CHEM 30B: SURVEY OF ORGANIC & BIOCHEMISTRY

Foothill College Course Outline of Record

Heading	Value
Units:	5
Hours:	4 lecture, 3 laboratory per week (84 total per quarter)
Prerequisite:	CHEM 30A.
Advisory:	UC will grant transfer credit for a maximum of one course from the following: CHEM 25, 30A or 30B.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students will be able to describe the general structure of carbohydrates, fatty acids, amino acids and proteins, nucleotides and nucleic acids. Students will know the roles of these bio-molecules in the body.
- Students will understand the chemistry of common metabolic processes.
- Students will be able to describe DNA replication, transcription and translation.
- Students will be able to name simple organic compounds and recognize and name functional groups in an organic compound. By recognizing a functional group, students will be able to determine general reactivity and write reactions to show that reactivity.

Description

Basic principles of organic chemistry and biological chemistry. Topics include organic chemistry nomenclature, functional groups, and an introduction to structure and properties of carbohydrates, lipids, nucleic acids, proteins and enzymes. An overview of metabolism will also be given. Primarily intended for students entering the allied health field, including: nursing, dental hygiene, and biotechnology.

Course Objectives

The student will be able to:
A. Name basic organic compounds
B. Identify functional groups by name and determine physical and chemical properties that result from that functional group
C. Identify chiral versus achiral compounds
D. Identify structural isomers and stereoisomers
E. Recognize common monosaccharides, disaccharides, and polysaccharides, and understand the basic reactions that carbohydrates undergo in biological processes
F. Understand the difference between saturated and unsaturated fats, and understand the basic reactions that lipids undergo in biological processes
G. Describe the structure and permeation of the lipid bilayer that makes up a cell membrane
H. Describe the difference between low density and high density lipoproteins (LDL and HDL)
I. Draw the basic structure of an amino acid and understand the formation of a peptide bond
J. Describe the various roles that proteins play in biological processes
K. Describe the primary, secondary, tertiary and quaternary structure of proteins and explain what causes proteins to denature
L. Know the vitamins that are water-soluble and fat-soluble
M. Explain enzymes, substrates and the induced-fit theory
N. Describe the structure of DNA, and show how base pairing occurs
O. Predict the complementary structure of a DNA strand in replication
P. Explain RNA synthesis (transcription) and state the function of mRNA, rRNA and tRNA in protein synthesis (translation)
Q. Understand how mutations can cause genetic diseases, such as sickle cell anemia
R. Explain photosynthesis in plants and metabolism in animals
S. Describe the ultimate fate of carbohydrates, lipids, and proteins in catabolism
T. Explain the significance of ATP and know how ATP is synthesized in glycolysis, the Krebs cycle and cellular respiration

Course Content

A. Name basic organic compounds (Lec, Lab)
1. Alkanes, alkenes and alkynes
2. Name straight chained and branched hydrocarbons
3. Name simple alcohols, alkyl halides, ethers, amines, aldehydes, ketones, carboxylic acids, esters, and amides
4. Identify D and L isomers from Fischer Projections
B. Identify functional groups by name and determine physical and chemical properties that result from that functional group (Lec)
1. Recognize and name functional groups: alcohols, alkyl halides, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides and benzene
C. Identify chiral versus achiral compounds (Lec, Lab)
1. Recognize a chiral compound
2. Understand the difference between enantiomers, diastereomers and meso compounds
3. Understand optical activity, and measure this property in lab
D. Identify structural isomers and stereoisomers (Lec, Lab)
1. Branched hydrocarbons and structural isomers
2. Cis-trans isomers (alkenes only)
3. Enantiomers
4. Diastereomers
5. Meso compounds
E. Recognize common monosaccharides, disaccharides, and polysaccharides (Lec, Lab)
1. Common monosaccharides, disaccharides and polysaccharides
2. Fischer projections and Haworth representations
F. Understand the difference between saturated and unsaturated fats, and understand the basic reactions that lipids undergo in biological processes (Lec)
1. Structures of fatty acids and triglycerides
2. Fats versus oils
3. Energy from stored fat
G. Describe the structure and permeation of the lipid bilayer that makes up a cell membrane (Lec)
1. Lipid bilayer, protein channels, cholesterol
2. Diffusion, passive and active transport
H. Describe the difference between low density and high density lipoproteins (LDL and HDL) (Lec)

1. Explain what is meant by good and bad cholesterol
I. Draw the basic structure of an amino acid and understand the formation of a peptide bond (Lec, Lab)
1. Amino acids, side groups and chirality
2. Functional groups in amino acids
3. Peptide bond formation
J. Describe the various roles that proteins play in biological processes (Lec)
K. Describe the primary, secondary, tertiary and quaternary structure of proteins (Lec)
1. Covalent bonds, ionic bonds and intermolecular forces of attractions in protein structure
2. Alpha helix and beta sheet
L. Know the vitamins that are water-soluble and fat-soluble (Lec)
M. Explain enzymes, substrates and the induced-fit theory (Lec)
1. Terminology: enzyme, substrate, product and active site
2. Enzyme activity
3. Cofactors and coenzymes; NAD+ and FAD
N. Describe the structure of DNA, and show how base pairing occurs (Lec, Lab)
1. Nucleosides, nucleotides and nucleic acids
2. Complementary base pairing and the double helix
O. Predict the complementary structure of a DNA strand in replication (Lec, Lab)
P. Explain RNA synthesis (transcription) and state the function of mRNA, rRNA and tRNA in protein synthesis (translation) (Lec, Lab)
1. mRNA, tRNA and rRNA roles
2. Verbalize the process of transcription
3. Verbalize the process of translation
Q. Understand how mutations can cause genetic diseases, such as sickle cell anemia (Lec)
R. Explain photosynthesis in plants and metabolism in animals (Lec)
1. Energy in biochemical reactions
2. Catabolic and anabolic processes
S. Describe the ultimate fate of carbohydrates, lipids, and proteins in catabolism (Lec)
1. Digestion: proteins, carbs and lipids
2. Common pathways: Krebs (citric acid) cycle, electron transport chain and oxidative phosphorylation
3. Carbohydrates: glycolysis and pruvate oxidation
4. Fatty acid oxidation: beta oxidation pathway (fatty acid spiral)
5. Amino acid catabolism: amino acid pool, transamination, oxidative deamination, and the urea cycle
6. Ketogenic versus glucogenic amino acids
7. Essential versus nonessential amino acids, complete proteins and complementary proteins
T. ATP
1. Explain the significance of ATP
2. Know how ATP is synthesized in glycolysis
3. The Krebs cycle
4. Cellular respiration (Lec)

Lab Content

A. Organic Nomenclature and Functional Groups
1. Review naming of hydrocarbons
2. Review the names for different functional groups
3. Practice naming organic molecules with up to one functional group
4. Practice drawing organic molecules in expanded, condensed and line formulas
5. Experience working collaboratively in a group setting
B. Stereoisomers and Optical Activity
1. Use of modeling kit to master the concept of stereoisomers (geometric isomers, enantiomers, and diastereomers)
2. Practice drawing molecules with one or more chiral carbon in Fischer Projection form
3. Use of a new piece of equipment, polarimeter, to measure optical activity of sucrose and fructose
4. Calculation of optical activity from measured rotation
5. Experience working collaboratively in a group
6. Ability to keep accurate experimental records and record data correctly
C. Reducing Sugars and Hydrolysis of a Disaccharide
1. Use of Benedict's reagent to test several carbohydrate solutions for reduction and to prove hydrolysis of sucrose
2. Experience working collaboratively with another student
3. Experience working with common laboratory equipment
4. Analysis of test results to determine experimental success or failure
D. Synthesis of Aspirin
1. Introduction to esterification reactions in the synthesis of aspirin
2. Introduction to a new laboratory technique, vacuum filtration, to separate solid product after reaction
3. Calculation of theoretical yield for synthesis of aspirin
4. Experience working collaboratively with another chemistry student in the lab
E. Percent Yield and Analysis of Aspirin
1. Development of a new laboratory technique, melting point analysis, and use of a new piece of equipment, the mel-temp apparatus
2. Experience in chemical and physical analysis to support the identity of a product
3. Use of common laboratory equipment
4. Experience keeping accurate experimental records
5. Use of reference manual to determine theoretical melting point for aspirin and salicylic acid
6. Calculation of percent error in experiment
7. Analysis of sources of error in an experiment
8. Experience working collaboratively with another chemistry student in the lab
F. Hydrolysis and TLC of Aspartame
1. Experience of a new lab technique, thin layer chromatography (TLC)
2. Further experience with hydrolysis reactions
3. Use of common laboratory equipment and techniques
4. Experience keeping accurate experimental records
5. Experience working collaboratively with other students in the lab
6. Experience analyzing data and sources of error
G. Transcribing and Translating the Genetic Code
1. Practice of transcribing DNA into mRNA
2. Practice of translating mRNA into protein using the genetic code
3. Practice naming and drawing nucleosides and nucleotides
H. Micropipette Practice
1. Practice using micropipettes to transfer small volumes of reagent
I. DNA Fingerprinting
1. Use of a new technique, electrophoresis, in the analysis of five DNA samples
2. Reinforcement of knowledge of DNA structure
3. Understanding of restriction enzymes and DNA ladder, and why these are used in the experiment
4. Ability to keep accurate experimental records and record data correctly
5. Experience working collaboratively with another chemistry student
6. Use of micropipettes to dispense microliter size samples
J. Analysis of DNA Fingerprinting Results
1. Graphing DNA marker results using semi-log graph paper, and use of this graph to extrapolate information about the size of five DNA samples
2. Experience working collaboratively with a group

3. Experience with data analysis

Special Facilities and/or Equipment

A. Safety goggles.
B. Calculator.
C. Mastering Chemistry access code.
D. When taught via Foothill Global Access, on-going access to computer with email software and hardware; email address. Student will be required to access both CANVAS and Mastering Chemistry.

Method(s) of Evaluation

A. Two midterm exams
B. Lab
C. Cumulative final exam
D. Online homework and book homework
E. Laboratory evaluation

Method(s) of Instruction

A. Lecture sessions
B. Problem solving sessions
C. Laboratory sessions
D. Online learning/homework

Representative Text(s) and Other Materials

McMurry, J., M. Castellation, and D. Ballantine. Fundamentals of General, Organic, and Biological Chemistry. 8th ed. Pearson Prentice Hall, 2016.
Norick, A. Chemistry 30B Lab Manual for Foothill College. Foothill College Bookstore, 2012.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Name basic organic compounds, and identify functional groups by name.
1. Draw the line structure for 4-isopropylnonane
2. Draw the expanded structure for ethanal
3. Draw the expanded structure for propanoic acid
4. Draw the line structure for ethyl ethanoate
B. Identify chiral versus achiral compounds.
1. Which of the following is optically active
a. A racemic mixture of 2-pentanol
b. A meso compound
c. D-glucose
d. 2-propanol
C. Identify structural isomers and stereoisomers.
1. Which of the following is an isomer of 3-methylhexane?
a. 3-methylpentane
b. 3-methyl-3-hexene
c. Heptane
d. Methylcyclohexane
e. None of the above
2. Which of the following can not exist as a cis and a trans isomer?
a. 2,3-dimethyl-2-butene
b. 2-butene
c. 3-methyl-2-pentene
d. 2-bromo-2-butene
e. All of the above can exist as a cis and a trans isomer
D. Define carbohydrates and recognize common monosaccharides, disaccharides, and polysaccharides; understand the basic reactions that carbohydrates undergo in biological processes.
1. The linkage between two monosaccharides to form a disaccharide is a(n):
a. Peptide linkage
b. Ester linkage
c. Hemiacetal
d. Hemiketal
e. Glycosidic linkage
2. Hydrolysis of sucrose will yield what two monosaccharides?
E. Define lipids and understand the difference between saturated and unsaturated fats; understand the basic reactions that lipids undergo in biological processes.
1. Triglycerides always contain the functional group known as _____.
2. Explain the structural difference between a saturated and unsaturated fatty acid.
F. Describe how soap can be produced from fatty acids.
1. Draw a triglyceride with two fatty acid chains of palmitic acid and one fatty acid chain of caproic acid.
2. Write a saponification reaction for the triglyceride drawn above in #1. Show the base (NaOH) above the arrow like your textbook does.
G. Describe the structure and permeation of the lipid bilayer that makes up a cell membrane.
1. Draw a picture to represent the lipid bilayer. Be sure to label hydrophobic and hydrophilic portions of the bilayer.
2. What molecule adds rigidity to the fluid lipid bilayer?
H. Describe the difference between low density and high density lipoproteins (LDL and HDL).
1. Explain how LDL and HDL affect the level of cholesterol in the blood stream, and leads to the terms "good" and "bad" cholesterol.
I. Draw the basic structure of an amino acid, know the differences in the side chains, and understand the formation of a peptide bond.
J. Describe the various roles that proteins play in biological processes.
K. Describe the primary, secondary, tertiary and quaternary structure of proteins.
1. Molecules of the enzyme glutamine synthetase have twelve globular polypeptide chains arranged in two hexagonal rings stacked one on top of the other. This best describes what ____protein structure.
a. Primary
b. Secondary
c. Tertiary
d. Quaternary
e. All of the above
L. Explain what causes a protein to denature.
M. Know the vitamins that are water-soluble and fat-soluble.
1. Vitamin A deficiency is known to cause blindness at a very early age. This deficiency is rampant in developing countries. Operation 20/20 began in 2007. The goal of this operation is to provide two high doses of vitamin A per year to children in 18 developing countries. What is it about the structure of this vitamin that makes these two infrequent doses effective in the body for an entire year? Use complete sentences when answering.
N. Explain enzymes, substrates and the induced-fit theory.
1. Alcohol dehydrogenase catalyzes the conversion of ethanol to ethanal in the body. This reaction requires zinc ion. In this reaction, what is the enzyme? What is the cofactor? What is the substrate?
2. True or False: The enzyme active site is a rigid structure that does not change at any point during catalysis.
O. Explain why enzymes are common drug targets, and understand the basic way in which these drugs function.

1. List three drugs that we discussed this quarter that work as enzyme inhibitors.
2. Antihistamines are used to treat allergic reactions. Antihistamines competitively block the attachment of histamine to its receptor, thus blocking the normal biological response (allergic reaction). Antihistamines are best described as:
a. Agonists
b. Antagonists
c. Irreversible enzyme inhibitors
d. Competitive enzyme inhibitors
e. Noncompetitive enzyme inhibitors
P. Describe the structure of DNA, and show how base pairing occurs.
Q. Predict the complementary structure of a DNA strand in replication.
1. If the base sequence along a strand of DNA is 5′ AAG CTG 3′, then what is the sequence along the DNA strand that runs complementary to this strand in the double helix?
R. Explain RNA synthesis (transcription) and state the function of mRNA, rRNA and tRNA in protein synthesis (translation).
1. If the base sequence on the DNA informational strand is 3′ AAA TCC GCT 5′, what is the correct base sequence of the mRNA synthesized from this DNA strand?
a. 3′ AAA TCC GCT 5′
b. 3′ AAA UCC GCU 5′
c. 5′ TTT AGG CGA 3′
d. 5′ UUU AGG CGA 3′
e. 5′ AAA UCC GCU 3′
S. Understand how mutations can cause genetic diseases such as sickle cell anemia.
1. We discussed in class how the genetic disease sickle cell anemia (SCA) occurs when the 6th amino acid of two of the protein chains in hemoglobin is changed from glutamic acid to valine. Since hemoglobin is a protein (not a gene), what is it that makes SCA a genetic disease?
T. Explain photosynthesis in plants and metabolism in animals.
U. Describe the ultimate fate of carbohydrates, lipids, and proteins in metabolism.
1. What common intermediate is made from all types of food molecules in catabolism? HINT: It enters the Krebs cycle!
2. Give an overview of what happens in one full turn of the Krebs cycle.
3. Give an overview of what happens in the 10 steps of glycolysis.
V. Explain the significance of ATP and know how ATP is synthesized in glycolysis, the Krebs cycle and cellular respiration.
1. How many ATP molecules can be made from reoxidation of 2 molecules of NADH in the electron transport chain and oxidative phosphorylation?
2. Calculate the theoretical yield of ATP from complete catabolism of 1 mol of glucose.
3. Calculate the theoretical yield of ATP from complete catabolism of 2 mol of caproic acid.
W. Discuss how blood sugar levels are controlled and explain diabetes.
1. Explain the difference between type 1 and type 2 diabetes.
2. What is the name of the hormone that acts to raise glucose levels in the bloodstream?
3. What is the name of the hormone that acts to decrease glucose levels in the bloodstream?

Discipline(s)

Chemistry