the second page of this report after its title.

To judge and improve the teaching of Origins, learning focused surveys provided traditional feedback about course progress and instructional methods. A mid-semester review queried the students about the aspects of the course that were most helpful and most challenging in meeting the established learning objectives. Their responses can be summarized by the following quotations.

The positive:

+ “I like that in class [there] is a lot of review and clarification of the material we read”
+ “Demonstrations (p&s waves, rocks) and activities (m&m, popcorn) that have me walk through the concepts step by step… breaking down complex concepts with [relevant] examples”
+ “I really enjoy the fact that the groups are a big part of class. The cooperation aspect really helps me understand the material”

and the negative:

− “Since this course needs all students on the same “playing field” in terms of scientific literacy, there is a lot of basic information that is hard to recall at times”
− “We rush through the activities and hardly spend any time on the lesson learned through the activity. I wish we focused more on the results [rather] than the process of our activities so I could grasp the concepts”
− “Work[ing] with teams prohibits extensive understanding that working as an individual would provide. Often, groups will search for the correct answer without being mindful of ensuring there is clear understanding between everyone”
In order to accommodate review requests from the different departments of the involved instructors and to address the effectiveness of the Tile-Constellation vision set out for the *Origins* course, a custom final evaluation form composed of snippet questions from the traditional ACE (Assessing the Classroom Environment) form and supplementary questions was created. Students were given two separate bubble sheets to complete; one specifically assessed the instructors’ ability while the other specifically assessed the effectiveness of the course. The free-response questions under the course assessment inquired about the most significant benefit of the TILE classroom and any changes that the students thought could be made to improve the course in the interim between semesters. For the limited use of technology in the classroom (multiple displays, document camera, and a few internet search activities), the reviews of the TILE space were mostly positive and focused more on the enhanced group work facilitated by the room seating than the electronic resources. The most striking criticisms, on the other hand, took the same tone as those listed above in the mid-semester survey. There is some learning tension with depending on in-class activities and teammates to uncover (process) an accurate description of the principles of a concept (results). Additionally, even though students were distributed in terms of basic qualifiers (class year, honors/general education, gender) into pre-assigned groups, individual students felt that not all learning styles (in terms of challenge) were catered to. Instructors can respond to this issue by designing a thoughtful progression through Bloom’s levels of proficiency in most assessment items of the upcoming Spring 2014 part of *Origins*.

“Overall, this course is excellent how it makes science appealing for those who don’t like science. The work/effort put into all of the activities and examples makes me think [that] you all actually care how I do in the class. I’m glad I took it!” (Mid-semester Survey, Q4)
IV. Concluding Remarks

❖ Summary of the Report

*Origins of Life in the Universe* attempts to bridge instructors and students from across the University of Iowa through new educational resources to renewed discoveries in learning under the TILE-Constellation vision. Implementation of this vision required the organization of an assessment cycle to effectively communicate information between faculty members and graduate assistants involved in the design and instruction of the course. Workshops and consultation with the Center for Teaching and Office of Assessment at Iowa facilitated the framework of educational principles that support the goals of *Origins*. The creation of learning objectives using the language of Bloom’s Taxonomy assisted the promotion of an active, guided-learning environment in which students worked in small groups and teams to complete tasks in class. These objectives also guided the interpretation of the success of the first part (Fall 2013) of *Origins* through the lens of different levels of student proficiency in learning. The enrolled student demographic challenged aspects of the course, in particular with respect to the level of difficulty of the assessment items confirmed by responses to the final evaluations and final distribution of student grades. Improvement can be made by the judicious selection of session topics and supporting examples for the concepts that are addressed by the desired learning outcomes of the course. *Origins* is, of course, a work still in progress.

❖ Chance for Discussion

Several assessment items in the course prompted students for Big Questions that were inspired by the *Origins* course. The second page of this document clearly shows how far reaching that collage of questions can be. Students even had the opportunity to ask a research professional working with NASA on some of these problems about the potential answers. Observations of the issues raised by students in these assessments can separate basic questions into two types—those that are fundamental and those that are topical. For example, some students demonstrated a lack of understanding, or misunderstanding, of the fundamental principles behind the concepts addressed in the short answer questions of the final exam (see Completed Grades). On the other hand, popular subjects often inquired by students were usually based on topics relevant to them before engaging material in *Origins* but nonetheless inspired by it (see 4 Questions Assignment). Because of the number of instructors and graduate students involved in the course, it is suggested that an online forum space be created where these questions can be discussed without disrupting the progress of the course yet also incorporating technology outside of the classroom.

“What I USED to think and what is inaccurate is the idea that there are more of the stronger species because they kill off the other ones. What [natural selection] really means is individuals with certain traits are more likely to survive, therefore more likely to pass those traits on to the next generation (Day 12 Lecture). Until this course I never thought there was a connection between evolution and natural selection” (3 Surprising Facts)

“[My father] continually asked about Creation and God, and when trying to tell him that science and religion can both function next to each other without conflict, I got pretty discouraged. This course is really challenging me to open up my mind as both a student and Christian, and inspires me to learn more in both areas” (Model Demonstration, Interview questions)
Final Recommendations

The next step in fully realizing a successful TILE-Constellation vision is to make transparent the assessment design to the students themselves, more so than their awareness of the feedback process and more inline with a course rubric that answers the question: *How will the students achieve the learning outcomes of Origins?* In particular, now that learning objectives are an established practice for the curriculum development, instructors should also utilize the levels of proficiency of Bloom’s Taxonomy to organize and describe assessment items to themselves and their students. This report proposes the use of a prioritized proficiency design in which students clearly recognize an ascending ladder of difficulty that is set to the levels of proficiency required to reach the desired learning objective. For example, the final exam short answer questions did just this in delineating multiple parts and point values to the questions. However, the expectations may have been set at a level too high for the students. Such a scheme should first be built into the in-class activities to improve familiarity with the system. An item tested at the beginning of the course was the introduction of extension questions placed at the end of an activity to provide early finishing groups with an opportunity to learn more and gain a glimpse at possible short answer questions. Since the amount of duration needed to complete each activity was not determined prior to class, many student groups did not finish the entirety of several activities. These types of questions could be kept for student review, if other recovery questions placed in different locations of the activity are used to test in-progress what the students are learning for instructor- and self- feedback. The bonus of these questions is the ability to grade them for accuracy as well rather than the counting whole assignment as participation. Origins is a program seeking to bring instructors in collaboration with students to enable self-discovered learning.

“Re-teaching the definitions and having to answer questions my parents had asked helped me to really understand the information more than I ever had before. Throughout this class, I have really learned some new concepts that I had never thought of before” (Model Demonstration, Conclusion)
V. Appendix

❖ Student Success Proposal

TILE Learning Across the Disciplines:
Development of the First TILE-Constellation Course

*Origins of Life in the Universe* (a Pilot Program)

**Director:** Professor Cornelia Lang, *Department of Physics & Astronomy*

**Collaboration** between the *Departments of Physics & Astronomy, Biology, Chemistry, Geosciences, Anthropology, Center for Teaching*, and the *Pentacrest Museums*

I. Introduction and Motivation of TILE-Constellation Courses

One of the keys to undergraduate student success is finding ways to actively engage students in their learning experience. Large introductory courses often rely heavily on textbooks and lecture-driven learning to cover a prescribed set of topics in a single semester. Student learning tends to be passive in these "listen-and-repeat" courses. However, research shows that students derive strong benefits from educational experiences that force them to directly engage with the material, their classmates, their TAs, and faculty members. Transitioning to active learning styles remains a challenge for large-enrollment courses. Another challenge to teaching introductory-level material is the increasingly cross-disciplinary nature of many of the most exciting and intriguing fields (e.g., biopsychology, astrobiology, women’s studies, etc.). It is by studying at these intellectual intersections that undergraduate students can become the most energized in learning and developing the skills for a successful career at the university and beyond (skills in critical thinking, analytic reasoning, presenting ideas coherently, questioning and even knowledge creation). How can we overcome these challenges in introductory-level teaching and improve student success in this area?

**The TILE-Constellation Course Vision:** One solution to the above problems requires a transformation in the way an introductory course is taught. There are two aspects of this transformation: (1) dedication to an inquiry-based mode of teaching (TILE; e.g., Lee, Virginia S., ed., *Inquiry-Guided Learning, in New Directions for Teaching and Learning*, Catherine Wehlurg, Editor-in-Chief, Number 129, Jossey-Bass, San Francisco, 2012) and (2) commitment to bringing together faculty from different departments to address exciting and cutting-edge cross-disciplinary subjects. A cross-disciplinary course need not be ‘content heavy’ just because it brings together material across disciplines. In fact, the reverse is true – because there is much overlap, we want students to view related material through the lens of different disciplines. Inquiry-guided learning facilitated by a TILE classroom allows ample time during class periods for the students to grapple with material, make presentations, acquire new knowledge, skills, and attitudes, explore topics of interest, and gain experience with research and communication amongst their peers. Because such a course will bring together a constellation of disciplines and learners (students, TAs, and even faculty themselves!), we have chosen the name of a “TILE-Constellation Course”. **Target audience:** First- and second-year students are particularly open to these types of experiences (and are working to fulfill GERs) and therefore represent an ideal target group for the TILE-Constellation Course. We also anticipate that exposure to the diverse collection of active research professors who would teach this course may inspire these early-career students to pursue research experiences at the university (which is ideal for a Research 1 campus such as ours).
The TILE-Constellation Courses have several objectives: (1) Provide students with a large number of their peers (~80 students) with whom they can identify and connect. We propose to teach TILE-Constellation Courses in VAN 350 (TILE room with 81 seats). Although students in this course will have a seminar-like experience, we want a large array of students to have the opportunity to learn in this way. (2) Extend over a year-long period (Fall AND Spring semester) to maximize student success through forging substantial relationships between students, TAs and faculty, and to allow students to develop academically over a longer period of time with the same instructors. (3) Provide meaningful learning experiences outside the TILE classroom, both on and off campus. To this end, we plan to incorporate the resources of the Pentacrest Museums, tours of faculty research labs and creative studios, libraries and facilities across campus, and nearby sites of related interest (the Devonian Fossil Gorge, Pal-Dows Observatory), into the TILE-Constellation Course experience. In addition, each semester we plan to bring in 1-2 well-known lecturers who will meet with the students in class and also give a general public lecture as part of their visit. Finally, faculty, students and TAs will have additional opportunities to connect during weekly student-faculty lunches offered at the dining halls.

Vision for TILE-Constellation Courses at U Iowa: The long-term vision is to use the experience gained through the proposed activities as a template for other TILE-Constellation courses across campus. Ultimately, the University would offer 10 such courses to first and second year students so that ~800 undergraduate students a year would have the opportunity to participate. Future courses have been discussed informally with faculty colleagues; several have already volunteered to be part of the following:

- **Writing, Visualizing and Performing Jazz** (Departments of Music, American Studies, English, History, and Art and Art History)
- **The (In)visible Universe: Imaging and Imagining Artscience** (Departments of Art and Art History, Physics and Astronomy, Chemistry **(note: this course was offered as a graduate studio art course in Spring 2010 taught by Professors Lang and Fryer and was very successful).**
- **The Bio-Sociology of Gender** (Departments of Sociology, Women’s Studies, Gender and Sexuality Studies, Biology and Psychology)
- **The Physical Body** (Departments of Dance, Theater, Exercise Science, Biology, Physics and Astronomy and Anatomy)

II. Design of First TILE-Constellation Course: Origins of Life in the Universe

We ask for funding support over the next three years to develop and teach a TILE-Constellation course that will serve as a template for others in the future. The first year will be spent developing the course (AY 12-13); in the second year (AY 13-14), the course will be taught without lab, and in the third year (AY 14-15), we will use our assessments to make changes and teach the course again, and offer a 1 s.h. lab. The topic we have chosen is one of fundamental interest: *Origins of Life in the Universe*. Based on GER course enrollments in the Departments of Physics & Astronomy, Geosciences and Anthropology, where similar courses are taught, there should be a healthy market for this new course. In fact, according to three years of enrollment records, there has been a steady large number (~600 students per semester) in these courses (e.g., 29:50, 29:52, 29:53, 12:004, 12:007, 113:13). The addition of biology and chemistry concepts that are fundamental to understanding the origins of life in the universe should only increase the interest level in taking the TILE-Constellation course.
The proposed topic can also be viewed as “Big History” which is an emerging field in its own right. “Big History” attempts to understand the integrated history of the Cosmos, Earth, Life, and Humanity, using the best available empirical evidence and scholarly methods (see https://eps.berkeley.edu/~sackow/chronozoom/). We plan to make use many interactive and cross-disciplinary resources. We will consider using one of the following popular books on Big History that have recently come out: e.g., Big History: From the Big Bang to the Present by Cynthia Brown and Maps of Time: An Introduction to Big History by David Christian. The curriculum of the Origins of Life in the Universe course will follow six thematic units (with “Big Picture” questions) listed below. During the third year (AY 2014-15), the second time the course is offered, we will offer a 1 s.h. lab, and students taking the year-long course will fulfill their entire Natural Sciences GER.

We have agreed on the following six “units” for our Origins of Life in the Universe Course:

(1) **Origin of the Universe (Astronomy & Geosciences)**
- What is the universe made of and how did it form?
- How was our Sun formed?
- What is the origin of our Solar System?

(2) **Origin of Life (Chemistry & Biology)**
- What happens when stars die, and how is this essential to the development of life?
- What is the biochemical basis of life as we know it?
- How do scientists study the Origin of Life?

(3) **Origin of Life on Earth (Chemistry, Biology & Geosciences)**
- How has the Earth’s surface and atmosphere changed through time?
- What is the evidence for the earliest forms of life on Earth?
- What are extremophiles and why are they important to understanding life?

(4) **Evolution of Life on Earth (Astronomy & Geosciences & Biology)**
- What was life like 3 billion years ago? 1 billion years ago? 500 million years ago?
- What were the major transitions in the evolution of life on Earth?
- How have we reconstructed this history from the fossil record and other evidence?
- How have mass extinction events impacted the evolutionary history of our planet?

(5) **Origin of Humanity (Anthropology)**
- How did humans originate on Earth?
- How have humans changed over time on Earth: from early history to modern times?
- What is the role of humans on Earth? Are we special?

(6) **Searching for Life in the Universe (Astronomy & Anthropology)**
- What are the physical constraints on life elsewhere in the Universe?
- What are the limits and limitations in our search for life in the Universe?
- How are humans modifying the world currently, and how does that affect the future of the planet?

![Figure 1: A schematic showing the six thematic units of Origins of Life in the Universe and the departments that will make the major contribution to each unit (faculty collaborators who will teach are listed in Section IV).](image-url)


III. Success and Assessment in TILE-Constellation Courses

**Student success:** The inquiry-guided (TILE) method of teaching allows students to develop critical thinking skills and become skillful communicators (as they work in teams to solve problems related to course content and present their findings and ideas to classmates, TAs and faculty members). We recognize that there will be challenges to student success in such a transformative course: student retention for both semesters and student adjustment to the TILE method of learning; however, we feel that once students are immersed in the course, they will become more confident, interested and ultimately be reluctant to leave. Finally, we are hopeful that a portion of students may be inspired to pursue physical science majors (though that is not our primary motivation).

**TA success:** The TAs will play a crucial role in assisting students and for providing feedback on students’ approaches to solving problems (a major role for TAs in the TILE classroom setting). This experience can be very important for the development of TAs into future faculty. One of the challenges to TA success will be to find the most qualified TAs for the positions and we will likely recruit TAs with considerable experience from a broad range of disciplines. The TAs will be responsible for attending each TILE session (class), grading homework and written assignments, leading some course activities, and attending meetings (we will need 2 TAs working 20 hrs/week to serve the class; a third for the lab).

**Faculty success:** Many emerging fields require knowledge of many disciplines and there is much we can learn from our colleagues. Designing and teaching inquiry-guided, team-based courses, developing more personal relationships with undergraduate students and TAs and helping them develop intellectually, over the arc of a year will be very rewarding for faculty. Challenges for faculty success include finding best models for “team teaching”, the large investment of time to develop TILE activities, and coordination with the other faculty. The first year of this project will be devoted to brainstorming with colleagues to anticipate and address these challenges. Continuous assessment of student learning and the course will help the faculty team reform and strengthen future iterations.

**Assessment:** Assessment of the impact of this curriculum transformation project will be designed and carried out by the faculty team in consultation with the Center for Teaching, and with advice and feedback from the Office of Assessment (Wayne Jacobson). A project of this scope and potential impact, however, would require a graduate RA (10 hrs/week from the onset of project) dedicated exclusively to working with the team to brainstorm and refine the assessment questions, collaboratively develop strategies to gather and analyze assessment data, and synthesize the significant amounts of information gathered. In particular, because development of the first TILE-Constellation Course is a pilot program, assessment is crucial. There are two aspects of assessment: (1) Project Assessment and (2) Student Learning. We will approach them the same way and first determine the essential questions: What are the most appropriate and useful objectives of the course? How can we best determine that we have achieved these objectives? Based on the assessment, what are the next steps? How will we change the courses, teaching strategies, or the project itself in the future? How can involve other disciplines at Iowa and serve as a model for peer institutions? Collaboration on the assessment design (for student learning in particular) is essential so that each unit of the overall course is in sync with the learning objectives and assessment methodologies of the others as well as the overall objectives of the project itself.
**IV. Activities and Preliminary Budget for Origins of Life in Universe**

Budget and activities are summarized below. The total budget ($180,100) for the 3-year program may seem high; however, TA support for this new course is critical to its success.

**Year 1-AY 2012-13: Development of Course**
- Teaching buyout for Lang to develop full TILE-Constellation curriculum (Spr 13)
- Grad RA (20 hr/week) to assist in course development/assessment plan (Spr 13)

**Year 2-AY 2013-14: Course Taught (without Lab; 6 s.h.)**
- Two field trips (transportation)
- Two invited lecturers (one each semester) to give public lecture, meet w students
- Teaching Assistants (2 TAs needed for new course (20 hrs/week for 2 semesters))
- Course Assessment (1 Graduate RA (10 hrs/week))
- Lab Development (Summer 2014) for AY 14-15
  - 1 month salary for Lang, RA and undergraduate support (20 hrs/week)

**Year 3-AY 2014-15: Course Revised & Taught (w Lab; 7 s.h.)**
- Two field trips (transportation)
- Two invited lecturers (one each semester) to give public lecture, meet w students
- Teaching Assistants (2 TAs (20 hrs/week for 2 semesters))
- Teaching Assistant for Lab (1 TA 20 hrs/week for 1 semester)
- Course Assessment (1 Graduate RA (10 hrs/week))

<table>
<thead>
<tr>
<th>Faculty Item</th>
<th>Year 1 (12-13)</th>
<th>Year 2 (13-14)</th>
<th>Year 3 (14-15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty Salary</td>
<td>$20,000*</td>
<td>$13,000 (summer)</td>
<td>---</td>
</tr>
<tr>
<td>Graduate RA Support (Develop; Assessment)</td>
<td>1 sem; 20 hrs $11,500**</td>
<td>2 sem; 10 hrs $11,500</td>
<td>2 sem; 10 hrs $11,500</td>
</tr>
<tr>
<td>Graduate TA Support (TILE, Grading)</td>
<td>---</td>
<td>2 TAs – 2 sem; 20hrs $46,000</td>
<td>2 TAs– 2 sem; 20 hrs $46,000</td>
</tr>
<tr>
<td>Lab Development (Grad/UG) &amp; Lab TA</td>
<td>---</td>
<td>G+UG: 1 mo (20 hrs) $3600</td>
<td>1 sem; 20 hrs $11,500</td>
</tr>
<tr>
<td>Invited Speakers</td>
<td>---</td>
<td>$2000</td>
<td>$2000</td>
</tr>
<tr>
<td>Field Trips (Buses)</td>
<td>---</td>
<td>$750</td>
<td>$750</td>
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<tr>
<td><strong>Total Budget</strong></td>
<td>$31,500</td>
<td>$76,850</td>
<td>$71,750</td>
</tr>
</tbody>
</table>

*=includes benefits; **=all RA, TA costs include benefits and full tuition for each semester (load > 9 s.h.)

**V. Personnel for TILE-Constellation Course: Origins of Life in the Universe**

**Professor Cornelia Lang** (Department of Physics & Astronomy) — *research interests*: Astrophysics of the Galactic Center; *teaching expertise*: all GER Astronomy courses; TILE activities in intro labs

**Professor John Logsdon** (Department of Biology and Pentacrest Museums) — *research interests*: Origin/Evolution of Biological Novelties; *teaching expertise*: evolutionary biology at all levels

**Professor Andrew Forbes** (Department of Biology) — *research interests*: Ecology in Origin of New Species; *teaching expertise*: co-developed TILE GER course entitled, “Ecology & Evolution”

**Professor Ann (Nancy) Budd** (Department of Geosciences) — *research interests*: Species Originations/Extinctions; *teaching*: TILE majors course and GER “Evolution and History of Life”

**Professor Robert Franciscus** (Department of Anthropology) - *research interests*: Human Evolution/Paleoanthropology; *teaching expertise*: wide range including GER “Human Origins”

**Jean Florman** (Director, Center for Teaching) – Jean will provide support, guidance, and resources to faculty members and research and teaching assistants engaged in this project.

**Consultant: Wayne Jacobson** (Office of Assessment) – Wayne will provide advice/feedback on assessment so that course is evaluated on several levels and adapted for future iterations.

**Note:** We have not yet identified a faculty member from Chemistry, but have several possibilities.
Course Syllabus

Origins of Life in the Universe (Part 1)
29:40 (ASTR:1060), 2:50 (BIOL:1060), 12:45 (GEOS:1060)
Fall Semester 2013

Course Meetings: Tues, Thursday at 3:30-4:45 pm in Van Allen (VAN) 350

Co-Instructors: Dr. Cornelia Lang (Physics/Astronomy) Dr. Andrew Forbes (Biology)
703 Van Allen Hall 434A Biology Building
phone: 335-1945 phone: 335-3006
cornelia-lang@uiowa.edu andrew-forbes@uiowa.edu
Office Hours: Tues 9:30-11:30 am, Thurs. 1:30-2:30 pm Mon. 2:30-4:30 pm, Wed 2:30-3:30 pm

Co-Instructors: Dr. John Logsdon (Pentacrest Museums and Biology Department) Dr. David Peate (Earth and Environmental Sciences)
310 Biology Building B21B Trowbridge Hall
phone: 335-1082 phone: 335-0567
john-logsdon@uiowa.edu david-peate@uiowa.edu
Office Hours: by appointment Mon. 12-3 pm

TAs: Gaby Hamerlinck Chamathca Kuda-Malwathumullage
phone: 335-1086 phone: TBD
gabriela-hamerlinck@uiowa.edu chamathcapri-kudamalwathumullage@uiowa.edu
Office Hours: TILE Student Lounge (VAN 310) TILE Student Lounge (VAN 310)
Mon. & Fri. 2:00-3:30 pm Wed. 8:30-9:30 am & 12:30-2:30 pm

Home Department Chair (DEO): Dr. Hallsie Reno, 203 Van Allen Hall; mary-hall-reno@uiowa.edu

Course Description: How old is the universe? What is the nature of life? How has life evolved on Earth? What are our human origins? Are there other habitable planets in the universe? These fundamental questions revolve around understanding origins from different perspectives: astronomy & physics, geoscience, biology, chemistry, and anthropology. In this course, students will work together with faculty from across several different departments to investigate these questions. We will use inquiry-based activities to build success in critical thinking, teamwork, and effective written and oral communication. This course is intended to be taken over two semesters. Students should plan on taking the spring semester course (29:41), which includes a 1 s.h. lab. If taken in its entirety (recommended), this course fulfills the 7 s.h. natural sciences GE requirement.

Year-long Course Objectives: By participating in this TILE-Constellation course students will be able to:

• Distinguish the parts of the scientific method (observation, hypothesis, experiment, theory) and use these aspects to differentiate between science and pseudoscience.

• Interpret the scale of a system by the use of orders of magnitude and chronology to compare and contrast its various components (e.g. space and time, geologic time, reaction rates, branches of the evolutionary tree of life, human history).

• Apply principles of biological evolution to understand the origin and the history of life on Earth and possibly beyond.

• Demonstrate that they can work effectively in a collaborative and cooperative learning environment.
Fall Semester (Part 1) Objectives: By participating in Origins - Part 1 students will be able to:

- Breakdown the structure and order of the universe over its 13.7 billion year history to the present day solar system.
- Classify the physical processes that have occurred throughout the 4.6 billion year history of the Earth.
- Establish, apply, and outline the biochemical origins and early evolution of life on Earth.

In-class Exams:  
In-Class Exam #1: Tuesday, October 1st in SC 1505 (Seamans Center)  
In-Class Exam #2: Thursday, November 7th in SC 1505

3 Required Books:  
Available: Iowa Book, University Book Store (supply may be limited)  
Amazon: (~$90 new): [http://www.amazon.com/Life-Universe-Edition-Jeffrey-Bennett/dp/0321687671/ref=sr_1_1?ie=UTF8&qid=1377513814&sr=8-1&keywords=life+in+universe+pearson](http://www.amazon.com/Life-Universe-Edition-Jeffrey-Bennett/dp/0321687671/ref=sr_1_1?ie=UTF8&qid=1377513814&sr=8-1&keywords=life+in+universe+pearson)

(2) A Short History of Nearly Everything (Illustrated), Bill Bryson, 2005, Broadway  
Available: Prairie Lights Bookstore (15 S Dubuque Street)

(3) The Universe Within, Neil Shubin, 2013, Pantheon  
Available: Prairie Lights Bookstore (15 S Dubuque Street)

Course websites:  
through ICON: [https://icon.uiowa.edu/](https://icon.uiowa.edu/) (additional reading assignments posted here)  
also, public course information and highlights: [http://astro.physics.uiowa.edu/origins](http://astro.physics.uiowa.edu/origins)

GE Natural Science Objectives (taken from CLAS GE website):

- Students will come to understand a significant segment of natural science and will become familiar with its major concepts and ways of framing questions. In laboratory courses, students will use laboratory investigations and appropriate procedures to generate accurate and meaningful data and derive reasonable conclusions from them. Students will understand and appreciate (if not adopt) the attitudes of science: logic, precision, experimentation, tentativeness, and objectivity.

- Students will develop and practice those communication skills that apply to the relevant discipline.
Grading Procedures: The course grade is based on the following components.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Proportion of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-class Activities</td>
<td>Students are expected to attend all class meetings, to participate in class discussions, and conduct themselves in a manner that encourages a positive learning environment. Grading on attendance and participation will be punitive: each student starts with a full complement of points, from which deductions will be made as the student misses class or conducts him or herself in a disruptive manner. Students work in groups and complete written or web-based activities that are collaborative. One activity is handed in per team. These assignments will be scored for accuracy and completeness but each student will receive an individual grade. Students will be responsible for worksheet material on midterm and final exams.</td>
<td>20%</td>
</tr>
<tr>
<td>Concept Mapping and Writing Activities (due Tuesdays)</td>
<td>Each week, students are expected to read a chapter of the book, <em>The Universe Within</em>, by Neil Shubin. Each Tuesday, students will submit a paragraph describing the main themes of the chapter, alongside a concept map of the chapter. Chapter 1 has been done for you as an example, and a full description of this weekly learning exercise can be found in your binder and on ICON. This is NOT intended as a collaborative assignment and should be done individually by each student. These assignments will be turned in using ICON.</td>
<td>20%</td>
</tr>
<tr>
<td>In-class Quizzes (Thursdays)</td>
<td>Weekly quizzes in lecture will cover material in the assigned readings. Students will answer questions individually, and then in collaboration with their team members, resulting in a quiz grade that is 50% collaborative and 50% individual. The collaborative part of the quiz score corresponds to the result from the group answering the quiz using an IF-AT (Immediate Feedback Assessment Technique) scratch-off form. Group members discuss the question and scratch off the agreed-upon answer. A small black star denotes a correct answer, at which point the group moves on to the next question. If no star is revealed, the group should make a second (and a third, if necessary) attempt at the correct answer. Partial credit will be given if 2 boxes (50%) or 3 boxes (25%) are scratched off (no credit if all 4 boxes are scratched off). With an approved absence, a student will be allowed to take an individual makeup quiz re-scheduled within a week of the missed quiz. However, the group score will not be incorporated and the individual result will account for 100% of the quiz score.</td>
<td>10%</td>
</tr>
<tr>
<td>In-class exams</td>
<td>Two mid-term exams will each count 15% toward the final course grade. Learning of material in the assigned readings, the content covered during lecture, and activities performed in class will be assessed on the exams. Questions will consist of multiple choice, matching, problems, and short answers. <strong>Mid-term Dates:</strong> Tuesday, 1 Oct and Thursday, 7 Nov (SC 1505)</td>
<td>30%</td>
</tr>
<tr>
<td>Final exam</td>
<td>The final exam is comprehensive, covering the major themes of the course. Again, a variety of question formats will be used. <strong>Final Exam:</strong> TBA during Finals Week</td>
<td>20%</td>
</tr>
</tbody>
</table>
Final Letter Grades: Letter grades will be assigned at the end of the semester based on a percentage of points earned and using the system recommended by the College of Liberal Arts and Sciences. http://clas.uiowa.edu/students/handbook/grading-system.

Policies on attendance & tardiness: Attendance in class is mandatory, and regular participation is expected. The faculty and TAs will keep track of attendance and participation through the in-class activities.

If you have a university-approved excuse for missing an exam, contact the instructor prior to the time of the exam. You will need documentation indicating why you are (were) unable to take the exam at the scheduled time. Registration for another course whose lectures are given at the same time as the lectures in this course will not be accepted as a reason for scheduling a makeup exam for this course. If an exam is missed and approval is granted for taking a makeup, you must schedule and take the makeup exam within one week of the scheduled exam. The exam may differ in format from the scheduled exam. Discussing the content of the scheduled exam with other students prior to taking the makeup is considered cheating. Each exam is closed book and students caught cheating will be given a zero for that exam. Incidents of cheating are reported to the Office of Academic Affairs; students involved in cheating incur other penalties from that office (See “Academic Misconduct”, below).

Course Format & Expectations: Course lectures are held in a newly redesigned TILE classroom. TILE stands for Transform, Interact, Learn & Engage, and the room design facilitates peer interaction within groups to actively participate in learning. The schedule of each class is organized to promote student-centered learning through involvement in a variety of activities. Each of you is expected to arrive on time, to be prepared (i.e., by having completed assigned readings and having brought requisite materials to class), to contribute equitably to group dialog, and to sometimes fulfill the role of spokesperson for your group. Tables of nine students represent the major organizational feature of the class, each subdivided into teams of three students.

Students in the class arrive with a diversity of backgrounds, and if something is unclear, then ask. It is up to you to master the material presented in the course, so be active in your education. Seek assistance from the instructors and teaching assistants when needed. We will do our best to facilitate your learning the material and we hope you find the subject matter intellectually stimulating, entertaining and enjoyable.

Policy on cell phone & computer use: Cell phone use of any kind is not permitted during class. Only use the laptop computers for class activities. Students are not permitted to use the laptop computers for non-class activities: Facebook, checking email, etc. Deviations from these expectations will result in deductions from the in-class activities grade.

Note on Team Assignments: As described in the previous page, much of your time in class will be spent working in a team on activities. We have randomly assigned students to teams of three (A, B or C). Three teams will sit at each table of nine (numbered 1-9). Your team will therefore have a designation such as “Team 6B” or “Team 9A”.

Notes on in-class activities: Each class period you will be working with your team on an in-class activity. One activity will be turned in for a grade for each team. It is important that you write your team member’s name at the top of each team activity so that everyone will receive credit for the work completed. If a team member is missing they will not receive credit for the team’s work. TAs and faculty members will be checking for accuracy in attendance.

Notes on in-class folders: Your in-class activities will be distributed each class period using a team folder. There will be a larger folder for each table, containing three team folders (each a different color). The class activity will be attached to the folder and you should keep the activity this way. The activity from the last class period will be graded and returned to your team in the left side pocket. The right side pocket will contain your Scantron forms (for in class quizzes) and your team IF-AT for team quizzes. Each team member should download a blank copy of the class activity from ICON and fill in the answers correctly to use for studying for in-class exams and the final exam. Faculty members and TAs can help during office hours answer questions related to the in-class activities.
## Schedule of Topics and Readings

**LTU: Life in the Universe by Bennett & Shostak**  
**BB: A Short History of Nearly Everything by Bill Bryson**

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 Aug (T)</td>
<td>Introduction to Course, TILE classroom and Scientific Method</td>
<td>--</td>
</tr>
<tr>
<td>29 Aug (Th)</td>
<td>Using orders of magnitude</td>
<td>LTU Ch 1</td>
</tr>
<tr>
<td>3 Sept (T)</td>
<td>What is science?</td>
<td>LTU Ch 2.3-2.4</td>
</tr>
<tr>
<td>5 Sept (Th)</td>
<td>What is our place in the universe?</td>
<td>LTU Ch 3.1-3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BB Ch 1, 2</td>
</tr>
<tr>
<td>10 Sept (T)</td>
<td>What are stars and how do they create energy?</td>
<td>LTU Ch 3.3-3.4</td>
</tr>
<tr>
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<td>BB 7, 9</td>
</tr>
<tr>
<td>12 Sept (Th)</td>
<td>How do stars change over the course of their lives?</td>
<td>LTU Ch 3.2 (61-64)</td>
</tr>
<tr>
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<td></td>
<td>BB Ch 3</td>
</tr>
<tr>
<td>17 Sept (T)</td>
<td>Origin of the Solar System and the Earth</td>
<td>LTU Ch 3.3, 3.5</td>
</tr>
<tr>
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<td></td>
<td>BB Ch 10</td>
</tr>
<tr>
<td>19 Sept (Th)</td>
<td>Earth: Internal Structure and Rock Types</td>
<td>LTU Ch 4.1, 4.2, 4.4 (p102-7; 123-5)</td>
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<tr>
<td></td>
<td></td>
<td>BB Ch 4, 14</td>
</tr>
<tr>
<td>24 Sept (T)</td>
<td>Earth’s Surface and Geological Processes</td>
<td>LTU Ch 4.2, 4.4 (p125-133)</td>
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<tr>
<td></td>
<td></td>
<td>BB Ch 12</td>
</tr>
<tr>
<td>26 Sept (Th)</td>
<td>Earth: Geologic Time</td>
<td>LTU Ch 4.2 (p108-118)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BB Ch 5</td>
</tr>
<tr>
<td>1 Oct (T)</td>
<td>In-class Exam #1 (Note Room: Seamans 1505)</td>
<td>LTU Ch 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BB 25</td>
</tr>
<tr>
<td>3 Oct (Th)</td>
<td>What is biological evolution?</td>
<td>LTU Ch 5.1</td>
</tr>
<tr>
<td>8 Oct (T)</td>
<td>What is Life?</td>
<td>LTU Ch 5.2</td>
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<td></td>
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<td>BB Ch 18</td>
</tr>
<tr>
<td>10 Oct (Th)</td>
<td>Biochemistry of Life 1</td>
<td>LTU Ch 5.2</td>
</tr>
<tr>
<td>15 Oct (T)</td>
<td>Biochemistry of Life 2</td>
<td>LTU Ch 5.2</td>
</tr>
<tr>
<td>17 Oct (Th)</td>
<td>Biochemistry of Life 3</td>
<td>LTU Ch 5.3</td>
</tr>
<tr>
<td>22 Oct (T)</td>
<td>Simulating Early Life</td>
<td>LTU 6.2</td>
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<tr>
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<td></td>
<td>BB Ch 19</td>
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<tr>
<td>24 Oct (Th)</td>
<td>Origin of Replicators</td>
<td>LTU Ch 6.2 (review)</td>
</tr>
<tr>
<td>29 Oct (T)</td>
<td>Origin of Cells</td>
<td>LTU Ch 5.2-5.3</td>
</tr>
<tr>
<td>31 Oct (Th)</td>
<td>DNA and Heredity 1</td>
<td>LTU Ch 5.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BB 26</td>
</tr>
<tr>
<td>5 Nov (T)</td>
<td>DNA and Heredity 2</td>
<td>LTU Ch 5.5</td>
</tr>
</tbody>
</table>

**Schedule continued on next page! → → →**
# Schedule of Topics and Readings (Cont’d)

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Nov (T)</td>
<td>Early Earth: Epoch of Heavy Bombardment</td>
<td>LTU Ch 4.6 (also pp 120-122)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BB Ch 13</td>
</tr>
<tr>
<td>14 Nov (Th)</td>
<td>Early Earth: David Des Marais (NASA visitor)</td>
<td>LTU Ch 4.4</td>
</tr>
<tr>
<td>19 Nov (T)</td>
<td>Early Earth: The Oldest Rocks on Earth</td>
<td>LTU 6.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BB Ch 15</td>
</tr>
<tr>
<td>21 Nov (Th)</td>
<td>Early Earth: Climate Conditions</td>
<td>LTU 6.3 (p 214-16)</td>
</tr>
<tr>
<td></td>
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<td>TBD</td>
</tr>
<tr>
<td>25-29 Nov</td>
<td>Thanksgiving Week (No Class)</td>
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</tr>
<tr>
<td>3 Dec (T)</td>
<td>How Life Arose on Earth – Part 1</td>
<td>TBD</td>
</tr>
<tr>
<td>5 Dec (Th)</td>
<td>How Life Arose on Earth – Part 2</td>
<td>TBD</td>
</tr>
<tr>
<td>10 Dec (T)</td>
<td>How Life Arose on Earth – Part 3</td>
<td>TBD</td>
</tr>
<tr>
<td>12 Dec (Th)</td>
<td>Course Summary and Preview of Origins – Part 2</td>
<td>TBD</td>
</tr>
<tr>
<td>10-14 Dec</td>
<td>Final Exam Week – Final Exam Date/Time/Place TBD</td>
<td></td>
</tr>
</tbody>
</table>

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### Academic Misconduct:

The College of Liberal Arts and Sciences considers academic fraud, dishonesty, and cheating serious academic misconduct. All students suffer when academic misconduct takes place. Academic fraud, dishonesty, and cheating disturb the mutual respect that should exist between instructors and students and among students, and can poison the atmosphere of a classroom. Perhaps most seriously, those who commit academic fraud, dishonesty, or cheating are robbed of the educational experiences that are the primary purpose of course work in the College of Liberal Arts and Sciences. We expect instructors to help students understand and avoid all academic fraud.

If you are unclear about the proper use and citation of sources, or the details and guidelines for any assignment, you should discuss the assignment and your questions with the instructor. All forms of plagiarism and any other activities that result in a student presenting work that is not really his or her own are considered academic fraud. Academic fraud includes these and other misrepresentations:

- presentation of ideas from any sources you do not credit;
- the use of direct quotations without quotation marks and without credit to the source;
- paraphrasing information and ideas from sources without credit to the source;
- failure to provide adequate citations for material obtained through electronic research;
- downloading and submitting work from electronic databases without citation;
- participation in a group project which presents plagiarized materials;
- taking credit as part of a group without participating as required in the work of the group;
- submitting material created/written by someone else as one's own, including purchased term/research papers;

Cheating on examinations and other work also interferes with your own education as well as the education of others in your classes. If you are unclear about the guidelines for any testing situation or assignment, you should discuss your questions with the instructor. Academic cheating includes all of the following, and any other activities that give a student an unfair advantage in course work:

- copying from someone else's exam, homework, or laboratory work;
- allowing someone to copy or submit your work as his/her own;
- accepting credit for a group project without doing your share;
submitting the same paper in more than one course without the knowledge and approval of the instructors involved;

- using notes, text messaging, cell phone calls, pre-programmed formulae in calculators, or other materials during a test or exam without authorization;

- not following the guidelines specified by the instructor for a “take home” test or exam.

When an instructor in the College of Liberal Arts and Sciences suspects a student of academic fraud or cheating these procedures will be followed:

- The instructor (or supervisor, if the instructor is a teaching assistant) must inform the student—in a printed letter—as soon as possible after the incident has been observed or discovered.

- If the instructor comes to the conclusion that the student academic fraud or cheating has occurred, he or she (in consultation with the supervisor if the instructor is a teaching assistant) will determine what action to take. The instructor may decide to reduce the student's grade on the assignment or activity, or in the course, or even to assign an F for the assignment or activity or for the course.

- The instructor will send a written report of the case to the Associate Dean for Academic Programs and send copies of the report to the DEO and to the student(s) involved.

- The associate dean for academic programs will impose the following or other penalties: disciplinary warning until graduation (usually for a first offense); suspension from the college for a calendar year or longer (usually for a second offense); or recommendation of expulsion from the University by the president (usually for a third offense).

If a student believes that the finding of academic fraud or cheating is in error or the penalty unjust, he or she may request information on appeal procedures from CLAS Academic Programs & Services, 120 Schaeffer Hall.

**IMPORTANT POLICIES OF THE COLLEGE OF LIBERAL ARTS AND SCIENCES**

**Academic Fraud**

Plagiarism and any other activities when students present work that is not their own are academic fraud. Academic fraud is a serious matter and is reported to the departmental DEO and to the Associate Dean for Undergraduate Programs and Curriculum. Instructors and DEOs decide on appropriate consequences at the departmental level while the Associate Dean enforces additional consequences at the collegiate level. See the CLAS Academic Fraud section of the Student Academic Handbook.

**CLAS Final Examination Policies**

Final exams may be offered only during finals week. No exams of any kind are allowed during the last week of classes. Students should not ask their instructor to reschedule a final exam since the College does not permit rescheduling of a final exam once the semester has begun. Questions should be addressed to the Associate Dean for Undergraduate Programs and Curriculum.

**Electronic Communication**

University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondences. *(Operations Manual, III.15.2. Scroll down to k.11.)*

**Making a Suggestion or a Complaint**

Students with a suggestion or complaint should first visit the instructor, then the course supervisor, and then the departmental DEO. Complaints must be made within six months of the incident. See the CLAS Student Academic Handbook.

**Accommodations for Disabilities**

A student seeking academic accommodations should first register with Student Disability Services and then meet privately with the course instructor to make particular arrangements. See [www.uiowa.edu/~sds/](http://www.uiowa.edu/~sds/) for more information.

**Understanding Sexual Harassment**

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment for assistance, definitions, and the full University policy.
Administrative Home The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Student Academic Handbook.

Reacting Safely to Severe Weather In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Public Safety web site.
# List of Activities

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<th>Titles</th>
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<td>27 Aug</td>
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<tr>
<td>A2: 4 Questions/Orders of Magnitude</td>
<td>29 Aug</td>
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<td>A3: What is Science?</td>
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<td>A4: Size Scale of Solar System, Universe of Stars</td>
<td>5 Sept</td>
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<td>A5: What is the Universe made of?</td>
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<td>A6: How does the Sun (and all stars) generate energy?</td>
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<td>A7: How did the Solar System Form?</td>
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<td>A8: Structure of the Earth</td>
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<td>A9: Rates of Change/Dynamic Earth</td>
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<td>A10: Geologic Time and Radiometric Dating</td>
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<td>A11: Evolution and Life</td>
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<td>A12: Family Trees and Natural Selection</td>
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<td>A13: Biochemistry 1 – Molecules</td>
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<td>A14: Biomolecules 2 – 4 different types</td>
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<td>A15: Biomolecules 3 – Metabolism/Extremophiles</td>
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<td>A16: Making Life in the Laboratory</td>
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<td>A17: Origin of Replicators</td>
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<td>A18: Origin of Cells</td>
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<td>A20: Inheritance/Mutation</td>
<td>5 Nov</td>
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<td>A21: Impactors</td>
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<td>A22: Early Earth – David Des Marais (guest speaker)</td>
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<td>A23: Deep Time</td>
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<td>A24: Planetology of Mars and Venus</td>
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<td>A25: Rock Record</td>
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<td>A26: Molecular Record of Life</td>
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<td>A27: Early Life on Earth – Cambrian and Pre-Cambrian</td>
<td>10 Dec</td>
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<tr>
<td>A28: 4 Questions/Timeline of Earth Review</td>
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# Legend

- **Biology** (12)
- **Astronomy** (4)
- **Geoscience** (8)
- **Chemistry** (3)
- **General** (2)