NOVA COLLEGE-WIDE COURSE CONTENT SUMMARY
BIO 206 – CELL BIOLOGY (4 CR.)

Course Description

Introduces the ultrastructure and functions of cells. Emphasizes cell metabolism, cell division, and control of gene expression.
Lecture 3 hours. Recitation and Laboratory 3 hours. Total 6 hours per week.

General Course Purpose

Knowing the components of cells and how cells function is fundamental to all biological sciences. This course is for students whose college and career paths require in depth knowledge of the composition and function of cells. Emphasis is placed on the biochemistry of the cell, structure and function of cell components, photosynthesis, cellular respiration, gene expression, signal transduction, communication between cells and the environment, and cell growth and differentiation.

Course Prerequisites/Corequisites

Prerequisites: BIO 101 and CHM 111.

Course Objectives

- Scientific Literacy
    - Evaluate different perspectives, opinions, and statements about biological issues in terms of their logic, content, scientific merit, and biases.
- Quantitative Reasoning
    - Perform accurate calculations, interpret scientific data and graphs, and use results to support conclusions.
    - Analyze data collected through experiments in lab. Present and discuss the findings and conclusions derived from data, with chart/spreadsheet and graphs.
- Critical Thinking
    - Discriminate among degrees of credibility, accuracy, and reliability of inferences drawn from given data, determine whether certain conclusions or consequences are supported by the information provided and use problem solving skills.
- General Biological Laboratory Skills
    - Use the metric system to convert between measurements
    - Properly weigh materials and liquids
    - Accurately measure liquids with volumetric flasks, graduated cylinders etc.
    - Properly pipette using serological and micropipettes
    - Calculate and perform dilutions
    - Properly care for and use a microscope effectively
    - Use a spectrophotometer to obtain spectra and to measure concentration
    - Measure pH
    - Use a spreadsheet to collect, analyze, and graph data.
    - Apply concepts and principles of molecular and cellular biology to hands-on, model problems in a laboratory environment, including the faithful reproduction of laboratory protocols and consistent attention to detail through experimental observation.
    - Apply concepts of the scientific method as part of the laboratory as well as in class discussions of experiments.
    - Critically analyze experimental data, including results of statistical tests and quantitative analysis.
    - Effectively communicate scientific principles, including experimental data, observations, conclusions, and scientific importance.
- Biochemistry: review of chemical bonds, organic molecules. Suggested laboratory topics: SDS

PAGE, protein chromatography.
    - Describe the chemical composition of cells
    - Compare and contrast major biomolecules in the living organism in terms of structure and function
    - Explain the levels of protein structure and the role of different covalent and non-covalent molecular interactions in maintaining the shape of the protein.
    - Explain the role of covalent modifications in control of protein activity.
    - Compare different methods for studying proteins.
- Cell Structure: unity and diversity of cells, prokaryotic and eukaryotic cell structure, model organisms, cytoskeleton. Suggested laboratory topics: microscopy and staining, cell fractionation.
    - Describe and explain the function of organelles commonly found in eukaryotic cells.
    - Explain the concept of unity and diversity of cell structure and function.
    - Compare the characteristics and functions of microfilaments, microtubules, and intermediate filaments.
    - Explain how motor proteins harness energy to move along cytoskeletal tracks.
- Enzymes, Bioenergetics & Biosynthesis: use of energy by cell, free energy protein structure and function, protein regulation, energy generation in chloroplasts and mitochondria. Suggested laboratory topics: enzyme activity and kinetics, photosynthesis and cellular respiration.
    - Describe and explain the major metabolic pathways of glycolysis, fermentation, respiration, and photosynthesis.
    - Describe the structure and function of enzymes and explain the general mechanism of catalysis.
    - Compare the different mechanisms of enzyme regulation.
    - Describe the structure and explain the general mechanism of action of and regulation of proteins, generally and enzymes specifically.
    - Describe how the principles of Thermodynamics explain the limits of cell function.
    - Construct an explanation for the interrelatedness of photosynthesis and respiration in an evolutionary context.
- Membranes and Transport: membrane structure, transmembrane transport structures, intracellular compartments and protein transport, ion channels. Suggested laboratory topics: cell permeability and active transport.
    - Explain how cells transport molecules across their membranes.
    - Compare the general mechanisms that allow some newly synthesized proteins to be released into the cytoplasm, whereas others are directed into other cellular compartments.
    - Compare the molecular recognition events and mechanisms required for movement of proteins through different uptake and secretion pathways.
- Regulatory Mechanisms: cell signaling, G-protein-coupled receptors, enzyme-coupled receptors, apoptosis.
    - Explain how cells communicate to one another and maintain multicellularity.
    - Explain the principles and molecular basis of cell communication and intracellular signal transduction such as G protein coupled receptors, tyrosine kinases, and Ras.
    - Compare and contrast the molecular mechanisms of membrane receptor-mediated and nuclear receptor-mediated signal transduction.
    - Describe different mechanisms by which membrane-bound receptors can affect cell physiology or behavior.
    - Describe both metabolic and genetic regulatory mechanisms in cells.
- Growth and Division: DNA replication and repair, cell cycle and control mechanisms, cancer development. Suggested laboratory topics: aseptic technique, bacterial growth curves, cell and tissue culture.
    - Mechanically describe mechanisms of cell division including mitosis, cytokinesis, and DNA replication, and describe characteristic changes in cellular activity throughout the cell cycle.
    - Describe the regulatory mechanisms that control the cell cycle.
    - Compare and contrast organization of the mitotic spindle in animal, fungal, and plant cells and discuss the evolutionary and functional relevance.
    - Describe the development of cancer including the classes of genes mutated in cancer cells.
- Differentiation: Central Dogma, how genes function, control of gene expression. Suggested laboratory topics: PCR, gel electrophoresis, DNA/RNA extraction genome sequencing, Western blot, protein analysis.
    - Describe the Central Dogma including the conversion of information encoded by the genome

(genotype) into functional gene products (essentially founding the phenotype)
    - Explain the principles and molecular basis of the control of gene expression, its post translational processing and the secretory pathway and vesicular transport of proteins
    - Compare and contrast how the presence of a nucleus in eukaryotes and its absence in prokaryotes alters the dynamics of gene expression.
    - Describe the role of differential gene regulation in causing cell differentiation.
- Specialized Cell Functions: excitation, motility and contraction, secretion, and immunity
    - Describe the molecular and cellular players in the immune system and how they protect us.
    - Compare and contrast the structure and function of different cell types.

Major Topics to be Included

- General Biological Laboratory Skills
- Biochemistry: review of chemical bonds, organic molecules. Suggested laboratory topics: SDS PAGE, protein chromatography.
- Cell Structure: unity and diversity of cells, prokaryotic and eukaryotic cell structure, model organisms, cytoskeleton. Suggested laboratory topics: microscopy and staining, cell fractionation.
- Enzymes, Bioenergetics & Biosynthesis: use of energy by cell, free energy protein structure and function, protein regulation, energy generation in chloroplasts and mitochondria. Suggested laboratory topics: enzyme activity and kinetics, photosynthesis and cellular respiration.
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