Course Name: BIOL 10A

Title: Cellular Biology, Genetics & Evolution

Units: 5

Course Description:
Investigates the principles governing cell biology, metabolism, genetics, evolution and history of life on earth. The first course in a 3-course sequence for Biology majors (Biol 10ABC). For majors in biological sciences but open to all qualified students. Total of 54 hours lecture and 108 hours laboratory.

Prerequisites:
Chem 1A

Corequisites:
n/a

Course Objectives:

Objectives for all credit courses must indicate that students will learn critical thinking and will be able to apply concepts at college level.
1. Demonstrate acceptable laboratory techniques in conducting biological experiments and dissections, be able to measure, quantify, graph/analyze and interpret experimental results, be able to keep a laboratory notebook, write formal scientific paper, and present a scientific poster.
2. Characterize the major properties of water, pH, buffers, chemical bonds, energy thermodynamics, and structure of molecules and their importance in biological systems.
3. Analyze the chemical structure and characteristics of carbohydrates, lipids, nucleic acids, and proteins.
4. Describe the structure and mechanisms of enzymes and factors that alter enzyme activity.
5. Compare the structure and function of viruses, prokaryotic and eukaryotic cell types.
6. Based on the detailed knowledge of the chemical and physical nature of cell membranes, describe active and passive transport mechanisms, and their kinetics and regulation.
7. Describe the extracellular matrix, and the mechanisms of intercellular communication and intracellular signal transduction.
8. Describe and compare the processes of cellular respiration, fermentation, and photosynthesis, and explain their importance to life on earth.
9. Describe the structure of the DNA molecule, its replication, mutation and repair in prokaryotes and eukaryotes.
10. Explain the process of transcription and translation and their regulation and control.
11. Analyze the principles of heredity including Mendelian inheritance, chromosomal linkage, pedigrees, and epigenetics.
12. Describe evidence supporting evolution, debate the pace of evolution, discuss mechanisms of speciation.
13. Discuss the significance of the Hardy-Weinberg principle as it relates to evolution and describe the conditions required for genetic equilibrium, apply the Hardy-Weinberg equation to determine allele, genotypic and phenotypic frequencies.
14. Describe the patterns and processes governing molecular evolution, the origin of life, and history of life on earth.

Course Content:

1. Scientific Method
    a.Making observations and developing hypotheses
    b.Performing a literature evaluating resources
    c.Designing experiments
    d. Analyzing data
    e. Producing professional scientific communications:
        i. Scientific papers
        ii. Scientific Posters
        iii. Formal presentations
2. Basic Chemistry
    a. Elements and isotopes
    b. Molecules, Reactions and Bonding
    c. Properties of Water
    d. Acids, bases, and buffers
    e. Carbon chemistry and organic molecules
3. Biomolecules
    a. Carbohydrates
    b. Lipids
    c. Proteins
    d. Nucleic Acids
4. Energy of Life
    a. Matter, Energy and Thermodynamics
    b. ATP and coupled reactions
    c. Enzyme structure, function and kinetics
5. Cellular respiration, fermentation
    a. Catabolism and oxidation
    b. Glycolysis
    c. Citric Acid Cycle
    d. Anabolic pathways
    e. Fermentation
6. Photosynthesis
    a. Light Reactions
    b. Calvin Cycle
    c. Alternative mechanisms of Carbon Fixation
7. Cell Communication
    a. Reception of signals
    b. Transduction
    c. Cellular responses
    d. Apoptosis
8. The Cell Cycle
    a. Mitosis
    b. Regulation of eukaryote cell cycle
9. Cellular Structure
    a. Technology for studying cells
    b. Prokaryote Vs Eukaryote cell structure
    c. Nucleus and ribosomes
    d. Endomembrane system
    e. Mitochondrai and plastids
    f. Cytoskeleton
    g. Extra-cellular matrix
10. Membrane Structure and Function
    a. Fluid mosaic model
    b. Selective permeability and transport
11. Introduction to Molecular Genetics and Genomics

12. DNA as a molecule
    a. DNA structure
    b. DNA replication
    c. DNA recombination
13. Meiosis and sexual reproduction
14. Mendelian inheritance and Transmission genetics
15. Chromosomes
    a. Chromosome structure
    b. Sex-Chromosomes
    c. Linkage and Mapping
    d. Molecular organization of chromosomes
    e. Karyotypes and Chromosome behavior
16. Transcription
    a. Regulation and control
    b. Genetic code
    c. RNA processing
    d. Epigenetics
17. Translation
    a. Control
    b. Post-translational modifications
18. Mutation and DNA repair
19. Bacterial Genetics
    a. Plasmid structure
    b. Conjugation
    c. Transduction
    d. Bacteriophages
20. Viral Biology
21. Mitochondrial DNA
    a. Extranuclear inheritance
    b. Organelle heredity
22. Genome Evolution
23. Genetic control of development
    a. Evo-devo
    b. Master Control genes
        i. HOX genes
        ii. MADs Box genes
24. Darwin and Evolutionary Theory
25. Population Genetics and Evolution
    a. Hardy-Weinberg
26. Speciation
    a. Mechanisms of speciation
    b. Species concepts
27. History and Origin of Life
    a. Molecular origin of life
    b. Pattern of life over the past 3.8 billion years

Labs

Principles of Microscopy
Probability and Measurement
Biological Molecules
Cell Structure Survey
Membrane transport
Cell Cycle; Mitosis and Meiosis
Enzyme Kinetics
Comparative metabolism: Cell Respiration, Fermentation and Photosynthesis
DNA extraction and PCR

Electrophoresis
Bioinformatics
Mendelian Genetics
Linkage Mapping
Karyotypes and Pedigrees
Population Genetics and Hardy-Weinberg
Macroevolution
History of Life

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Methods of Instruction:

Substantial writing assignments including:
*Written Homework
*Lab Reports
*Term or other papers
*Essays

Out-of-Class Assignments:

1. In this project on enzyme kinetics you will be designing and carrying out Experiments to test hypotheses regarding the optimal performance of a variety of enzymes from different organisms to explore the adaptive nature of bio-molecules. Enzymes from animals (amylase), plants (catalase), and bacterial must be included in the project. Some reference to extremophiles must be included in the analysis. You must include a diagnosis of the pH and temperature optimums for all enzymes in your experiments. You will be presenting a scientific poster on your project during a dedicated session.

2. In this project you will formulate and test hypotheses regarding factors that affect the rate of photosynthesis in 3 different organisms to demonstrate your understanding of the basic function and process of photosynthesis. The organisms must include at least one plant species but may include algae and bacteria as well. The functional anatomy of the photosynthetic tissue should be described with respect to their influence on the process as well. You will produce a professional quality scientific paper on your research.

Methods of Evaluation:

*Multiple choice
*True/False
*Matching Items
*Completion

Examples of Appropriate Texts or Other Required Reading:

Title: Biological Science
Author: Freeman
Date: 2010

Title: Biology w/Study Guide
Author: Campbell and Reece
Date: 2010

Title: Principles of Biology
Author: Tenney
Date: 2011

Title: Life
Author: Sadava
Date: 2010

Title: Biological Investigations: Form, Function and Diversity & Process
Author: Warren Dolphin
Date: 2008

Other Appropriate Reading:

Lab Manual:
Biological Investigations: Form, Function and Diversity & Process
Warren Dolphin
Publisher: McGraw-Hill; eighth edition (2008)