BIOLOGY PROGRAM ASSESSMENT PLAN
2015

Bachelor of Science in Biology
Bachelor of Arts in Biology

Department of Biology
University of Kentucky,
Lexington, KY 40506

October 23, 2015
1. Introduction
College: Arts and Sciences
Unit: Biology
Degree Programs: Bachelor of Science and Bachelor of Arts

Unit Mission Statement
The mission of the Biology Undergraduate Program is to provide a curriculum that enables and encourages students to learn and apply the fundamental concepts and methods of biology. Students should learn to critically evaluate evidence, formulate and test hypotheses, solve problems, and gather, interpret and discuss scientific data.

Basic Assessment Approach
Our approach to assessment involves measuring student progress toward our SLOs in our lower-level, mid-level, and upper-level core courses. All outcomes will be assessed within a three year cycle, using direct and indirect methods. Assessment may take the form of pre- and post- course questions that directly assess a SLO or scoring student work from courses with rubrics that can measure value-added over the course of the curriculum. We are also developing assessment tools to administer to students near graduation to assess outcomes at the end of students’ undergraduate career. See artifact map (Appendix C) for more details.

Definition of Key Terms
Curriculum Map: A visual depiction of how learning outcomes and/or professional standards are translated into individual courses taught within a program

Student Learning Outcomes (SLOs): Statements of learning expectations.

Indirect Evidence: Data from which you can make inferences about learning but do not demonstrate actual learning, such as perception or comparison data. Includes, but is not limited to: surveys, focus groups, exit interviews, grades, and institutional performance indicators.

Direct Evidence: Students show achievement of learning goals through performance of knowledge and skills. Includes, but is not limited to: score gains between entry and exit and substantial course assignments that require performance of learning.

2. Assessment Oversight, Resources
The Director of Undergraduate Studies in the Department of Biology will serve as Assessment Coordinator. The Undergraduate Affairs Committee members will serve as the Assessment Coordination Committee. Other faculty members may participate in the evaluation of student work pertaining to the learning outcomes.

3. Student Learning Outcomes (SLOs)
a. Outcome #1 The nature of science—its logic and values
Students will be able to implement the scientific method to formulate and test hypotheses. In the process, they will sharpen their ability to think critically and to solve problems systematically based on evidence.

b. Outcome #2 The conceptual foundations and knowledge base of biology
Students will demonstrate a clear understanding of the most important and fundamental theories and ideas in contemporary biology, such as evolution, heredity, levels of organization,
unity and diversity, structure and function. They will be able to link key facts, research findings, and concepts to each other and to the physical, chemical, and biological environments of organisms.

c. **Outcome #3 The collection and analysis of biological data**
Students will be able to gather reliable data for specific purposes using established laboratory and field methods. They will be able to analyze their data statistically, present results in tabular and graphical form, and interpret results accurately. Students will have the opportunity to conduct independent research in biological laboratories.

d. **Outcome #4 The presentation and discussion of biological research**
Students will be able to present and discuss the concepts, methods, and results of biological research. They will be able to review the biological literature, critically analyze published papers, present written reports in scientific format (introduction, methods, results, discussion), and present oral reports according to current biological style. Students will be encouraged to present original research at scientific meetings.

4. **Curriculum Map**
See Appendices A (for B.A) and B (for B.S)

5. **Assessment Methods and Measures**
**See Appendix C for an artifact map detailing assessment methods for each SLO.**
Direct methods:
- Pre- and post-exams in core courses (BIO 148, BIO 304, and BIO 315) using a detailed item analysis directly aligning to outcome
- Multiple choice assessment of core concepts from all major core courses using a detailed item analysis directly aligning to outcome (BIO 425)
- Written lab reports (BIO 155, BIO 325, and BIO 350, 430) evaluated with Quantitative Literacy VALUE rubric (Appendix F) and Lab Report Rubric (Appendix E)
- Analysis of student presentations in BIO 425- Scored using the Oral Communication VALUE rubric (Appendix G)
- Analysis of BIO 155 lab reports and BIO 395 student contracts and end-of-semester presentation using rubric attached (Appendix D)

Indirect methods:
- Determine percentage of graduating seniors participating in independent research
- Grades in core courses

6. **Data Collection and Review**
The Director of Undergraduate Studies will coordinate data collection. Data will be gathered annually for all outcomes. Because of the large number of our majors, samples of data may be required for some assessments.
For artifacts collected from course work, faculty members teaching the course will collect and analyze the data. When necessary, a second reviewer of student work will be selected from the faculty. Data will be discussed and reviewed by the Director of Undergraduate Studies, the Undergraduate Affairs Committee, and the Department Chair. **See Appendix C for an artifact map detailing data collection, review, and benchmarks.**
7. Assessment Cycle and Data Analysis

Assessment Cycle
Program-level assessment data will be gathered at summative points in the curriculum as described in the artifact map. Assessment will be conducted annually. The program will follow a three year assessment cycle, with one outcome being assessed in years one and three and two outcomes assessed in year two.

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<th>Student Learning Outcome</th>
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<th>Reporting Cycle</th>
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<td>Year 2</td>
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<td>3. The collection and analysis of biological data</td>
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Data Analysis Process/Procedures
Assessment results will be reviewed and analyzed by the Undergraduate Affairs Committee (including the Director of Undergraduate Studies) and the Department Chair at the end of the Spring semester. Benchmarks will be adjusted as necessary after discussion in Undergraduate Affairs Committee. The assessment measures and methods will be evaluated and aligned with student learning outcomes every three years. Programmatic improvements will be discussed and improvement actions will be planned prior to the first or second Department of Biology Faculty Meeting of the Fall semester. The dissemination of the analysis/interpretation of assessment results and the approval of the plan for improvement will take place at the first or second Department of Biology Faculty Meeting of the Fall semester. Assessment reports will be completed no later than October 1st of every year and turned in to the college’s assessment coordinator for review. Final reports will be sent to the university’s assessment office no later than October 31st of every year.

8. Teaching Effectiveness

Measures of Teaching Effectiveness
All instructors will use the University Teacher Course Evaluation (TCE) process to be evaluated by their students each semester. Each instructor will be asked to provide a self-reflection which will include areas of improvement as part of their FMER (Faculty Merit Evaluation Report). The Department Chair will review the TCE results and the self-reflection and provide feedback to the instructor. The FMER committee will evaluate all information included in FMER reports. This will occur on an annual basis.

Efforts to Improve Teaching Effectiveness
The department chair and/or FMER committee may suggest methods to improve teaching effectiveness based on the FMER report. Faculty may utilize workshops and/or services offered by the Center for the Enhancement of Learning and Teaching (CELT). Faculty may also consult the Associate Chair for Education or the Director of Undergraduate Studies for additional resources to improve teaching effectiveness.
9. **Plans to evaluate students’ post-graduate success**

Currently, we do not have a plan in place to evaluate students’ post-graduate success. The Director of Undergraduate Studies will work with the Undergraduate Affairs Committee to devise and implement a plan.

10. **Appendices**

    Appendix A: Curriculum map for the B.A.
    Appendix B: Curriculum map for the B.S.
    Appendix C: Artifact map
    Appendix D: Scoring rubric for SLO #1
    Appendix E: Lab Report Rubric
    Appendix F: Quantitative Literacy VALUE Rubric
    Appendix G: Oral Communication VALUE Rubric
    Appendix H: Sample pre- and post-assessment (BIO 148)
Appendix A: Curriculum map for B.A. in Biology

Rating system:  **I** = Introduced, topics introduced, basic techniques introduced; **R** = Reinforced, content taken to a higher level, skills and content from introductory classes applied; **E** = Emphasize, analysis, synthesis and evaluation of content and skills.

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Appendix B: Curriculum map for B.A. in Biology

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### Appendix C: Artifact map detailing data collection, review, and benchmarks.

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Students will be able to implement the scientific method to formulate and test hypotheses. In the process, they will sharpen their ability to think critically and to solve problems systematically based on evidence. | Year 1 | 2014-15 | October 31, 2015 | * Lab reports from BIO 155 (Principles of Biology I Lab)  
* Evaluated by faculty/TAs using scoring rubric for SLO #1 (Appendix D)  
*Gathered Yearly  
**Benchmark:** 50% of students will receive a score of accomplished (3) or exemplary (4) for each section of the rubric | *BIO 395 student contracts Responses to questions in the contract form will be scored according to the scoring rubric for SLO #1 (Appendix D)  
*Evaluated by DUS and one other faculty reviewer  
*Gathered Yearly  
**Benchmark:** 75% of students will receive a score of accomplished (3) or exemplary (4) for each section of the rubric | *Student presentation of BIO 395 (Independent Research) project scored according to the scoring rubric for SLO #1 (Appendix D)  
*Evaluated by DUS and one other faculty reviewer  
*Gathered Yearly  
**Benchmark:** 85% of students will receive a score of accomplished (3) or exemplary (4) for each section of the rubric |
| 2. The conceptual foundations and knowledge base of biology  
Students will demonstrate a clear understanding of the most important and fundamental theories and ideas in contemporary biology, such as evolution, heredity, levels of organization, unity and diversity, structure and | Year 2 | 2015-16 | October 31, 2016 | *Pre- and post-assessment multiple choice exam administered in BIO 148 (Introductory Biology I) on the first day of class and during final exam. Questions matched to specific concepts | *Pre- and post-assessment multiple choice exam administered in 300 level core courses (Ex: BIO 304 and BIO 315) on the first day of class and during final exam.  
*Evaluated by faculty members teaching course | *Multiple choice exam representing core concepts from all major core courses administered to students enrolled in BIO 425 (most of whom are graduating seniors)  
*Evaluated by Director of Undergraduate Studies |
function. They will be able to link key facts, research findings, and concepts to each other and to the physical, chemical, and biological environments of organisms.

<table>
<thead>
<tr>
<th>3. The collection and analysis of biological data</th>
<th>Year 3</th>
<th>2016 - 2017</th>
<th>October 31, 2017</th>
<th>*Student laboratory reports from BIO 315, BIO 325, BIO 350, and/or BIO 430G will be scored according to the quantitative literacy VALUE rubric (Appendix F)</th>
<th>*Percentage of graduating seniors participating in independent research (Bio 395) will be determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to gather reliable data for specific purposes using established laboratory and field methods. They will be able to analyze their data statistically, present results in tabular and graphical form, and interpret results accurately. Students will have the opportunity to conduct independent research in biological laboratories.</td>
<td>*Evaluated by faculty members teaching course *Gathered yearly</td>
<td>*Benchmark: 70% of students will score above 70% on the post-assessment. Value added of 25% from pre- to post-assessment for 75% of students.</td>
<td>*Gathered yearly</td>
<td>75%</td>
<td></td>
</tr>
</tbody>
</table>

*Benchmark: 85% of students will score above 70% on the assessment
| 4. **The presentation and discussion of biological research (GCCR)** Students will be able to present and discuss the concepts, methods, and results of biological research. They will be able to review the biological literature, critically analyze published papers, present written reports in scientific format (introduction, methods, results, discussion), and present oral reports according to current biological style. Students will be encouraged to present original research at scientific meetings. | 2015 - 2016 | October 31, 2016 | Written examples of student work from BIO 350 or BIO 430G (GCCR courses for the Biology major) will be scored using the Lab Report Rubric (Appendix E)  
*Evaluated by faculty members teaching course and Director of Undergraduate Studies  
*Gathered yearly  
**Benchmark**: Not yet determined | Student oral presentations from BIO 425 (GCCR course for the Biology major) will be scores according to the oral communication VALUE rubric (Appendix G)  
*Evaluated by faculty members teaching course and Director of Undergraduate Studies  
*Gathered yearly  
**Benchmark**: 75% of students will achieve at least Level 3 for all categories |
# Appendix D: Scoring Rubric for SLO #1

<table>
<thead>
<tr>
<th>Student Learning Outcome 1</th>
<th>4 - Exemplary</th>
<th>3 - Accomplished</th>
<th>2 - Developing</th>
<th>1 – Beginning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to implement the scientific method to formulate and test hypotheses</td>
<td>Problem is meaningful (novel) and well researched. Hypothesis/driving principle is clearly stated.</td>
<td>Problem is addressed and researched. Hypothesis/driving principle is stated and allows for investigation.</td>
<td>Problem is somewhat addressed and somewhat researched. Hypothesis/driving principle is stated but unclear/too vague/not specific</td>
<td>Problem is not stated and research is unclear or hypothesis/driving principle is not stated or hypothesis as stated is not testable</td>
</tr>
<tr>
<td>Experimental design and procedures are listed and detailed. The experimental design matches the stated hypothesis/driving principle. Technical details are described</td>
<td>Experimental design and procedure are listed but lack detail. Experimental design matches the stated hypothesis/driving principle. Technical details are missing or vague.</td>
<td>Experimental design and procedures are listed but inadequate. Experimental approach has a general relevance to the hypothesis/driving principle but lacks specificity. Technical details are missing.</td>
<td>Experimental design and procedures are missing or have no relevancy to the hypothesis.</td>
<td></td>
</tr>
<tr>
<td>Discussion of results addresses the hypothesis/driving principle and includes a detailed discussion of data that would indicate whether the hypothesis/driving principle is supported or not.</td>
<td>Discussion of results of the investigation relates to the hypothesis/driving principle but does not include a discussion of data that would indicate whether the hypothesis/driving principle is supported or not.</td>
<td>Discussion of results of the investigation partially relates to the hypothesis/driving principle.</td>
<td>Discussion of results missing or shows no relevance to the hypothesis/driving principle.</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix E: Lab Report Rubric

<table>
<thead>
<tr>
<th></th>
<th>1 Beginning or incomplete</th>
<th>2 Developing</th>
<th>3 Accomplished</th>
<th>4 Exemplary</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract/Summary</strong></td>
<td>Several major aspects of the experiment are missing, student displays a lack of understanding about how to write an abstract</td>
<td>Abstract misses one or more major aspects of carrying out the experiment or the results</td>
<td>Abstract references most of the major aspects of the experiment, some minor details are missing</td>
<td>Abstract contains reference to all major aspects of carrying out the experiment and the results, well-written</td>
<td></td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td>Very little background information provided or information is incorrect</td>
<td>Some introductory information, but still missing some major points</td>
<td>Introduction is nearly complete, missing some minor points</td>
<td>Introduction complete and well-written; provides all necessary background principles for the experiment</td>
<td></td>
</tr>
<tr>
<td><strong>Experimental procedure</strong></td>
<td>Missing several important experimental details or not written in paragraph format</td>
<td>Written in paragraph format, still missing some important experimental details</td>
<td>Written in paragraph format, important experimental details are covered, some minor details missing</td>
<td>Well-written in paragraph format, all experimental details are covered</td>
<td></td>
</tr>
<tr>
<td><strong>Results: data, figures, graphs, tables, etc.</strong></td>
<td>Figures, graphs, tables contain errors or are poorly constructed, have missing titles, captions or numbers, units missing or incorrect, etc.</td>
<td>Most figures, graphs, tables OK, some still missing some important or required features</td>
<td>All figures, graphs, tables are correctly drawn, but some have minor problems or could still be improved</td>
<td>All figures, graphs, tables are correctly drawn, are numbered and contain titles/captions.</td>
<td></td>
</tr>
<tr>
<td><strong>Discussion</strong></td>
<td>Very incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results</td>
<td>Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident</td>
<td>Almost all of the results have been correctly interpreted and discussed, only minor improvements are needed</td>
<td>All important trends and data comparisons have been interpreted correctly and discussed, good understanding of results is conveyed</td>
<td></td>
</tr>
<tr>
<td><strong>Conclusions</strong></td>
<td>Conclusions missing or missing the important points</td>
<td>Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding</td>
<td>All important conclusions have been drawn, could be better stated</td>
<td>All important conclusions have been clearly made, student shows good understanding</td>
<td></td>
</tr>
<tr>
<td><strong>Spelling, grammar, sentence structure</strong></td>
<td>Frequent grammar and/or spelling errors, writing style is rough and immature</td>
<td>Occasional grammar/spelling errors, generally readable with some rough spots in writing style</td>
<td>Less than 3 grammar/spelling errors, mature, readable style</td>
<td>All grammar/spelling correct and very well-written</td>
<td></td>
</tr>
<tr>
<td><strong>Appearance and formatting</strong></td>
<td>Sections out of order, too much handwritten copy, sloppy formatting</td>
<td>Sections in order, contains the minimum allowable amount of handwritten copy, formatting is rough but readable</td>
<td>All sections in order, formatting generally good but could still be improved</td>
<td>All sections in order, well-formatted, very readable</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix F: Quantitative Literacy VALUE Rubric

**Quantitative Literacy VALUE Rubric**

*for more information, please contact valuel@acu.org*

#### Definition

Quantitative Literacy (QL) — also known as Numeracy or Quantitative Reasoning (QR) — is a "habit of mind," competency, and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason with quantitative evidence and to use data to make informed decisions and solve problems. They understand and can assess the implications of data-assisted decisions made by others. They are able to effectively communicate those decisions in a variety of formats (e.g., graphs, tables, written arguments). Educational institutions are encouraged to assign a zero to any work sample or collection of work that does not meet benchmarks (full or partial performance).

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Capstone 4</th>
<th>Milestones 3</th>
<th>Benchmark 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to explain information presented in mathematical forms (e.g., graphs, tables, written arguments).</td>
<td>Provides accurate, thoughtful explanations of information presented in mathematical forms.</td>
<td>Provides accurate, thoughtful explanations of information presented in mathematical forms.</td>
<td>Provides somewhat accurate, thoughtful explanations of information presented in mathematical forms, but occasionally incorporates errors or logical flaws in the reasoning.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attempts to explain information presented in mathematical forms, but draws inaccurate conclusions about what the information means.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Representation</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to support relevant information with various mathematical forms (e.g., graphs, tables, written arguments).</td>
<td>Skillfully presents relevant information in a thoughtful and logical manner in an appropriate and desired mathematical format.</td>
<td>Comprehensively presents relevant information in an appropriate and desired mathematical format.</td>
<td>Completes presentation of information but makes mathematical portrayals inappropriate or inaccurate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculation</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculations attempted are essentially all meaningful and sufficiently comprehensive to solve the problem. Calculations are also presented clearly, concisely, etc.</td>
<td>Calculations attempted are essentially all meaningful and sufficiently comprehensive to solve the problem.</td>
<td>Calculations attempted are either unsatisfactory or attempt only a portion of the calculations required to comprehensively solve the problem.</td>
<td>Calculations are attempted but are both unsatisfactory and inaccurate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application / Analysis</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis.</td>
<td>Uses the quantitative analysis of data as the basis for making judgments, drawing conclusions and evaluating conclusions from this week.</td>
<td>Uses the quantitative analysis of data as the basis for making judgments, drawing conclusions and evaluating conclusions from this week.</td>
<td>Uses the quantitative analysis of data as the basis for making judgments, drawing conclusions and evaluating conclusions from this week.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumptions</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicitly describes assumptions and provides compelling rationale for why such assumptions are appropriate. Shows awareness that assumptions in final conclusions are limited by the necessity of the assumptions.</td>
<td>Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.</td>
<td>Explicitly describes assumptions.</td>
<td>Attempts to describe assumptions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use quantitative information in connection with the argument or purpose of the work, presents it in an effective format, and uses it with consistently high quality.</td>
<td>Use quantitative information in connection with the argument or purpose of the work, presents it in an effective format, and uses it with consistently high quality.</td>
<td>Use quantitative information, but does not effectively connect it to the argument or purpose of the work.</td>
<td>Presents an argument that is quantitative evidence is pertinent, but does not provide adequate experimental support.</td>
</tr>
</tbody>
</table>

*Note: Additional rubric criteria may apply depending on the specific context and requirements.*
**Appendix G: Oral Communication VALUE rubric**

**ORAL COMMUNICATION VALUE RUBRIC**

*for more information, please contact value@cacan.org*

**Definition**
Oral communication is a prepared, purposeful presentation designed to increase knowledge, foster understanding, or to promote change in the listeners’ attitudes, values, beliefs, or behaviors.

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (call one) level performance.

<table>
<thead>
<tr>
<th></th>
<th>Capstone</th>
<th>Milestones</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supporting Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Message</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **Organization:** Organizational pattern (specific introduction and conclusion, sequenced material within the body, and transitions) is clearly and consistently observable and is skillful and makes the content of the presentation cohesive.
- **Language:** Language choices are imaginative, memorable, and compelling, and enhance the effectiveness of the presentation. Language in presentation is appropriate to audience.
- **Delivery:** Delivery techniques (posture, gesture, eye contact, and vocal expressiveness) make the presentation compelling, and speaker appears polished and confident.
- **Supporting Material:** A variety of types of supporting materials (explanations, examples, illustrations, statistics, analogies, quotations from relevant authorities) make appropriate reference to information or analysis that significantly supports the presentation or establishes the presenter’s credibility/authority on the topic.
- **Central Message:** Central message is compelling (precisely stated, appropriately repeated, memorable, and strongly supported.)

**Evaluation Criteria:**
- **Capstone:** 4
- **Milestones:** 3
- **Benchmark:** 1
  - Organizational pattern (specific introduction and conclusion, sequenced material within the body, and transitions) is not observable within the presentation.
  - Language choices are uncluttered and moderately support the effectiveness of the presentation. Language in presentation is appropriate for audience.
  - Delivery techniques (posture, gesture, eye contact, and vocal expressiveness) make the presentation compelling, and speaker appears polished and confident.
  - Supporting materials (explanations, examples, illustrations, statistics, analogies, quotations from relevant authorities) make appropriate reference to information or analysis that partially supports the presentation or establishes the presenter’s credibility/authority on the topic.
  - Central message is clear and consistent with the supporting material.

**Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (call one) level performance.**
Appendix H: Sample pre- and post-assessment (BIO 148)

BIO 148 001-004
Fall 2015
Pre-assessment

NAME__________________________________________

1. Which of the following statements is TRUE about the evolution of plants and animals?
A. All plants and all animals share a common ancestor with each other.
B. All plants share a common ancestor, but all animals do not share a common ancestor.
C. All animals share a common ancestor, but all plants do not share a common ancestor.
D. No plants share a common ancestor with each other, no animals share a common ancestor with each other, and no plants share a common ancestor with any animals.

2. By reference to the tree at left, which of the following is an accurate statement of relationships?
A. A seal is more closely related to a horse than to a whale
B. A seal is more closely related to a whale than to a horse
C. A seal is equally related to a horse and a whale
D. A seal is related to a whale, but is not related to a horse

3. What is TRUE about cells?

A. All living things are made up of many cells, and all cells are the same size and shape.
B. All living things are made up of many cells, but not all cells are the same size and shape.
C. All cells are the same size and shape, but not all living things are made up of many cells.
D. Not all cells are the same size and shape, and not all living things are made up of many cells.

4. Which of the following describes the relationship between chromosomes (before replication) and double-stranded DNA molecules?

A. Each chromosome is made of a single double-stranded DNA molecule.
B. Each chromosome is made of many double-stranded DNA molecules.
C. Each double-stranded DNA molecule is made of many chromosomes.
D. There is no relationship between chromosomes and DNA molecules.
5. A scientist collects a single stomach cell from a mouse. She determines the sequence of nucleotides in the DNA molecules from that cell. In what other cells in the mouse will the same sequence of nucleotides be found?

A. In that one cell that was collected from the mouse's stomach, but not in any other cells
B. In all of the other stomach cells, but not in any other types of cells
C. In stomach cells and other cells in the digestive tract, but not in any other types of cells
D. In stomach cells, in other cells in the digestive tract, and in all other somatic (body) cells

6. Which structure is common to plant and animal cells?
   A. chloroplasts
   B. walls made of cellulose
   C. central vacuoles
   D. mitochondria

7. In a plant cell, DNA may be found _____.
   A. only in the nucleus
   B. only in the nucleus and mitochondria
   C. only in the nucleus and chloroplasts
   D. in the nucleus, mitochondria, and chloroplasts

8. DNA replication occurs in the _______ of eukaryotes. RNA synthesis occurs in the _______ of eukaryotes.
   A. nucleus, nucleus
   B. ribosomes, nucleus
   C. nucleus, ribosomes
   D. ribosomes, ribosomes
   E. none of the above answers is correct

9. The cell at left is beginning mitosis. How many chromosomes will be in each daughter cell from the cell at the end of mitosis and cytokinesis?
   A. 1
   B. 2
   C. 4
   D. 8
   E. 16
10. Chimpanzees have 48 chromosomes in a normal body cell. At the end of Meiosis I, each cell has _____ chromosomes. After meiosis II and cytokinesis, each cell has ____ chromosomes.
   A. 48, 48  
   B. 48, 24  
   C. 24, 24  
   D. 24, 12  
   E. 22, 48

11. Plants produce more seeds when they reproduce asexually than sexually. Yet most plants reproduce sexually in nature. What is the probable explanation for the prevalence of sexual reproduction? Sexual reproduction
   A. is more energy efficient than asexual reproduction  
   B. ensures that parents are identical to offspring  
   C. mixes up alleles contributing to variation in a species  
   D. is not dependent on fertilization

12. In certain plants, tall is dominant to short. If a heterozygous plant is crossed with a homozygous tall plant, what is the probability that the offspring will be short?
   A. 1  
   B. 1/2  
   C. 1/4  
   D. 1/6  
   E. 0

13. Many different types of protein molecules are made within cells. Which of the following could be influenced by the actions of those protein molecules?
   A. Both an organism's physical characteristics and the function of the organism's cells  
   B. An organism's physical characteristics but not the function of the organism's cells  
   C. The function of the organism's cells but not the organism's physical characteristics  
   D. Neither an organism's physical characteristics nor the function of the organism's cells
14. The bottom sequence below represents a DNA strand in the process of being replicated. The top sequence is a complete RNA primer. What DNA nucleotide will be added next to the primer?

\[ \begin{align*}
5' & \quad {\text{UUUCGCGU}} & 3' \\
3' & \quad {\text{TTCAAACGCATGC}} & 5'
\end{align*} \]

A. nucleotide with a “T” base  
B. nucleotide with a “G” base  
C. nucleotide with a “C” base  
D. nucleotide with a “A” base  
E. nucleotide with a “U” base

15. Which of the following is the best definition of a gene?

A. A stretch of DNA nucleotides and associated regulatory regions that code for a protein  
B. A stretch of DNA nucleotides that encodes a visible trait  
C. RNA nucleotides that will be translated by a ribosome  
D. A trait that has alternative forms

Read the following paragraph to answer questions 16 - 20:

The Sand Hills of Nebraska are a relatively recent geological formation with an age of approximately 10,000 to 15,000 years old. Because of quartz crystals in the sand, the Sand Hills are lighter in color than the surrounding area. Deer mice (Peromyscus maniculatus) inhabit much of the Midwest and have a dark brown coat color. However, at the Sand Hills where the sand is lighter, the Deer Mice have a lighter, golden coat. In other words, the mice on the Hills have a coat color that blends in with the sand. The main predators of these mice are birds and it is thought that blending in with the background increases their likelihood of survival. Scientists have identified a single gene, Agouti, which is responsible for the differences in coat color (Linnen et. al. 2009). Below are partial DNA nucleotide sequences from the Agouti gene, which codes for the protein that affects coat color. These sequences were obtained from five mice and identified from five different deer mouse populations. Mice A, B and C come from regions other than the Sand Hills whereas Mice D and E come from the Sand Hills.

Mouse A (dark)  – AGG CCT TGC TCA AAA GTA TCG CGC TAG  
Mouse B (dark)  – AGG CCT TGC TCA AAA GTA TCG CGC TAG  
Mouse C (dark)  – AGG CCT TGC TCA AAA GTA TCG CGC TAG  
Mouse D (light) – AGG CCT TGC GTA TCG CGC TAG  
Mouse E (light) – AGG CCT TGC GTA TCG CGC TAG
16. How would a biologist explain why the mice on the Sand Hills have a lighter coat?

A. These mice have a difference in their DNA sequence, which causes the lighter coat color.
B. These mice were born on the lighter sand and thus match their surroundings.
C. It is completely random if mice will be light or dark (not heritable), only the lighter colored mice survive on the Sand Hills.
D. The mice saw the birds and adapted their color to blend in with the sand.

17. Using a technique called mutation analysis, the new Sand Hills Agouti allele (gene variant in mouse D and mouse E) is estimated to be around 8,000 years old. That means the lighter coat color appeared after the formation of the Sand Hills. How would a biologist best explain the reason for the appearance of the allele?

A. A group of mice came to the Sand Hills and the dark coat color gene mutated because the mice needed to blend in with the sand to avoid being eaten by birds.
B. One mouse randomly obtained the lighter coat color mutation and produced lighter coat colored offspring. Because they survived more than the darker colored mice, now all the lighter-coat colored mice are descendants of the original mouse.
C. The lighter mouse always existed and simply came to the Sand Hills from somewhere else.
D. The dark coat color gene mutated into the light coat color gene because the mouse was exposed to the lighter colored sand.

18. Assuming that the DNA nucleotide sequences above are from the coding region and contain the only different region of the Agouti gene, what is the difference between the Agouti protein produced by dark-colored mice and light-colored mice?

A. Nothing is different.
B. There are three more amino acids in the Agouti protein produced by dark-colored mice.
C. There is one less amino acid in the Agouti protein produced by the lighter-colored mice.
D. There is one different amino acid between the dark and light-colored mouse while everything else is the same.

19. Which of the following would be a possible explanation for the molecular origin of the Sand Hills Agouti allele?

A. UV light caused the mutation in the skin cells of a mouse.
B. The mouse drank some radioactive water causing the mutation only in intestinal cells.
C. DNA polymerase skipped three nucleotides during replication causing a mutation during meiosis.
D. RNA polymerase skipped three nucleotides causing a deletion in the mRNA of sperm cells.

20. If the dark and light colored mice are two different species, which of the following statements could be true?
A. A dark female and light-colored male mice can mate and have offspring, and vice versa. Additionally, those offspring can
mate and have offspring.
B. There is a large lake near the Sand Hills, which reduces chances that dark and light colored mice will encounter each other, but
they still sometimes interbreed.
C. Foxes catch more dark colored mice because they tend to be slower.
D. Dark and light colored mice mate at different times of the year, such that a dark mouse will never mate with a light mouse and
vice versa.