

Contra Costa College

Course Outline

Department & Number: BIOSC 147

Course Title: Cell and Molecular Biology

Pre-requisite: CHEM 120 and
BIOSC 106 or
BIOSC 172L and
MATH 120

Corequisite: None

Advisory: ENGL 001A

Entry Skill: None

Lecture Hours: 54.00 - 54.00

Lab Hours: 54.00 - 54.00

Composition Hours: 0.00

Activity Hours: 0.00

Lecture Hours By Arrangement: 0.00

Lab Hours By Arrangement: 0.00

Units: 4.00 - 4.00

Course/Catalog Description:

This course, intended for majors, will cover principles and applications of prokaryotic and eukaryotic cell structure and function, biological molecules, homeostasis, cell reproduction and its controls, molecular genetics, classical/Mendelian genetics, cell metabolism including photosynthesis and respiration, and cellular communication. The philosophy of science, methods of scientific inquiry and experimental design are foundational to the course. In the laboratory portion of the course, students will apply techniques and experimental skills commonly used in biotechnology and molecular biology laboratories.

Requisites

1. Pre-requisite: CHEM 120
Comment or Non Course Requisite: May be taken concurrently and
 2. Pre-requisite: BIOSC 106
or
 3. Pre-requisite: BIOSC 172L
and
 4. Pre-requisite: MATH 120
 5. Advisory: ENGL 001A
Comment or Non Course Requisite: Eligibility for ENGL 1A
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Course Objectives:

At the completion of the course the student will be able to:

1. Identify and describe biological molecules and cell structures and explain their functions; Compare and contrast cellular processes and interactions between prokaryotes and eukaryotes (including metabolism, reproduction, communication) 1. Identify and define the structure, function, and organismal distribution of carbohydrates, lipids, proteins, and nucleic acids. 2. Discuss the roles of ATP and NADH in cellular energetics. Define and interpret the overall equation for cellular respiration. Discuss the events of glycolysis, the citric acid cycle, and electron transport, and the use of a proton gradient to generate ATP within mitochondria. Evaluate the yield of ATP molecules in respiration. Explain the process of fermentation in various prokaryotic and eukaryotic cells. Compare and contrast fermentation process and ATP yield with cellular respiration. 3. Define and interpret the overall equation for photosynthesis. Discuss, compare, and contrast the molecular events of the light and dark reactions. Discuss the functional anatomy of leaves and chloroplasts and their involvement in photosynthesis. 4. Identify, explain, and interpret the distribution, structure, and function of organelles in eukaryotic cells. Compare and contrast the structure and functions of prokaryotic and eukaryotic cells. Discuss the origin of prokaryotic and eukaryotic cells. Define and give examples of tissues, organs, and organ systems in animals and plants. 5. Explain, discuss, and interpret cell-signaling systems. Explain, discuss and interpret the structure and functions of various hormones and endocrine glands in invertebrates and vertebrates. Explain how these

- process are involved in organismal homeostasis. 6. Define, interpret, and provide examples of the various kinds of passive and active transport occurs in cells. 7. List, evaluate, and discuss the biochemistry and mode of operation of hormones and other regulatory substances, and environmental factors influencing the growth of plants 8. Describe and discuss those factors determining and affecting the growth rate of populations.
2. Apply the principles of classical and molecular genetics to solve problems in genetics and biotechnology; Explain how DNA replicates and transmits genetic information within organisms. 1. Define, explain, and interpret the basic vocabulary of genetics. Analyze and solve basics problems in Mendelian genetics. Analyze and solve problems involving non-Mendelian genetics. Define and explain mutations, and their molecular and cellular consequences 2. Explain recent advances in genetic engineering and biotechnology involving the introduction of new or modified genetic material into the organismal genome and the cloning of organisms. 3. Analyze proteins using chromatography, SDS-PAGE, and ELISA technologies. Determine protein concentration with a microtiter plate format assay. 4. Analyze DNA molecules using the polymerase chain reaction and agarose gel electrophoresis, determine the relative sizes of DNA molecules using standards. 5. Discuss the process of cellular reproduction in prokaryotic and eukaryotic cells. 6. Identify, explain, and interpret the events and sub-divisions of mitosis and cytokinesis in both animal and plant cells. Compare and contrast mitosis with meiosis; identify, explain, and interpret the events and sub-divisions of meiosis. 7. Explain, interpret, and discuss the structure and function of DNA. Discuss the process of DNA replication. Explain, interpret, and discuss the encoding of genetic information in DNA, and how this is later expressed in transcription and translation. Construct the flow diagram of gene expression from DNA to protein 8. Compare and contrast DNA replication and gene expression in prokaryotic and eukaryotic cells. Evaluate the timing of these events in the cell cycle. Explain and interpret those factors regulating the expression of genes in prokaryotic and eukaryotic cells. 9. Discuss the general structure and function of viruses. Compare and contrast the lytic and lysogenic cycles of viruses.
 3. Relate evolutionary processes to the origin and evolution of cells. 1. Define, explain, and interpret evolution and natural selection. Explain how our understanding of natural selection and evolution is applied in Biotechnology and Molecular Biology
 4. Apply the processes of scientific inquiry and experimental design to the study of biological concepts; Acquire, read, evaluate, apply and cite scientific literature; Practice scientific writing 1. Use laboratory investigations and appropriate procedures to generate accurate and meaningful data and derive reasonable conclusions from them 2. Understand, analyze and interpret scientific articles. Connect ideas discovered in scientific articles to a broader context, including other scientists' ideas 3. Present laboratory findings using the format of scientific writing. Include a clear thesis synthesizing ideas from both new data and a variety of sources Organize ideas logically and effectively according to the standard scientific paper format. Properly cite papers used in background and analysis sections.
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Student Learning Outcomes

1. Demonstrate knowledge of the structure and function of the 4 groups of organic molecules and organelles occurring in living organisms.
2. Demonstrate knowledge of differences between anabolic and catabolic energy metabolism in cells.
3. Demonstrate knowledge of the structure of DNA and its expression in protein synthesis and its relationship to inheritance and expression of alleles in different patterns of inheritance.
4. Accurately set up reaction mixes
5. Correctly perform calculations for and prepare buffers.

Course Content

Course Content (Lecture):

1. Structure and Function of Prokaryotic and Eukaryotic Cells
 - a. Cell theory: Distribution, structure, and functions of Eukaryotic and Prokaryotic cells.
2. Origin and evolution of cellular life and molecular evolution

- a. Evolution of cells, organelles, tissues, organs, and the molecules involved
 - b. Applications of knowledge of natural selection and evolution in Biotechnology and Molecular Biology
 - c. Viral structure and function
3. Organelle structure and function
 - a. Organelles, molecules, and cellular function
4. Membrane structure and function
 - a. Fluid mosaic model, trans-membrane proteins
 - b. Cell signaling
5. Cellular transport
 - a. Endocytosis, exocytosis
 - b. Endomembrane and cytoskeletal system
6. Cellular chemistry and biomolecules
 - a. pH scale, acids and bases.
 - b. Structures, formulae and functions of simple compounds and basic biological molecules (carbohydrates, lipids, proteins, and nucleic acids).
 - c. Structure and function of organic molecules
7. Cellular metabolism (respiration and photosynthesis)
 - a. Cellular respiration and fermentation
 - b. Photosynthesis
8. Cell reproduction and its controls
 - a. Cellular reproduction: prokaryotic and eukaryotic
 - b. Cell cycle
 - c. Growth regulation
 - d. Control of prokaryotic reproduction and sporulation
9. Cell communication
 - a. Cell signaling
 - b. Immune system
10. Classical/Mendelian genetics

- a. Mendelian and non-Mendelian genetics
 - b. Meiosis and life cycles
11. Molecular genetics
- a. Relationship of DNA sequence and gene expression to genotypes and phenotypes
 - b. Analysis of alleles using DNA sequence and bioinformatics technologies
 - c. Molecular phenotypes
12. DNA structure and function
- a. DNA structure and replication
 - b. Gene regulation
13. Gene structure, gene expression and control of gene expression
- a. Transcription and translation
 - b. Promoter, coding sequence, un-translated regions
 - c. Molecules and logic of regulation of gene expression
14. Biotechnology
- a. DNA technology and its applications
 - b. Biotechnology and Molecular Biology concepts:
 - 1. Recombinant protein production
 - 2. UV spectrophotometry
 - 3. Column chromatography
 - 4. Microtiter plate format protein assay
 - 5. SDS-PAGE
 - 6. Critical examination and analysis of data
 - 7. Genomic DNA extraction
 - 8. Polymerase chain reaction (PCR)
 - 9. Agarose gel electrophoresis
15. Scientific Inquiry
- a. Use of the scientific method to test and modify ideas about our understanding of molecular biology concepts

Course Content (Lab):

- 1. Microscopy -preparation and analysis of samples using of dissecting, compound, and fluorescence microscopes.
 - a. Microscopes: Testing predictions that compare

prokaryotic and eukaryotic cells

- b. Microscopes: Testing predictions about similarities and differences between plant, animal, protist, and fungal cells (and tissues)
 - c. Microscopes: Using fluorescence microscopy to analyze the relationship between protein expression, localization, and cell function
2. Testing hypothesis about effects of genetics and environment on metabolic pathways
 - a. Measurement and analysis of cellular respiration and fermentation under varying environmental and genetic conditions
 - b. Measurement and analysis of Photosynthesis under varying environmental and genetic conditions
 3. Techniques and data analysis related to protein structure and function
 - a. Using enzyme activity assays to test predictions about enzyme function under various conditions
 - b. Use of cell culture, protein purification and SDS-PAGE to investigate protein expression, structure, and function
 - c. Quantitation of protein using spectrophotometry and standard curves
 4. Testing hypothesis about relationships between genotypes, gene expression, and measurable phenotypes using classical and molecular genetic techniques
 - a. Genetic analysis of meiosis and fertilization using Punnett squares and observable data
 - b. Molecular and genetic analysis of eukaryotes using PCR genotyping and phenotypes
 - c. Molecular and genetic analysis of prokaryotes using restriction digests, DNA electrophoresis, selective and differential media
 - d. Analysis of natural selection and evolution using comparative sequence analysis
 5. Use of and analysis of data from other common techniques used in the field of cellular and molecular biology
 - a. Use of antibody assay technologies (Western blot or ELISA) to detect and analyze the presence of molecules

in samples

b. Control and analysis of population growth using cell culture techniques

Methods Of Instruction:

1. Lecture
2. Lab
3. Collaborative Learning/Peer Review
4. Computer Assisted Instruction
5. Demonstration/Modeling
6. Discussion

Other Method:

Field trips Supervised practice with instrumentation used in assays of biological macromolecules and cell biology

Instructional Materials

Note: To be UC/CSU transferable, the text must be dated within the last 7 years OR a statement of justification for a text beyond the last 7 years must be included

Textbooks

Title: Life: The Science of Biology

Author: David E. Sadava, H. Craig Heller, David M. Hillis, May Berenbaum

Publisher: Sinauer/Freeman Publishing

Edition: 10th ed

Date: 2012

Manuals

Title: Laboratory Manual for BIOSC 147: Cell and Molecular Biology

Author: Krolkowski, K. and Tarp, C

Date: 12/15/2014 12:00:00 AM

Publisher: Contra Costa College Bookstore

Outside of Class Weekly Assignments

Title 5, section 55002.5 establishes that a range of 48 -54hours of lecture, study, or lab work is required for one unit of credit. For each hour of lecture, students should be required to spend an additional two hours of study outside of class to earn one unit of credit.

- State Mandates that sample assignments must be included on the Course Outline of Record

Outside of Class Weekly Assignments

Hours Per Week

Weekly Reading (*Include detailed assignment below, if applicable*)

2.00

Tu Mendel explains inheritance Ch. 12 Th More genetics Ch. 13

Weekly Writing (*Include detailed assignment below, if applicable*)

2.00

GENETICS PROBLEMS These genetics problems are maximally worth 30 points and are due on Tuesday 10/22/2013. No credit given unless all relevant and supporting work is included. Of course, I expect the work you hand in to be your own. Please ask if you are

confused... 1. Two tall pea plants were cross-bred. Their offspring consisted of 73 tall and 27 dwarf plants. Which of the two phenotypes is dominant? Which recessive? What are the genotypes of parent and offspring? Can you tell all of the offspring's genotypes by examining their phenotypes? 2(2). The pea grower in question # 1 only wants to grow tall pea plants, but occasionally small peas appear. What must have occurred to produce these small plants? Using only those peas on hand, devise and explain a low-tech procedure that allows our grower to only produce tall peas. Provide the page number in the current edition of our text that explains this procedure. 3(4). In guinea pigs, black coat color (B) is dominant to white (b), and rough coat (R) is dominant to smooth (r). What are the expected genotypic and phenotypic results of the following crosses: a) BBrr x bbRR b) BbRr x bbrr c) BbRr x BbRr d) BBrr x BbRr 4(4). A dihybrid cross from Mendel's garden: P: Round yellow x Wrinkled green F1: 100% Round yellow x F1 Round yellow F2: 315 Round yellow 108 Round green 101 Wrinkled yellow 32 Wrinkled green From the results of this cross, what two aspects of inheritance are evident? What ratio of phenotypes occurs in the F2? What numbers would Mendel have obtained if the reality corresponded exactly to the theoretical? Also, explain whether or not these 2 genes are located on the same chromosome 5(3). Black Rough guinea pigs were mated to each other. Several litters were produced, and one of the F1 females was bred repeatedly to a F1 male. Their F2 offspring belonged to 4 phenotypic classes and occurred in a ratio of 1:1:1:1. Please provide phenotypes and genotypes for the original parents, F1 parents, and F2 offspring. More than one answer is possible, but you need provide only one answer. 6(4). A species of Scallop (a marine bivalved Mollusc) displays 3 color varieties, all determined by a single gene: yellow, orange, and black. Breeding experiments revealed the following: Yellow X Yellow: offspring were $\frac{1}{4}$ black and $\frac{3}{4}$ Yellow Black X Black: 100% of the offspring were Black Orange X Orange: offspring were $\frac{1}{4}$ Black and $\frac{3}{4}$ Orange. Using symbols you specify, explain these results completely. And, what other trait you've learned about recently seems to have a similar explanation? 7(2). Given parents with the following genotypes: AabbCcDdEe and AaBbccDdEe, calculate the probability of having offspring with the following genotypes: a) AABbccDdEE b) aaBbCcDDEe c) AaBbCcDdee For this problem, what assumption is crucial in allowing you to calculate these probabilities? 8(2). In fruit flies, red eyes is the normal, "wild" phenotype. White eyes are determined by a sex-linked recessive gene. Please explain, using symbols and Punnett Squares: a) How it is possible for females to have white eyes, and whether or not the parent of a white-eyed female must have white eyes herself. b) Can two red-eyed flies produce white-eyed female flies? How? c) Can a white-eyed female and a red-eyed male produce male offspring with white eyes? How? d) Can two white-eyed parents produce red-eyed offspring? How? 9. The cross-over percentage between linked genes A and B is 44%, between B and C 8%, between C and D 11%, between A and C 36%, and between B and D 19%. What is the linear sequence of genes on this chromosome and how many map units separate genes A and D? 10(3). Blood group (A, B, AB, O) is an example of multiple alleles, while the Rh antigen (Rh+ or Rh-) is an example of two alleles and complete dominance (Rh+ is dominant). For each of the following, the phenotypes of the parents and offspring are given. Indicate the genotypes of both parents: a) P: AB Rh+ X O Rh+ F1: $\frac{3}{8}$ A Rh+, $\frac{3}{8}$ B Rh+, $\frac{1}{8}$ A Rh-, $\frac{1}{8}$ B Rh- b) P: B Rh+ X A Rh- F1: $\frac{1}{4}$ AB Rh+, $\frac{1}{4}$ A Rh+, $\frac{1}{4}$ B Rh+, $\frac{1}{4}$ O Rh+ c) P: B Rh+ X A Rh+ F1: $\frac{3}{16}$ AB Rh+, $\frac{3}{16}$ A Rh+, $\frac{3}{16}$ B Rh+, $\frac{3}{16}$ O Rh+, $\frac{1}{16}$ AB Rh-, $\frac{1}{16}$ A Rh-, $\frac{1}{16}$ B Rh-, $\frac{1}{16}$ O Rh- 11(4). In rabbits, a dominant gene produces solid body color, and its recessive allele produces spotted body color. Another dominant gene produces long hair, while its recessive allele produces short hair. Rabbits heterozygous for both characteristics were mated with rabbits homozygous recessive for both characteristics. The results of these crosses were as follows: solid, long 139 solid, short 23 spotted, long 18 spotted, short 126 Using standard symbols, answer these questions: a) What evidence for linkage is shown here? Please demonstrate how other possibilities were eliminated. b) What are the recombinant phenotypes? c) Using symbols for chromosomes, show what must happen to get the recombinant phenotypes. d) Calculate the map distance between the two genes.

Other Performance (Include detailed assignment below, if applicable)

2.00

Lecture, Team-based projects and discussions, Homework problems, Reports and presentations, Laboratory experiments, Laboratory reports, Laboratory practical exams DNA Electrophoresis As your lab manual has partially detailed, in this lab we will attempt

to estimate the sizes and identities of unknown DNA fragments by comparing them with fragments of known sizes. We will have 2 known DNA marker "ladders": λ /HindIII and ϕ X174/HaeIII, both viral DNAs digested with restriction endonucleases; both have reliably known DNA fragment sizes. There will be 4 unknowns (A, B, C, and D), also consisting of viral DNA digested with restriction endonucleases. We will run 2 different gels; both will have the known DNA ladders scattered across the gel. The 4 unknowns will be distributed throughout each gel. The λ /HindIII digest produces fairly large DNA fragments plus some smaller fragments, while the ϕ X174/HaeIII digest produces an assortment of smaller DNA fragments (see the attached fragment sizes). After the gel has run and data have been distributed, you will draw 2 standard curves (with migration distance in cm on the X-axis and fragment size on the Y-axis) on 3-cycle semi-log graph paper. One standard curve will be for the larger DNA fragments (almost all λ /HindIII) run for a long time on both gels to separate these heavy fragments. The other curve will be for the smaller DNA fragments (ϕ X174/HaeIII and some of the smaller λ /HindIII fragments) run for less time on both gels, as lighter fragments migrate more quickly on a gel. The migration distances for the fragments belonging to unknowns A, B, C, and D will be plotted against the appropriate standard curves and their sizes will be estimated. Please average the migration distances for the known standards and the unknown fragments. The next step is to identify the unknowns. Go to the web-site of Promega (www.promega.com), a large supply house for biotech and molecular biology reagents, and search for "molecular weight markers." and follow this to "conventional DNA markers." Under each product, check "figures and tables." You will also need to visit the web-site of New England BioLabs (www.neb.com), another large supply house, and follow their pop-up menus to "products" then to "DNA markers/ladders." Once here, move on to "conventional markers." Both web-sites provide data on fragment sizes of various commercially available viral DNA/endonuclease digests, which you will match to your unknown's fragment sizes in an effort to determine the true identity of unknowns A, B, C, and D. Your lab-write-up will include the hypothesis we are testing, a complete procedure, 2 standard curves (large and small fragments from both gels, so 2 curves with both gels on each), migration distances of the unknown DNA fragments and your estimates of their sizes, and your guesses as to the true identities of the unknowns. Also, please provide an explanation for any odd results. Finally, please include print-outs of the home-pages of Promega and New England BioLabs, showing the date and time you accessed their Web-sites. As always, I expect you to do your own work; please feel free to ask me questions and seek clarification. This lab is due 3 weeks from today.

Student Evaluation

Essay

Computation or non-computational problem solving skills

Objective examinations

Laboratory assignments: weekly quizzes, written work in the form of laboratory reports (drawings, answers to questions, analysis of experimental results) for all labs.

Grading Policy

Letter Grade

90% - 100% = A

80% - 89% = B

70% - 79% = C

60% - 69% = D

Below 59% = F

Prepared by Katherine Krolkowski

