BIOLOGY TRANSFER ASSURANCE GUIDE (TAG)
January 2, 2008

Ohio Transfer Module:

Ohio Transfer Module (OTM) Requirements: 36-40 semester hours / 54-60 quarter hours. Students should select courses within the OTM that complement the selected major and meet any specific general education requirements. Students are encouraged to complete the OTM to ensure maximum transferability and application of credit.

Required Disciplines	Minimum Required Hours	Recommended Courses
Area I. English Composition	3 sem. / 5-6 qtr.	
Area II. Mathematics	3 sem. / 3 qtr.	**Calculus I(Prerequisite for College Physics) or College Algebra (Prerequisite for General Physics)**
Area III. Arts & Humanities	6 sem. / 9 qtr.	
Area IV. Social Sciences	6 sem. / 9 qtr.	
Area V. Natural & Physical Science	6 sem. / 9 qtr.	**Full year sequence of General Chemistry I & II for the science major with Lab (Prerequisite)**

Additional courses beyond the minimum required hours, from any of the disciplines listed above, will count toward the completion of the OTM (36-40 semester hours or 54-60 quarter hours.

Advising notes: Calculus-based Physics sequence will require a full year of calculus as a co-requisite.

Foreign Language - Demonstrate competencies through the 200 level Credits: Up to 16 semester hours / 24 quarter hours.

Major Courses– Hours/courses listed below that count toward the major or pre-major requirements.

a. Biology I & II for the science major w/ Lab – (OSC003 AND OSC004) OR OSC024 Credits: 8-10 semester hours of credit /12-15 quarter hours of credit. Lab to be included.

Advising Notes: All non-sequence coursework will be reviewed on a course by course basis by the receiving institution for transfer and application to the major.

b. Organic Chemistry I & II w/Lab – OSC010 Credits: 8-10 semester hours of credit /12-15 quarter hours of credit. Lab to be included.

Advising Notes: All non-sequence coursework will be reviewed on a course by course basis by the receiving institution for transfer and application to the major.

c. One semester of Physics either College Physics (calculus-based) or General Physics (college-algebra based) w/ Lab, for the science major – OSC016 (College Physics) or OSC014 (General Physics) Credits: 4-5 semester hours /4–5 quarter hours. Lab to be included.

Advising notes: The amount and type of physics (calculus or non-calculus-based) required in the biological sciences varies from institution to institution. Many institutions require at least one semester of physics, others none. Students are strongly encouraged to check with the receiving institution within the first year of study.

Transfer Assurance Guides Total Guaranteed Credits (Range)		
• Ohio Transfer Module	36 – 40 sem.	54 – 60 qtr.
• Foreign Language	0 – 16 sem.	0 – 24 qtr.
• Pre-major / Major	0 – 20 to 25 sem.	0 – 28 to 35 qtr.

Institutional Requirements: For entrance and graduation, a transfer student must meet all institutional requirements which would include, but may not be limited to: minimum grade point average, residency requirements, upper division credits attained, minimum grades in specific courses, performance requirements (ex. dance, music) and other requirements of native students from the same institution.

OSC024 – BIOLOGY I & II MAJOR SEQUENCE w/ labs
8-10 Semester Hours/12-15 Quarter Hours

Related TAGs: Biology

Although the learning outcomes are grouped into two courses entitled Biology I and II, they do not necessarily have to be delivered in the arrangement suggested by the structure of this list, i.e. some institutions may chose to deliver the content of "Biology II" in the first course of their majors sequence, others may split the content of Biology I and II into three courses, etc.

OSC003 – BIOLOGY I
4-5 Semester Hours/6-8 Quarter Hours

Related TAGs: Biology, Bioengineering

This course explores general biological problems and processes as they are experienced by all living organisms: the chemistry and energetics of life, molecular genetics, cell reproduction, evolution and ecology. The course includes a required laboratory; topics of the lab align to the course.

<u>Scientific theory</u>

1. Illustrate the scientific method through analysis of major biological discoveries.
2. Characterize the scientific method and its limitations in the search for answers to biological questions.

<u>Life processes in living systems including organization of matter and energy</u>

3. Demonstrate understanding of basic atomic structure and how atoms combine to form molecules.
4. Understand that the characteristics of life result from unique combinations that occur among a relatively small number of common atoms.
5. Understand the unique properties of the carbon atom, why it is important to life and the basic ways in which organic molecules are constructed.
6. Know the basic chemical and physical properties of water and how they facilitate processes essential for life.
7. Know the basic structural characteristics and biological importance of carbohydrates, lipids, proteins and nucleic acids.
8. Apply chemical principles to the analysis of structure and function of biological macromolecules.
9. Understand the relationship of chemical processes to the cellular processes of life.

Principles of biological evolution (Covered as part of Biology I or II)

10. Understand and describe the evidence for evolution.
11. Identify the evolutionary processes that lead to adaptation and biological diversity.

General concepts of genetics and heredity

12. Recognize that unity and diversity of life on earth are a result of genetic inheritance through DNA and evolution by natural selection.
13. Understand DNA and its role in heredity, and how information from DNA is expressed in cells, and ultimately, the organism.
14. Compare mechanisms of regulation of gene expression.
15. Understand the structure, function and reproduction of cells, including viruses and microorganisms.
16. Understand the major steps in a typical eukaryote cell cycle including the details of mitosis and cytokinesis.
17. Understand the stages of meiosis, their significance, and how meiosis relates to sexual life cycles.
18. Understand different types of mutations and their effects on gene products and on phenotype.
19. Understand the basic principles of development.

Regulation of biological systems including homeostatic mechanisms

20. Understand that cells have evolved elaborate mechanisms for communicating and coordinating their functions in a living organism.
21. Recognize that regulatory mechanisms ensure balance in living systems and that organisms interact continuously with their environments; compare regulatory mechanisms within and across species
22. Apply knowledge of cellular regulatory mechanisms to explanations of aberrant cell behavior.

Bioenergetics including major biochemical pathways

23. Understand that living organisms harvest energy by breaking the chemical bonds of organic molecules through sequences of enzyme mediated reactions.
24. Understand the process of energy transfer from its source (the sun) through biological systems.
25. Understand the overall organization of the chemical pathways involved in cellular respiration and fermentation and how these pathways accomplish the processing of energy.
26. Understand current models of cell membrane structure and function.
27. Understand the overall organization of the chemical pathways involved in photosynthesis and how these pathways accomplish the conversion of light energy into chemical bond energy.

Historical development and perspectives in biology (Possible continuation and integration over Biology I&II. The degree and manner by which this addressed is an institutional decision.)

28. Understand historical developments and perspectives in biology, including contributions of significant figures and underrepresented groups, and the evolution of theories in biology.

How to design, conduct, and report research in biology (Possible continuation and integration over Biology I&II. The degree and manner by which this addressed is an institutional decision.)

29. Document the solution to scientific problems through collection and analysis of experimental data and the preparation of scientific reports.
30. Collect, organize, analyze, interpret, and present quantitative and qualitative data and incorporate them into the broader context of biological knowledge.

Applications of biology and biotechnology in society, business, industry, and health fields (Possible continuation and integration over Biology I & II. The degree by which this addressed is an institutional decision.)

31. Effectively use current research literature, online information, and information related to scientific and biological issues in the mass media.
32. Understand the uses of recombinant DNA technologies and genomics.
33. Integrate and relate knowledge learned from classroom with real life situations.

OSC004 – BIOLOGY II
4-5 Semester Hours/6-8 Quarter Hours

Related TAGs: Biology

This course explores general biological problems and processes as they are experienced by all living organisms: plant and animal diversity, evolution, basic plant and animal systems, hormones, and immunology. The course includes a required laboratory; topics of the lab align to the course.

Scientific theory – Covered above in Biology I

Life processes in living systems including organization of matter and energy - Covered above in Biology I

Principles of biological evolution (Covered as part of Biology I or II)

1. Understand and describe the evidence for evolution.
2. Identify the evolutionary processes that lead to adaptation and biological diversity.

Similarities and differences among animals, plants, fungi, microorganisms, and viruses

3. Recognize levels of biological organization from cells, the basic unit of life, to the organism and the relationship of structure to function at all levels of biological organization.
4. Explain the basic structures and fundamental processes of life at molecular, cellular, and organismal levels.
5. Understand that all living organisms consist of cells; understand the differences between prokaryotic and eukaryotic cells.
6. Develop a basic understanding of plant and animal cell structure and function including their respective organelles and other components, particularly cell membranes, and methods of study.

Form and function of living organisms

7. Describe the general organization of the animal body and vascular plants.
8. Describe and contrast reproduction and development in plant and animal systems.
9. Compare the structure of nutrient procurement and processing systems in plants and animals.
10. Describe the structure and function of the nervous system, the musculo-skeletal system, the respiratory system and the mechanisms of internal transport and regulation in various organisms.
11. Understand the fundamentals of the endocrine system at the systemic level.
12. Describe basic processes of infectious disease and defense against infection.

Principles and practices of biological classification

13. Explain differences among classes of organisms in terms of biological structures and their functions.
14. Outline and describe the major invertebrate and vertebrate phyla in terms of structure, nutrition, life history, and evolutionary relationships.
15. Correlate the processes and results of scientific inquiry with the remodeling of animal phylogenetic relationships.

Ecological systems including the interrelationships and dependence of organisms with each other and their environments

16. Describe the relationship between life forms and their environment and ecosystems.
17. Describe the different types of relationships that exist between living organisms.
18. Explain how populations grow, and how we can describe this mathematically.
19. Explain how energy moves through an ecosystem.
20. Describe the basic principles of conservation biology.

Behavior of organisms and their relationships to social systems

21. Describe and explain various types of animal behavior.
22. Describe advantages and disadvantages of social behavior.

Historical development and perspectives in biology (Possible continuation and integration over Biology I&II. The degree and manner by which this addressed is an institutional decision.)

23. Understand historical developments and perspectives in biology, including contributions of significant figures and underrepresented groups, and the evolution of theories in biology.

How to design, conduct, and report research in biology (Possible continuation and integration over Biology I&II. The degree and manner by which this addressed is an institutional decision.)

24. Document the solution to scientific problems through collection and analysis of experimental data and the preparation of scientific reports.
25. Collect, organize, analyze, interpret, and present quantitative and qualitative data and incorporate them into the broader context of biological knowledge.

Applications of biology and biotechnology in society, business, industry, and health fields (Possible continuation and integration over Biology I & II. The degree and manner by which this is addressed is an institutional decision.)

26. Effectively use current research literature, online information, and information related to scientific and biological issues in the mass media.
27. Compare costs and benefits of preserving endangered species and protecting the environment.
28. Integrate and relate knowledge learned from classroom with real life situations.

OSC010 – FULL YEAR SEQUENCE OF ORGANIC CHEMISTRY (w/labs)
8-10 Semester Hours/12-15 Quarter Hours
Prerequisites: General Chemistry I & II for the major w/ lecture and lab.
Suggested Textbook Topics: Lecture: A standard modern organic chemistry text designed for chemistry and ancillary science majors.

Related TAGs: Biology, Chemistry

Organic Chemistry lecture and lab (8-10 semester hours or 12 – 15) quarter hours transfers as a full year sequence only. All non-sequence coursework to be reviewed on a course by course basis by the receiving institution. Note: These outcomes were aligned with the American Chemical Society (ACS) recommendations in mind.

Students must be proficient in all of the following core competencies:

1. Theories of structure and bonding in organic compounds including Lewis structures and molecular orbital theories, hybridization, resonance.
2. Acid-base reactions of organic compounds
3. Stereochemistry, isomerism and conformational analysis
4. Nucleophilic substitution and elimination reactions
5. Chemistry of alkenes and alkynes
6. Chemistry of aromatic compounds (including aromaticity, electrophilic aromatic substitution, nucleophilic aromatic substitution)
7. Chemistry of alcohols, ethers, alkyl halides and epoxides
8. Chemistry of aldehydes and ketones – addition reactions
9. Chemistry of carboxylic acids and derivatives – nucleophilic acyl substitution
10. Enol and enolate chemistry, condensation reactions
11. Chemistry of dienes, including Diels-Alder reaction
12. Free radical chemistry
13. Chemistry of amines
14. Spectroscopy and its use in the structural elucidation of organic compounds (including ^{1}H and ^{13}C NMR, IR, mass spectrometry)

Students must have developed:

15. Familiarity with IUPAC nomenclature
16. An understanding of curved arrow reaction mechanism, with an ability to apply these skills to new situations
17. An ability to design syntheses, use of retro-synthetic analysis
18. An understanding of stereochemical implications in organic reactions
19. Students should have been exposed to a variety of applications of organic chemistry in society

Lab Course Learning Outcomes: Students must be proficient in all of the following core competencies:

20. In the organic chemistry laboratory, the student should perform and master the basic techniques for: (i) the separation and purification of organic compounds (recrystallization, distillation, column chromatography), (ii) the analysis of organic compounds (TLC, gas chromatography) and (iii) the characterization of organic compounds (melting and boiling points, IR spectroscopy (hands-on) and NMR (either hands on or through the use of standard spectra).
21. Students should conduct a broad range of organic transformations which illustrate topics drawn from the organic chemistry lecture sequence, including multi-step syntheses.
22. Students should learn how to keep a laboratory notebook, and write reports detailing their experiments.
23. Students should understand and practice safe laboratory techniques.

OSC016 - PHYSICS I – CALCULUS BASED PHYSICS FOR THE MAJOR (W/LABS)
4-5 Semester Hours/8-10 Quarter Hours
Co-requisites: Calculus I.

Related TAGs: Bioengineering, Biology, Chemistry, Computer/Electrical Engineering, Geology, Industrial Engineering, Math, Physics

Understanding and/application of the following topics using calculus concepts and methods where appropriate:

1. Kinematics – one and two dimensional
2. Vectors – vector Arithmetic
3. Force and Newton's Laws of Motion
4. Work, Energy, Conservation of Energy
5. Linear momentum
6. Collisions
7. Rotational kinematics and dynamics
8. Angular momentum and rotational energy
9. Simple harmonic motion
10. Waves and sound
11. Solid and fluid properties
12. Heat and thermodynamics
13. Kinetic theory of gases

OSC014 – ALGEBRA-BASED PHYSICS I (w/labs)
4-5 Semester Hours/8-10 Quarter Hours
Co-requisites: College Algebra and Pre-calculus.

Related TAGs: Biology, Chemistry, Civil/Construction Engineering Technology, Electrical Engineering Technology, Mechanical Engineering Technology

Understanding and/application of the following topics using algebra concepts and methods where appropriate:

1. Kinematics – one and two dimensional
2. Vectors – vector Arithmetic
3. Force and Newton's Laws of Motion
4. Work, Energy, Conservation of Energy
5. Linear momentum
6. Collisions
7. Rotational kinematics and dynamics
8. Angular momentum and rotational energy
9. Simple harmonic motion
10. Waves and sound
11. Solid and fluid properties
12. Heat and thermodynamics
13. Kinetic theory of gases

OMT005 -CALCULUS I
4-5 Semester Hours/8-10 Quarter Hours

Related TAGs: AACM Engineering, Biology, Bioengineering, Chemical Engineering, Chemistry, Economics, Electrical Engineering Industrial Engineering, Math, Physics

The successful Calculus I student should be able to:

1. Determine the existence of, estimate numerically and graphically and find analytically the limits of functions.
2. Determine the continuity of functions at a point or on intervals and to distinguish between the types of discontinuities at a point.
3. Recognize and determine infinite limits and the relationship to vertical asymptotes.
4. Determine the derivative of a function using the limit definition and derivative theorems and to understand the correlation of the derivative to finding tangent lines to a graph, finding the slope of a graph at a point and finding the rate of change of a dependent variable with respect to an independent variable.
5. Demonstrate the ability to determine the derivative and higher order derivatives of a function explicitly and implicitly and to solve related rates problems.
6. Determine absolute extrema on a closed interval for continuous functions and to use the first and second derivates to analyze and sketch the graph of a function, including determining intervals on which the graph is increasing, decreasing, constant, concave up or concave down and any relative extrema or inflection points.
7. Recognize and determine limits at infinity and the relationship to horizontal asymptotes.
8. Determine when the Mean Value Theorem can be applied and use it to solve theoretical and applied problems.
9. Solve applied optimization problems.
10. Use differentials and linear approximations to analyze applied problems.
11. Demonstrate the ability to determine indefinite and definite integrals, use definite integrals to find areas of planar regions, use the Fundamental Theorems of Calculus, and integrate by substitution.
12. Apply the competencies above to a wide range of functions, including polynomial, rational, algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, hyperbolic and inverse hyperbolic.

OMT001 - COLLEGE ALGEBRA
3-4 Semester Hours/4-5 Quarter Hours
Recommendation: This course should significantly reflect the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics recommendations.

Related TAGs: Biology, Civil/Construction Engineering Technology, Mechanical Engineering Technology, Electrical Engineering Technology

The successful College Algebra student should be able to:

1. Represent functions* verbally, numerically, graphically, and algebraically.
2. View a function as a set of ordered pairs or a correspondence between two sets.
3. Find the domain and range of functions*.
4. Perform translations and dilations of functions*.
5. Perform operations (addition, subtraction, multiplication, division, composition) with functions*.
6. Use functions* to model a variety of situations.
7. Solve equations, including application problems.
8. Solve systems of linear equations, including 3×3 systems and application problems.
9. Solve nonlinear inequalities.
10. Apply the factor theorem, the remainder theorem, and the rational roots theorem, including application problems.
11. Find inverses of functions* and relate the graph of a function to the graph of its inverse.
12. Analyze the graph of a function* to answer questions about the function (such as intercepts, domain, range, intervals where the function is increasing or decreasing, possible algebraic definitions, etc.)

* This course should consider the following types of functions:
1. polynomial
2. rational
3. root/radical/power
4. exponential and logarithmic
5. piece-wise defined

OSC023 – FULL YEAR SEQUENCE OF GENERAL CHEMISTRY I & II W/ LAB FOR THE MAJOR
8-10 Semester Hours/12-15 Quarter Hours

This is a combination of OSC008 and OSC009, General Chemistry I & II, with outcomes listed below:

OSC008 - GENERAL CHEMISTRY I (w/lab)
4-5 Semester Hours/6-8 Quarter Hours
Prerequisites: Proficiency with algebra
Suggested Textbook Topics: Lecture to include a standard modern general chemistry text designed for a full year sequence of general chemistry for science majors.

Related TAGs: Biology, Bioengineering, Chemical Engineering, Chemistry, Geology, Physics

Note: These outcomes were aligned with the American Chemical Society (ACS) recommendations in mind.

Students must be proficient in all of the following core competencies:

1. Significant figures
2. Fundamental structures of atoms and molecules: introduction to quantum mechanics, atomic orbitals
3. Principles of ionic, covalent and metallic bonding; including Lewis structures, valence bond and molecular orbital theories of bonding
4. Mole concept, stoichiometry, and the laws of composition
5. Acids and bases, oxidation-reduction chemistry, and solutions
6. Thermochemistry
7. Classification of elements, including periodicity
8. Students should have been exposed to a variety of applications of chemistry in society
9. Students must have developed sufficiently strong analytical and interpretative skills to effectively apply algebraic methods to solve problems
10. In a general chemistry laboratory, the student should have been exposed to a broad range of chemical laboratory experiences which build on topics covered in the corresponding lecture course, and which develop (1) analytical and preparative skills (2) the ability to effectively collect, analyze and report data. Students should understand safe laboratory practice.

OSC009 - GENERAL CHEMISTRY II (w/lab)

4-5 Semester Hours/6-8 Quarter Hours
Prerequisites: General Chemistry I
Suggested Textbook Topics: Lecture to include a standard modern general chemistry text designed for a full year sequence of general chemistry for science majors.

Note: These outcomes were aligned with the American Chemical Society (ACS) recommendations in mind.

Related TAGs: Biology, Bioengineering, Chemical Engineering, Chemistry, Geology

Students must be proficient in all of the following core competencies:

1. Intermolecular forces and phase changes
2. Solutions and colligative properties
3. Chemical kinetics
4. Chemical equilibrium
5. Acid-base equilibria
6. Thermodynamics (including entropy and free energy)
7. Electrochemistry
8. Descriptive chemistry, including chemical properties and classification of the elements, periodic patterns of reactivity
9. Students should have been exposed to a variety of applications of chemistry in society
10. Students must have continued to develop strong analytical and interpretive skills to effectively apply algebraic methods to solve chemical problems.
11. In a general chemistry laboratory, the student should have been exposed to a broad range of chemical laboratory experiences which build on topics covered in the corresponding lecture course, and which develop (1) analytical and preparative skills (2) the ability to effectively collect, analyze and report data. Students should understand safe laboratory practice.

BIOLOGY TAG – FACULTY PARTICIPANTS

Faculty	Institution
Kelly Smith	Bowling Green State University
Robert Bast	Cleveland State University
Wendy Vermillion	Columbus State Community College
Steve Leidich	Cuyahoga Community College
Steve Leidich	Cuyahoga Community College
Caroline Breitenberger	Ohio State University (The)
Scott Moody	Ohio University
Lauren DiCaprio	Ohio University
Robert Connor	Owens Community College
Bob Deal	Shawnee State University
Phyllis Williams	Sinclair Community College
Terry Flum	Southern State Community College
William Bishoff	University of Toledo (The)