UNIVERSITY COLLEGE OF THE FRASER VALLEY

COURSE INFORMATION

DISCIPLINE/DEPARTMENT: BIOLOGY **DATE**: June 1994

Revised: Feb. 1995

Biology 201	Cell Biology I	4
SUBJECT/NUMBER OF COURSE	**DESCRIPTIVE TITLE**	**UCFV CREDITS**

CALENDAR DESCRIPTION: A study of the structure, function, and the biochemistry of cellular components. Topics include biochemistry of carbohydrates, lipids, proteins and nucleic acids; enzymes; membranes; mitochondria, and energetics.

RATIONALE: This course, together with Cell Biology II, provides an introduction to bilchemistry and cell biology which integrates cell and molecular form with function.

COURSE PREREQUISITES: BIO 112, or (BIO 101 and 102) with a "B" or higher

PRE- OR CO-REQUISITES: Chemistry 211

HOURS PER TERM FOR EACH STUDENT	**Lecture**	**60**	**hrs**	**Student Directed Learning**	**hrs**
	Laboratory	**45**	**hrs**		
	Seminar		**hrs**	**Other - specify:**	
	Field Experience		**hrs**	_____	**hrs**
				TOTAL 105	**HRS**

MAXIMUM ENROLMENT: 24

Is transfer credit requested? ☒ **Yes** ☐ **No**

AUTHORIZATION SIGNATURES:

Course Designer(s): Ernest M. Kroeker, Ph.D.

Chairperson: Henry Speer, Ph.D.

Curriculum Committee

Department Head: Henry Speer, Ph.D.

Dean: J.D. Tunstall, Ph.D.

PAC: Approval in Principle N/A

PAC: Final Approval: Feb 1, 1995
Date

Biology 201
NAME & NUMBER OF COURSE

SYNONOMOUS COURSES:

(a) replaces _____
(course #)

(b) cannot take _____ **for further credit**
(course #)

TEXTBOOKS, REFERENCES, MATERIALS (List reading resources elsewhere)

Moleculor and Cellular Biology by S. L. Wolfe
In-house lab manual

OBJECTIVES:

To equip the student with the background necessary for an understanding of the basic priniples and concepts of the molecular biology of cells and to enable the student to read and comprehend the literature in which progress in this field is reported. (For detailed objectives, see course content.)

METHODS:

Lecture, demonstration, small group practice, discussion, A/V materials, use of models and charts, and lab exercises.

STUDENT EVALUATION PROCEDURE:

Midterm lecture	25%
Final lecture	40%
Lab reports	20%
Lab exam	15%

COURSE CONTENT

List of major topics:
- Introduction
- Chemical reactions and biological molecules
- Biological reactions and enzymes
- Membranes
- Transport across membranes
- Intracellular communication
- Extracellular matrix
- Cellular energy and mitochondria
- Photosynthesis and chloroplasts
- Cytoskeleton

COURSE CONTENT: (cont'd)

I. INTRODUCTION
Includes a brief overview/review of eukaryotic structure and major processes like metabolism, transcription and protein synthesis.

II. BIOLOGICAL MOLECULES

A. A brief review of chemical bonds, functional groups, pH (acids/bases) precedes the discussion of the four major groups of biological molecules.

Students should be able to:
a) Explain the difference between ionic, covalent and hydrogen bonds as well as van der Waals forces and hydrophobic/hydrophilic interactions within molecules.
b) draw/recognize hydroxyl, carbonyl, carboxyl, amino, phosphate, sulfhydryl groups and aldehydes, ketones, alcohols and organic acids.

B. Carbohydrates
Students should be able to:
a) Draw the structure of glucose and ribose and recognize different isomers of glucose
b) Form disaccharides and polysaccarides from simple sugars and understand the condensation reaction

C. Lipids
Phospholipids:
Students should be able to draw the molecular structures of glycerol, fatty acids, ethanolamine, choline, and serine and using a phosphate group show how a phospholipid molecule is constructed.

Spingolipids, steroids and glycolipids:
Students should be able to recognize these as amphipathic molecules and be able to fit them into a lipid bilayer.

D. Proteins
Students should be able to:
a) Recognize each of the 20 biologically important amino acids and describe their properties at pH 7.
b) Draw the general structure of an amino acid and link amino acids via a peptide bond.

E. Protein Structure
Students should be able to:
a) Explain the four levels of protein structure and use the structure of a particular molecule as an example.
b) Differentiate between an alpha-helix and a beta-pleated sheet structurally.
c) Explain tertiary structure in terms of the bonds present and the properties of the R groups considering the environment the protein is found in.
d) Illustrate the quaternary structure is the interaction of subunits.

F. Nucleotides
Students should be able to recognize the structure of ATP, GTP, TTP, and CTP.

COURSE CONTENT: (cont'd)

III. ENZYMES AND BIOLOGICAL REACTIONS

A brief discussion of thermodynamics and the rate and direction of reactions as well as standard free energy change is included prior to a discussion of enzymes.

A. Enzymes

Students should be able to:

a) Explain the mechanism of enzyme action based on the induced-fit model and relate molecular function to a reduction in activation energy of reactions.
b) Determine Km and Vmax for a reaction given appropriate data.
c) Determine whether a molecule acts as a competitive or non-competitive inhibitor or an activator of an enzyme using Lineweaver-Burke analysis.

IV. MEMBRANES

Students should be able to:

a) Explain the properties of the Bluid Mosaic Model based on experimental evidence.
b) Cite experimental evidence to support that the membrane is fluid and asymmetric considering both proteins and lipids.
c) Explain how a molecule can be located using a fluorescently-labelled antibody.
d) Define membrane proteins as being integral or peripheral and define the structure and characteristics of those domains.
e) Explain limitations on fluidity of membranes due to interaction with the cytoskeleton and environmetal effectis.
f) Identify where lipids are synthesized and inserted into membranes.

V. IONIC AND MOLECULAR TRANSPORT

Students should be able to:

a) List factors affecting passive diffusion across a membrane.
b) List features of facilitated diffusion.
c) Distinguish between voltage-gated and ligand-gated membrane channels.
d) Describe active transport in terms of the molecular mechanism employed by both P-type and V-type pumps.
e) Explain how primary active transport systems affect movement of molecules using symports and antiports.

VI. CELL SURFACE MOLECULES AND INTRACELLULAR COMMUNICATION

Students should be able to:

a) Describe the sequence of events during signal transduction involving receptors with integral protein kinase activity and the operation of the cAMP and $InsP_3$/DAG receptor-response pathways.
b) Recognize the following junctions and correlate the structural features with function:
    i) tight junctions
    ii) desmosomes
    iii) gap junctions
    iv) plasmodesmata

COURSE CONTENT: (cont'd)

VII. EXTRACELLULAR MATRIX

Students should be able to:

a) Describe the general structure of collagen, proteoglycans, hyaluronic acid, fibronectin, and laminin.
b) Illustrate how these molecules interact with each other and cell membrane receptors and the cytoskeleton to integrate the function of the extracellular matrix, plasma membrane and cytoskeleton.
c) Describe the general structure of cellulose, hemicellulose, extensins and lignin.
d) Illustrate how these molecules interact with each other to form the cell wall of higher plant cells.

VIII. CELLULAR ENERGY AND MITOCHONDRIA

Students should be able to:

a) Illustrate how sugars are oxidized to produce ATP, pyruvate, and NADH.
b) Illustrate how fatty acids are oxidized to produce acetyl-CoA, NADH, and FADH.
c) Discuss the role of the citric acid cycle in the regulation of metabolism of sugars, amino acids and lipids.
d) Draw a mitochondrion and illustrate the location of the important reactions (ETC, TCA cycle, H+ pumps, and ATP synthesis).
e) Identify the structural features of five types of electron carriers essential in electron transport (FMN, cytochromes, Fe-S centers, Cu centers and ubiquinone).
f) Explain the relationship between oxidation and reduction reactions and Mitchell's Chemiosmotic Theory.
g) Cite experimental evidence supporting the thesis that H+ gradient drives ATP synthesis.
h) Compare and contrast FoF1 ATPases in mitochondria and bacteria with proton pumps in membranes.
i) Discuss the transport of molecules and ions into and out of the mitochondrion.
j) Give three pieces of evidence that support the endosymbiotic origin of mitochondria.

IX. PHOTOSYNTHESIS AND CHLOROPLASTS

Students should be able to:

a) Draw a chloroplast of higher plants and illustrate the location of the important reactions.
b) Define the structure and function of LHCs.
c) Describe how chloroplasts harvest light energy and use it for biosynthesis of carbon compounds.
d) Compare and contrast cyclic versus non-cyclic photophosphorylation.
e) Compare and contrast carbon fixation in C3 and C4 plants.
f) Compare and contrast mitochondria and chloroplasts.
g) Describe the function of the glyoxylate cycle and the glycolate pathway in cells of higher plant.
h) Discuss the transport of molecules and ions into and out of the chloroplast.

X. CYTOSKELETON

Students should be able to:

a) Describe microtubules, microfilaments, and intermediate filamenmts in terms of; molecular structure, associated molecules, cellular distribution, and name at least three functions of each.
b) Explain the difference between stable and dynamic filamentous structures, e.g., cilium vs. spindle.
c) Define a centriole.
d) Draw the structure of a cilium/flagellum and label the parts.
e) Draw the structure of a skeletal muscle cell and label the parts.
f) Explain the mechanism of motility for microtubule-based and microfilament-based systems.
g) Describe the interaction between the cytoskeleton, plasma membrane and extracellular matrix.

LABORATORY EXPERIMENTS:

Lab 1: Photometry

In this lab, the operation of a spectrophotometer and principles of photometry are addressed. Students perform a Biuret protein assay and perform a brief exercise to demonstrate that Beer's Law applies to a solution of copper sulphate.

Lab 2 and 3: Proteins

In the first week, the lab exercise involves separation of bovine plasma proteins by salting out with ammonium sulphate. A Lowry protein assay is then performed to estimate protein concentrations in whole plasma and the 25, 50, 75 and 100% AS cuts.
In the second week, SDS-PAGE is performed using whole plasma and the different fractions as samples to demonstrate the principles of PAGE and to show that salting out separates the proteins into distinct groups.

Lab 4: Enzymes

In this lab, students use an acid phosphatase and measure the rate of appearance of a coloured product. The effects of substrate conc., pH, and the presence of competitive and non-competitive inhibitors on rate of reaction are examined. Students present data graphically and predict Km and Vmax using both substrate conc. vs. rx'n rate and double reciprocal plots.

Lab 5 and 6: Carbohydrates

Students study the chemistry of sugars and learn to perform the Molisch, Iodine, Barfoed's, Bial's orcinol, Benedict's, Seliwanoff and yeast fermentation tests to identify unknown sugars.
In the second week, students perform TLC using standards and their unknowns as samples.

Lab 7 and 8: Lipids

In this lab, students perform an acetone extract to separate phospholipids from egg yolk. They then isolate phosphotidyl choline using column chromatography. In the second week, students porepare fatty acid methyl esters using the phosphotidyl choline from week one and analyze the fatty acids using gas chromatography. Lipid TLC using phosphotidyl choline standards and fractions from the column chromatography in week one is also performed in week 2.

Lab 9: Mitochondria

In this lab, students use an oxygen electrode to study oxygen uptake in a Keilin-Harttree heart mitochondrial particle preparation. Various inhibitors are used to demonstrate electron transport associated with oxidation of Krebs cycle intermediates.

Lab 10: Chloroplasts

In this lab, students isolate chloroplasts from spinach leaves and measure the rate at which an artificial electron acceptor is reduced when different coloured light is used as an energy source.

SUPPORTING LAB EQUIPMENT AVAILABLE:

In-house manual presently in use as is all necessary equipment

LIBRARY RESOURCES:

Books: *Biochemistry*, Metzler
Biochemistry, Lehninger
Molecular Biology of the Gene, Watson et al
Physical Chemistry, Brey
Genes IV, Lewin

Journals: Science
Nature
Cell