Biology 103
Living Chemistry
5 credit hours

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Prerequisite: Biology 101

Concurrent enrollment in Chemistry 100

Course Format:

Lecture: M,W,F-- 48 minutes per lecture
Recitation: T or R --2 hours per week

This course meets the requirements for the Natural Science, Biological Science Course for the GEC.

This course consists of three distinct components. The lecture will explore the nexus between biology and chemistry in a way that builds on the basic biology learned in Biology 101 and expand the conceptual base with chemistry communicated in Chemistry 100. The melding of chemistry and biology in the cluster courses will serve as a platform to further develop topics that would be found in a typical introductory biology course AND current topics in popular culture that have a biological basis. The recitation component will engage students in discussions of the philosophical underpinnings of science, the nature of the scientific method, the meaning of scientific literacy, the societal need to develop citizen scientists and some recurring controversies in biological science. The recitation sections will be supported by a variety of modalities including selected readings, DVDs designed by the instructor and web-based media. The third component of the course is a quarter-long project selected by the student. Students will be asked to choose one of the topics about which each wrote a short paper in Chemistry 100. Students will then be asked to explain the relationship between their chemistry topic and a biological phenomenon, also of their choosing, using either an artistic medium (music, dance, poetry, painting, quilting etc.) OR the students may create a digital narrative that explains the relationship between chemistry and biology. The latter will occur in conjunction with the Digital Union which will teach the students to use Imovie, Iphoto, Photoshop and Garage Band to create their digital narratives.

1. ***To understand basic principles and facts and their interrelationships.***

The course is structured to identify and explicate several major themes that would normally be found in Biology 101. They include:

- Cell structure and evolution
- Cellular energetics
- Evolution
- Ecology
- DNA structure & function

The lectures that address these topics are not divided into separate sections as would typically be done in an introductory course. Rather, these major biological themes are interwoven in individual lectures. For instance, four themes appear in the lectures on oxygen. Here, evolution is recounted, not just in biological terms, but chemical and geological evolution is addressed as well. Further, cellular structure and energetics are explicitly addressed in the origin of life lectures as is ecology when students are asked to understand the reciprocal ecological relationship between photosynthetic organisms and respiratory activity of all organisms. Thus, the lectures both instruct the students about the major themes of biology and explain the interrelationships between other areas of biology. One of the strengths of the cluster format is to extend this interweaving of themes to include relevant chemistry.

2. ***To understand when, where and how principles and facts were discovered and impact on methods of science***

Experience with other introductory biology courses has shown that, despite rigorous coverage of the foundations of science, the scientific method and its history, and exploration of how scientific thought is different from other types of thought, students memorize enough to pass exams and fail to process and internalize the information. Such students emerge from their science classes with no real understanding of what it means when we say science is "evidence based" or that scientific thought is different from belief. Biology 103 will take this thorny issue on as a major focus in the recitation section. Students will be asked to read articles or analyze DVDs, prepared by the instructor, that address the history of scientific thought, the nature of science (and other modes of thought), scientific literacy and the relationship between science and technology. In addition, students will learn about and examine several current controversies, e.g., religion and science and stem cells and cloning. They will be asked to apply the principles of science to an examination of these issues. They will be graded on their participation and short writing assignments based on these exercises.

3. ***To understand the interaction between science and technology***

This issue will be explicitly addressed in the recitation section. First the, history of scientific thought will be traced and, in so doing, the nexus between science and technology will be explored. Several historically interesting examples will be given and discussed. For example, the article by Stephen J. Gould (The Great Asymmetry, recitation week 2) discusses how unsavory technical applications of science have led the

public to distrust science. The specific example he uses to illustrate this point is a problem encountered by the executioner during the French Revolution in meeting the heavy demand to execute prisoners. His solution, an advance in technology, is suggested by the executioner's surname: Guillotin. The articles and DVDs have been carefully chosen to ignite interest and facilitate discussion.

4. ***To understand the social and philosophical implications of major scientific discoveries***

This goal will be addressed in both lecture and recitation. As basic biological themes are being covered in lecture, social and philosophical themes are interspersed. For instance, as carbon-based biological chemistry is covered, the ecological impact of the basic information will be embedded in the lectures as will the social consequences of that impact. Thus, global warming (introduced in Chemistry 100) will be revisited from a biological perspective as will measuring one's biological carbon footprint. The consequences of choices we might make and the political ramifications will be explored.

I believe that students come to us with a variety of skills which I, as a teacher, can use to teach biology. Non-majors will probably not have great interest or competence in science. However, they may have great interest in the arts (broadly defined) or technology. Biology 103 allows students to utilize such skills to explore and learn biology. The quarter-long project is an expression of this philosophy. Instead of having students do a project that is explicitly science-based, students can choose a modality that is of interest to them individually and use it to make connections between chemistry and biology.

Biology 103

Lecture	Topic	Date
	Part I. The Elements	
	Oxygen	
1	In the Beginning: chemical & geological evolution	
2	Life in four easy steps	
3	The world goes green: photosynthesis & oxygen production	
4	Oxygen Toxicity: the other side of the equation	
	Phosphorus	
5	Those hungry cells; ATP and energy storage	

6	Oxidative metabolism: photosynthesis to respiration
7	An athlete's story: pyruvate, lactic acid and sports-related Cellular chemistry
8	Phosphorus and DNA: DNA structure, function, central dogma
9	More tales of phosphorus: DNA replication and protein synthesis

Carbon

10	Carbon and the chemistry of life
11	Carbon-based energy flow in the food chain
12	Converting dinosaurs into gasoline
13	Determining your biological carbon footprint
14	**Midterm I**

Part II. Simple Molecules

Water

15	H-bonding in living molecules
16	The amazing power of water to explain biology: surface water Tension, sweat & heat of evaporation; winter lakes; watering the tree tops

EtOH

17	Respiration revisited: ethanol in the mix
18	Beer, wine & assorted libations: how they impact your brain
19	Converting corn to biofuels

NaCl

20	Why vertebrates crave potato chips
21	The nervous system, the resting potential, nervous transmission

22	Neurotransmitters and substances that mimic them

Part III. Complex Molecules

Antibiotics

23	Microbes and the germ theory of disease
24	Penicillin and other antibiotics; modes of action
25	Antibiotic resistance-an evolutionary tale
26	**Midterm II**

Chocolate and other Pleasures

27	Chocolate and other neuroactive compounds
28	Chemical mediation of behavior

Aflatoxins and other Biotoxins

29	Aflatoxins and the Salem Witch Trials
30	Botulinum and Bo-Tox

Recitation Schedule:

Week	Topic and Assignments	Date
1	The Evolution of Biological Thought	

Reading:

Silver, B.L. (1998). Ascent of Science. Oxford University Press, New York, London, 552 pgs.

Chapter 1: Newton Gets it Wrong pp. 3-10
Chapter 2: I believe pp. 11-28

DVD: Know the Difference (Between Hypothesis and Theory).

2	The Consilience of Knowledge

Reading:

Snow, C.P. (1959). *The Two Cultures*, Cambridge University Press, New York. pp. 1-22

Wilson, E.O. (1999) *The Great Branches of Learning.* In: Consilience: The Unity of Knowledge. Pp.8-14

Gould, S.J. (1998). *The Great Asymmetry.* Science 279: 812-813.

3 Perspectives on the Origin of Life on Earth

Reading:

Cairns-Smith, A.G. (1985). Seven Clues to the Origin of Life. Cambridge University Press, London, pp. 1-8.

Eiseley, L. (1957). The secret of life. In: The Immense Journey, Vintage Books, New York, pp.195-210.

Collins, F.S. (2006). The Language of God. Free Press, New York, London, 294 pp.
Chapter 4: Life on Earth

DVD: The Origin of Life on Earth

4 Can Faith and Reason be Reconciled?

Reading:

Collins, F.S. (2006). The Language of God
Chapter 1: From Atheism to Belief, pp. 11-31.

Dawkins, R. (1996). The Blind Watchmaker. W.W. Norton & Co., New York, 357 pp.
Chapter 1: Explaining the Very Improbable, pp. 1-20.

DVD: Know the Difference (Between Science and Religion)

5 Science and Citizenship

Reading:

Hively, W. (1988). How much science does the public understand? Am. Scientist 76: 439-444.

Roth, W.-M. and A.C. Barton (2004). Rethinking Scientific Literacy. Routledge Falmer, publisher, N.Y., London, chpts. 1&2.

Augustine, N. (1998). What we don't know does hurt us. How scientific illiteracy hobbles society. Science 279: 1640-1641.

6 Science and Technology: An Unholy Alliance?

Reading:

Burnham, J.C. (1987). How Superstition Won and Science Lost; Popularizing Science and Health in the US. Rutgers University Press, New Brunswick, Chpts 1-4.

Brock, W.E. (1987). The Bozeman Chainsaw Massacre. Discover (November) 119187: 79-85

7 Understanding the Genetic Code and the Basis for Life

Reading:

Watson, J.D. and F.H.C. Crick (1953). A Structure for Deoxyribose Nucleic Acid (with annotations). Nature 171: 737-738.

Watson, J. (1989). *The DNA Puzzle: Finding How the Pieces Fit.* In: Science and the Human Spirit, Wadsworth Publishing, New York. pp. 133-135.

Asimov, A. (1962). *Breaking the Code.* In: The Genetic Code, Clarkson-Potter, New York. pp. 161-1Genes, Stem Cells, Cloning

8 The Human Genome Project and What's Next

On-line Education Kit http://www.genome.gov/25019879
Understanding the Human Genome Project (National Institutes of Health)

9 Project Presentations

10 Project Presentations

Grading

Your grade will be determined as follows:

Midterm I	100 points
Midterm II	100 points
Comprehensive Final	200 points
Recitation (participation and short papers)	100 points
Quarter Project	100 points
Total	600 points

Absences and Late Work: Delayed work will suffer reduced credit. A reduction of 20% of the possible points is levied for each day late unless a valid medical excuse is presented.

Academic Misconduct: OSU has a strict code of academic conduct that requires us to report any and all cases of suspected misconduct (e.g. cheating on exams, plagiarism etc.) to the OSU Committee on Academic Misconduct for adjudication. I adhere to this policy.

Disability Services

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

Course cohesion between Chemistry 100 and Biology 103:

Coherence between the courses will be achieved in a variety of ways. First, the courses are divided into chemical topics that increase in complexity as the quarter advances. Each chemical class is covered in both courses, albeit from a different perspective. Both courses will be offered in the same quarter, thus, helping students to see how a single chemical topic can be

relevant both to chemistry and biology. The consilience of chemistry and biology will be repeatedly demonstrated throughout the quarter in this manner. In addition, the students will be asked to make the connection between chemistry and biology in a personal way: Students will write several short papers on the relationship between chemistry and a societal issue. Each student will choose one of those topics to explore in a quarter-long project in Biology 103, thus ensuring that students can integrate, expound upon and understand the wider relevance of material from both courses

I. The Elements

A.) Oxygen

Chemistry 100

- Composition of air
- Measurement and Science
- Substances and Mixtures
- Chemical Formulas and Nomenclature
- Chemical Reactions: Combustion

Biology 103

- In the Beginning: chemical & geological evolution
- Life in four easy steps
- The world goes green: photosynthesis & oxygen production
- Oxygen Toxicity: the other side of the equation

B.) Carbon

Chemistry 100

- "Diamonds are forever" - not to a chemist but they certainly have intriguing chemical and physical properties
- CO_2 and the Greenhouse Effect
- Conservation of Mass
- Mole concept
- Energy
  - Fossil Fuels
  - Carbon Cycle
  - Combustion rxns
  - Energy/Enthalpy calculations

Biology 103

- Carbon and the chemistry of life
- Carbon-based energy flow in the food chain
- Converting dinosaurs into gasoline
- Determining your biological carbon footprint

II. Simple Compounds

A.) Salt (NaCl)

Chemistry 100

- Metals and nonmetals
- The Periodic Table (the finest crip sheet in science)
- Ionic compounds

Biology 103

- Why vertebrates crave potato chips
- The nervous system, the resting potential, nervous transmission
- Neurotransmitters and substances that mimic them

B.) Water (H_2O)

Chemistry 100

- Molecular compounds
- Molecular shapes and their impact on chemical and physical properties
- Unusual Properties of Water
- Aqueous solutions: The universal solvent
- Electronegativity and Polarity

Biology 103

- H-bonding in living molecules
- The amazing power of water to explain biology: surface water
- Tension, sweat & heat of evaporation; winter lakes; watering the tree tops

C.) Ethanol

Chemistry 100

- Polarity of molecules: Why chemists drink red wine with red meat and sometimes use soap
- Intermolecular forces of attraction: Liquids, Solids, and Solutions

Biology 103

- Respiration revisited: ethanol in the mix
- Beer, wine & assorted libations: how they impact your brain
- Converting corn to biofuels

III. Complex Molecules

A.) Antibiotics

Chemistry 100

- Organic chemistry introduction
- Antibiotics obtained chemical synthesis, such as sulfa drugs

Biology 103

- Microbes and the germ theory of disease
- Penicillin and other antibiotics; modes of action
- Antibiotic resistance-an evolutionary tale

B.) Macronutrients and Micronutrients: Carbohydrates, Proteins, and Fats/Vitamins and Minerals

Chemistry 100

- Carbohydrates – simple vs. complex
- Proteins – amino acids, Complementarity in global diets

- Fats – saturated, unsaturated, trans, cholesterol
- Geometry and polarity of molecules: How not to overdose on vitamins
- Why do chemists sometimes bathe?
-

C.) Chocolate

Chemistry 100

- What makes them taste different

Biology 103

- Chocolate and other neuroactive compounds
- Chemical mediation of behavior

D.) Poisons

Chemistry 100

- Chemical structure and behavior of some of the more potent poisons
- Chemical structure of blood
- Equipment and methodology in forensic chemistry
- We solve the **murder** of the head of the chemistry department using **Forensic Chemistry**

Biology 103

- Aflatoxins
- Botulinum and Bo-Tox