



COURSE OUTLINE

Course Number
CHE107

Course Title
General & Physiological Chemistry

Credits
4

Class Hours: 3/2
Lecture/Lab/Other

Prerequisites: MAT 037 or MAT 042
Minimum C grade
High school chemistry or CHE100

Implementation
Fall 2022

Catalog description:

The student is introduced to basic chemical and physical principles and their application to life processes. Laboratory exercises are selected to illustrate these principles and the behavior of physiologically significant materials.

General Education Category:
Goal 3: Science

Course coordinator:
Helen Tanzini
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Required texts/other materials:

Required Textbook: Chemistry, An Introduction to General, Organic, and Biological Chemistry

Author: Karen C. Timberlake
Publisher: Pearson
Edition: Thirteenth Edition, 2018

Lab Manual: CHE 107 Lab Manual, 11th edition, by Helen Tanzini, 2022

Lecture Notes: CHE 107 General and Physiological Chemistry

Supplementary Notes
Author: H. V. Tanzini
Publisher: MCCC
Edition: 10th Edition, 2021

Course Student Learning Outcomes (SLO):

Upon successful completion of this course the student will be able to:

1. Relate the function and interaction of life processes related to chemical structure and reactions.
[ILG Goals 1,3&11]

2. Develop skills in observation, organizing and analyzing data, synthesizing and communicating conclusions in writing **[ILG Goals 1,3&11]**
3. Demonstrate a working knowledge of basic chemical concepts and methods. **[ILG Goals 3&11]**
4. Apply chemical concepts to courses needed for health professions programs. **[ILG Goals 1, 3&11]**
5. Perform chemical experimentation using proper scientific and laboratory safety procedures. **[ILG Goals 1, 3&11]**
6. Solve problems by analysis rather than relying on memorization. **[ILG Goals 1, 3&11]**

Course-specific Institutional Learning Goals (ILG):

ILG 1. Written and Oral Communication in English. Students will communicate effectively in both speech and writing.

ILG 3. Science. Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.

ILG 11. Critical Thinking: Students will use critical thinking skills understand, analyze, or apply information or solve problems.

Units of study in detail – Unit Student Learning Outcomes:

Unit I Introduction

Learning Objectives

The student will be able to:

Unit 1 – Measurement [ILG Goals 1,3&11]

The student will be able to:

1. Name the fundamental units of length, mass, time, and temperature.
2. Name and use the common metric prefixes: kilo-, deci-, centi-, milli-, and micro-.
3. Estimate approximate sizes in metric units to show that you can "think metric"
4. Distinguish between solid and liquid volume and state the metric relationship between them. **[Core]**
5. Given the density of two immiscible liquids or the density of a liquid and a solid, indicate which would "float" on the other.
6. Demonstrate an understanding of the temperature scales by being able to convert from one scale to the others.
7. State what is body temperature and what is common room temperature in terms of approximate degrees Celsius.
8. Define the terms calorie, and kilocalorie.
9. Distinguish between mass and weight.
10. Report the number of significant figures a given number contains.
11. Round off, to the correct number of significant figures, the results of an arithmetic operation.
12. Given appropriate data, calculate the density of a substance.
13. Given a number in ordinary decimal form, rewrite it in scientific notation; or given a number in scientific notation, rewrite it in ordinary decimal form.

Unit 2 – Chemistry Introduction [ILG Goals 1,3&11]

The student will be able to:

1. Name the three states of matter.
2. Describe, and give examples of, chemical and physical properties.
3. Define and give examples of elements, compounds, and mixtures.
4. Describe and give examples of chemical and physical change.
5. Define the term atom.

- Given the name, write the symbol; or given the symbol write the name of the more common elements found in living organisms, such as calcium, carbon, chlorine, cobalt, hydrogen, iodine, iron, magnesium, nitrogen, oxygen, phosphorus, potassium, sodium, sulfur, and zinc.

Unit 3 – Atomic Theory [ILG Goals 1,3&11]

The student will be able to:

- Name the three major subatomic particles.
- Compare and contrast the size, mass, and charge of electrons, neutrons, and protons.
- Name the particles found in the atomic nucleus.
- Discuss what determines the atomic number of an atom; the atomic mass of the atom; and the number of electrons present in a neutral atom.
- Define the term isotope and give at least two examples.
- Describe the basic format of the periodic table and indicate what constitutes the periods, and what constitutes groups or families of elements.
- Describe where in the periodic table one will find the representative elements, the transition elements, the metals, the non-metals, the semimetals or metalloids, and the noble gases, alkali metals, alkaline earth metals, halogens.
- Describe how the atomic size and ionization energy vary as one moves from right to left within a period; or from the top down in a group or family.

Unit 4-Chemical Bonding [ILG Goals 1,3&11]

The student will be able to:

- Define the terms ion, ionization, anion, cation, monatomic ion and polyatomic ion.
- Compare and contrast covalent bonds, ionic (electrovalent) bonds, and coordinate-covalent bonds.
- Define the terms oxidation and reduction.
- Define and illustrate empirical formula, molecular formula, and structural formula.
- Based on the atomic numbers of the first 20 elements, predict if any given two of them can form a compound and if so predict whether the bonding in the compound is more likely to be ionic or covalent.
- For the A group elements, determine, from the position of the element in the periodic table, the number of valence electrons the element has and the most likely ion the element will form.
- Write the names and formulas for ionic substances involving any combination of oppositely charged ions which can include both monatomic and the common polyatomic ions.
- Using the normal covalence numbers of elements such as carbon, chlorine, hydrogen, nitrogen, oxygen and sulfur, predict the formula and structure of simple compounds involving any two of the given elements.
- Describe what is meant by a polar molecule.
- Use the order of relative electronegativity to predict whether a given covalent bond will be polar and, if polar, indicate which end of the covalent bond will attract the electrons most strongly.

Unit 5 - Chemical Reactions [ILG Goals 1,3&11]

The student will be able to:

- Define the terms: formula, formula mass, molar mass, mole, and Avogadro's number.
- Calculate the formula mass (molar mass) of a compound given its formula and the atomic weights of the elements involved.
- Calculate how many moles there are in a given weight of a given compound or calculate the weight of a given number of moles of a given compound.
- State whether or not a given chemical equation is balanced.
- Balance a simple equation.
- Review the 5 types of reactions: combustion, combination, decomposition, single and double replacement reactions.
- Define activation energy.
- Define the terms catalyst and inhibitor and explain how they affect the speed of chemical reactions.
- Define equilibrium.

Unit 6 – Kinetic Molecular Theory [ILG Goals 1,3&11]

The student will be able to:

1. Review the kinetic molecular theory of matter.
2. List the three common states of matter and discuss how they differ at the molecular level.
3. Define the terms boiling point, melting point, heat (enthalpy) of fusion (melting), heat (enthalpy) of vaporization.
4. Define pressure; explain how it is measured, and list three commonly used pressure units.
5. Describe what is meant by STP.
6. Explain, in your own words or by use of suitable equation, the behavior of gases as they relate to Dalton's and Graham's law.
7. Distinguish between endothermic and exothermic changes in chemical reactions.
8. Describe intermolecular forces and how they affect the physical properties of substances.

Unit 7 - Solutions and Colloids [ILG Goals 1,3&11]

The student will be able to:

1. Show, by means of a structural formula, why water is a polar molecule.
2. Define the terms surface tension and surface active agent.
3. State the difference between a hydrogen bond and a covalent bond and illustrate by means of a suitable drawing how we symbolize hydrogen bonds in water.
4. Explain how surface tension in water occurs.
5. Describe what a surfactant does and give two examples of surfactants.
6. Distinguish between true solutions, colloidal dispersions, and suspensions.
7. Explain Brownian motion by describing what is happening at the molecular level.
8. Describe the Tyndall effect and explain briefly why it is given by a colloidal dispersion but not by a true solution.
9. Indicate what is the dispersed phase and the dispersion medium for: an aerosol, an emulsion, a gel, a smoke, and a sol.
10. Define the terms solute, solvent, solution.
11. Explain what is meant by solvation in solution and when such solvation is called hydration.
12. Explain why a solvent whose molecules are not polar, such as gasoline, would not be able to dissolve a salt such as sodium chloride (NaCl).
13. Describe what we mean by dilute, concentrated, unsaturated, saturated, and supersaturated solutions.
14. Describe a saturated solution in terms of a dynamic equilibrium.
15. Define Molarity as it applies to solutions.
16. Define mass percent and volume percent as they apply to solutions.
17. Work problems involving molarity, mass percent, and volume percent units: calculate the weight of solute needed to make a certain volume of solution of a specified molar concentration; calculate the weight of solute needed to make a certain volume of a solution of a specified percent concentration; and calculate what volume of solution should be used in order to get a specified amount of its solute if you are given the concentration of the solution.
18. Calculate the volume of a solution of a specified concentration which must be taken for dilution to form a specified volume of a second solution of a lower specified concentration.
19. Describe the difference between a permeable and semipermeable membrane.
20. Define osmotic pressure.
21. Describe the difference between osmosis and dialysis and how they are involved in physiological processes.
22. Compare and contrast isotonic, hypotonic, and hypertonic solutions.
23. Define hemolysis and crenation and describe the solution environment of the red blood cell to cause hemolysis or crenation.

Unit 8 - Ionization, Acids, Bases and Salts [ILG Goals 1,3&11]

The student will be able to:

1. Compare and contrast the terms ionization and dissociation.
2. Name the three principal kinds of ion-producing substances.

3. State what is meant by an acid and by a base in terms of the Arrhenius theory and in terms of the Bronsted theory.
4. Write structures and formulas for: ammonia, ammonium ion, bicarbonate ion, carbonate ion, carbon dioxide, carbonic acid, hydronium ion, and hydroxide ion.
5. Distinguish between a hydrogen ion, a proton, and a hydronium ion.
6. Explain what is meant by the self ionization of water and illustrate how this represents a dynamic equilibrium.
7. Give the names and formulas of at least five substances that are strong acids and at least two that are strong bases and explain why they are classified as strong acids or bases.
8. Explain the difference between strong and weak acids and bases.
9. Describe what is formed from the reaction of water with: active metals, metal oxides, nonmetal oxides.
10. Illustrate the principle reactions of the hydrogen ion by writing ionic equations for its reactions with an active metal, a hydroxide ion, a bicarbonate ion, or a carbonate ion.
11. State what is done to neutralize an acid or to neutralize a base and write an equation that illustrates the process of neutralization.
12. Make a drawing which shows how hydrogen bonds help keep ammonia molecules dissolved in water.
13. Write an ionic equation for the slight reaction of ammonia with water and for the reaction of ammonia with a strong acid.
14. Define and illustrate by means of names and formulas what is meant by a salt.
15. Write equations illustrating how salts may be prepared by the action of an acid on a metal, on a metal hydroxide, on a metal carbonate, and on a metal bicarbonate.
16. State the difference between a strong electrolyte, a weak electrolyte, and a nonelectrolyte.
17. Define the ion product constant of water; state its normal value; and use it for the calculation of hydrogen ion and hydroxide ion concentrations.
18. Define pH.
19. State the range of pH values that corresponds to an acidic solution and the range that corresponds to a basic solution.
20. Give the normal hydrogen ion concentration of pure water and the pH.
21. Estimate the pH of a strong acid or strong base to within a half of a pH unit given either the concentration of that acid or base in moles/liter, or the hydrogen ion concentration in the solution.
22. Describe how to measure the pH of a solution.
23. Define the term indicator and describe its purpose.
24. Define the term buffer.
25. Describe the components of a buffer.
26. Write ionic equations that show how a bicarbonate buffer works.
27. Describe a titration and explain what it is used for.
28. Determine how many moles of an acid (or base) are needed to titrate a given amount of base (or acid) taking into account the fact that acids can have more than one ionizable hydrogen and bases can yield more than one hydroxyl group.

Unit 9 - Introduction to Organic Chemistry [ILG Goals 1,3&11]

The student will be able to:

1. Define organic chemistry.
2. Compare and contrast the typical physical properties of organic compounds with those of inorganic compounds.
3. State the ways in which carbon is a unique element.
4. State how a molecular formula and a structural formula are the same and how they are different.
5. Compare and contrast a condensed structural formula with an expanded (or full) structural formula.
6. Describe the molecular geometry about a carbon atom bonded to four other atoms; to three other atoms; and to two other atoms.
7. Define the term isomer.
8. Compare and contrast conformational isomers with constitutional isomers.
9. Explain why each possible conformation of a carbon chain does not represent a different compound.
10. Give the names and structures of two compounds related as isomers.
11. Examine a pair of structures and tell if they are identical, related as isomers, or otherwise different.
12. Define the term functional group and give the names and structures of at least five common functional groups found in organic molecules.
13. Define hydrocarbon.

14. Compare and contrast saturated and unsaturated hydrocarbons.
15. Compare and contrast aliphatic and aromatic hydrocarbons.
16. Define and give an example of an alkane, alkene, and an alkyne.
17. List the type of physical properties we expect of a compound when its molecules are entirely or mostly hydrocarbon like.
18. Give the names and structures for the first five straight chained alkanes.
19. Give the structures and common names of the isomeric butanes.
20. Define the term alkyl group.
21. Give the structures and names of all four of the alkyl groups having one to three carbon atoms.
22. Use systematic nomenclature (IUPAC) to name saturated hydrocarbons and their substituted derivatives.
23. Give the names and structures for the cycloalkanes having rings containing three to six carbon atoms.
24. Write equations to illustrate substitution reactions of alkanes with halogens such as bromine or chlorine.
Write a balanced equation for the complete combustion of any given hydrocarbon.

Unit 10 – Alkenes and Alkynes [ILG Goals 1,3&11]

The student will be able to:

1. Define geometric isomerism and write structures that illustrate how two alkenes can be related as geometric isomers.
2. Describe what it is about a carbon-to-carbon double bond that makes cis- and trans- isomerism possible.
3. Use IUPAC nomenclature to name unsaturated hydrocarbons.
4. Write equations to illustrate addition reactions of alkenes including the addition of hydrogen (hydrogenation), water (hydration), hydrobromic or hydrochloric acids, and the halogens such as bromine or chlorine.
5. Describe several properties of benzene including how it differs from cycloalkenes.
6. Draw the structures and name at least two aromatic hydrocarbons.
7. Write an equation that illustrates the kind of reaction that benzene undergoes and name this general class of reaction.

Unit 11 - Alcohols, Thiols, Ethers And Benzene [ILG Goals 1,3&11]

The student will be able to:

1. Show the general structures for alcohols, ethers, thiols, disulfides, and amines, and be able to pick these functional groups out in a molecule which contains more than one functional group.
2. Write structures for the C1 through C6 compounds in the families of alcohols, thiols, ethers.
3. Write an IUPAC name for the C1 through C10 alcohols.
4. Determine from the structure of an alcohol or an amine if it is 1°, 2°, or 3°.
5. Give an example of a phenol and explain how phenols differ from alcohols.
6. Make a drawing that illustrates hydrogen bonds between molecules of an alcohol, an alcohol dissolved in water.
7. Explain why alcohols have higher solubilities in water and higher boiling points than compounds of similar molecular weights in the alkane or ether families.
8. Give an example of a synthesis of an alcohol.
9. Explain an elimination reaction and illustrate with appropriate examples.
10. Write equations, not necessarily balanced, that are specific illustrations of each of the following kinds of reactions: dehydration of an alcohol to an alkene, conversion of an alcohol into an ether, oxidation of a 1° alcohol to an aldehyde or carboxylic acid, oxidation of a 2° alcohol to a ketone, oxidation of a thiol to a disulfide, reduction of a disulfide to a thiol, and the reaction of an amine with aqueous acid.
11. Define heterocyclic compound and name at least one example

Unit 12 - Carbonyl Compounds [ILG Goals 1,3&11]

The student will be able to:

1. Define and illustrate the carbonyl group.

2. Give the general class structure for the following families: aldehydes; ketones; carboxylic acids and their salts, esters, and amides.
3. Examine a structure containing several functional groups and identify each functional group present.
4. Identify the amide linkage and the ester linkage when present in a molecule.
5. List the functional groups that best participate in hydrogen bonding between molecules that have these functional groups.
6. Write an equation that is a specific illustration of each of the following reactions: oxidation of an aldehyde to a carboxylic acid, reduction of a ketone of a 2° alcohol, ionization of a carboxylic acid in water, neutralization of a carboxylic acid by aqueous alkali (base), conversion of a carboxylic acid to an ester and/or to an amide, hydrolysis of an ester and/or an amide, saponification of an ester, preparation of a hemiacetal, and preparation of an acetal.
7. For the Benedict's, Fehlings', and Tollens' tests, indicate which substances give positive tests, what can be seen in the test tube when the test is positive, the name and formula of the inorganic substance that forms in a positive test.
8. Arrange a given set of compounds in order of increasing boiling points or increasing solubility of water.
9. Distinguish between esterification and hydrolysis with respect to an ester.
10. Define enantiomers and describe the "handedness" properties of compounds that are chiral.

Unit 13 – Carbohydrates [ILG Goals 1,3&11]

The student will be able to:

1. Describe the structural features present in carbohydrates.
2. Name the three classes of carbohydrates we study and differentiate among them.
3. Interpret the terms: aldose, ketose, aldohexose, ketohexose.
4. Name the three nutritionally important monosaccharides.
5. Name the three nutritionally important disaccharides and name the products which result from the hydrolysis of each one.
6. Name the three polysaccharides made up entirely of glucose units and state where each is found in nature.
7. Write the structures of alpha-, beta-, and the open forms of glucose.
8. Review enantiomers and the "handedness" properties of compounds that are chiral.
9. Give the name of the linkage that forms the ring of a monosaccharide.
10. Explain what is meant by a reducing sugar and name at least three.
11. Name and describe two positive tests for reducing sugars.
12. Give the name of the linkage between monosaccharide units in forming disaccharides and higher polysaccharides.
13. Name the common sugar which is not a reducing sugar.
14. Describe an instance in which two polysaccharides differ only in the orientation, that is the geometry, of their oxygen bridges.
15. Describe what one does and what one sees in the starch-iodine test.
16. Give the name of the reserve or storage carbohydrate "animal starch" and compare it with the plant starches.
17. Describe the structural relation between amylopectin and amylose.
18. Explain in general terms the significance of optical activity of a substance, especially sugars and amino acids, in reactions in living cells.
19. Define mutarotation and describe an example of the phenomenon.

Unit 14 – Lipids [ILG Goals 1,3&11]

The student will be able to:

1. Define the term lipid.
2. List the major classes of lipids.
3. Compare and contrast the terms triacylglycerol and triglyceride.
4. Define and give examples of the terms: fatty acid, fat, oil, unsaturated fat or oil, polyunsaturated fat or oil, wax.
5. Draw the structure of a "typical" triacylglycerol (triglyceride) molecule.
6. Name and write the structures of at least two common saturated fatty acids and two common unsaturated fatty acids.

- Using appropriate structural formulas illustrate: the hydrolysis of a triacylglycerol, the saponification of a triacylglycerol, and the hydrogenation of an unsaturated triacylglycerol.
- Name the two general classes of compounds which result from the saponification of a triacylglycerol.
- Describe the principal structural differences between animal fats and vegetable oils.
- Explain what polyunsaturated means when used to describe vegetable oils.
- Briefly explain why steroids are classified as lipids.
- Describe the structure of a cell membrane naming the major types of components used in forming the membrane and describe, in general terms, how substances are carried across the membrane.
- Describe the importance of cis and trans double bonds with respect to the cell membrane.

Unit 15 – Proteins [ILG Goals 1,3&11]

The student will be able to:

- Define the term alpha-amino acid and indicate how an acid simply named an amino acid can differ from an alpha-amino acid.
- Write the names and draw the structures of at least the amino acids alanine, cysteine, glutamic acid, glycine, and lysine.
- Write the structure of an amino acid in its dipolar ion (zwitterion) form.
- Write equations showing an amino acid in its dipolar ion form acting as a buffer.
- Explain why amino acids are optically active and indicate which "handedness" is found in the amino acids of proteins.
- Define and illustrate the term peptide bond or peptide linkage.
- Define terms polypeptide and protein.
- Write the structure of any di-, tri-, tetra-, or penta-peptide based on the amino acids you have learned and identify the peptide bonds.
- Translate a polypeptide unit labeled with the 3 letter codes for the amino acids, for example gly-ala-glu-lys-cys, into a condensed structural formula.
- Write structures that illustrate the other kinds of bonds in proteins such as salt bridges, disulfide links, and hydrogen bonds.
- Given the structure of a small polypeptide, write the structures of the products of its digestion and give the chemical name for the process.
- Describe the primary, secondary, tertiary, and quaternary structures of proteins.
- Name two kinds of secondary structures for proteins.
- Describe what electrophoresis is and how it can be used to identify proteins.
- Describe what happens structurally, when a protein is denatured.
- Describe, in general terms, how denaturation affects the properties of a protein.
- List at least four agents which denature proteins.

Unit 16 – Enzymes [ILG Goals 1,3&11]

The student will be able to:

- Define the term enzyme and discuss the role enzymes play in living organisms.
- Describe how enzymes are classified and named.
- Define the following terms using examples where appropriate: activator, apoenzyme, coenzyme, cofactor, minerals, substrate, vitamin.
- Describe the relation between an enzyme and an apoenzyme, and between an enzyme and a cofactor.
- Name two kinds of cofactors.
- Explain the role that the B vitamins have in the structure and function of certain enzymes.
- Describe in general terms how enzymes work including their specificity and also their sensitivity to denaturing agents.
- Describe the relationship of enzyme activity to pH and to temperature.
- Name two ways enzymes are involved in the body's control of biochemical reactions in cells.
- Explain what the term "enzyme-substrate complex" means and discuss the role the complex plays in the action of enzymes.
- Describe the role of the "active site" in the action of enzymes.
- Explain the need for the regulation of enzymes and discuss ways it might be accomplished.

13. State what hormones and neurotransmitters are in such a way that they are distinguished carefully from enzymes and vitamins.
14. Compare and contrast hormones and neurotransmitters from the standpoint of where they are formed and where they act.
15. Explain how neurotransmitters work and discuss why they must be deactivated after they have delivered their message.

Unit 17 - Biochemical Energetics [ILG Goals 1,3&11]

The student will be able to:

1. Define the terms anabolism, catabolism, and metabolism.
2. Name the compounds represented by ADP and ATP.
3. Write an equation for the conversion of ATP into ADP and inorganic phosphate.
4. Describe the principal function of electron transport (respiratory chain, oxidative phosphorylation).
5. Discuss the role of NAD⁺ and NADH in the respiratory chain.
6. Describe the connection between the oxygen we breathe and the synthesis of ATP.
7. State the purpose of the citric acid cycle.
8. List two other names for the citric acid cycle.
9. Describe the role of Acetyl-CoA in biochemical energetics.
10. Describe the relationship between glycolysis and the citric acid cycle and between the citric acid cycle and the respiratory chain.

Unit 18 - Carbohydrate, Lipid and Protein Metabolism [ILG Goals 1,3&11]

The student will be able to:

1. Define the terms glycogenolysis, glycolysis, gluconeogenesis, and glycogenesis.
2. Write an overall equation, not each detailed step, for glycolysis from glucose to lactic acid and ATP.
3. Distinguish between aerobic and anaerobic glycolysis and explain why anaerobic glycolysis ends in forming lactate instead of pyruvate.
4. Discuss the importance of glycolysis in the life process.
5. Name the nutrient preferred by brain cells as their source of energy.
6. Describe the Cori cycle.
7. Define the terms hypoglycemia, hyperglycemia, renal threshold, and glycosuria.
8. State the normal range for the adult fasting blood sugar level.
9. Describe the glucose tolerance test and state its purpose.
10. Discuss the role of insulin and glucagon as they relate to blood sugar levels.
11. Describe, in general terms, what diabetes mellitus is.
12. Distinguish between juvenile-onset and adult-onset diabetes.
13. Define hyperinsulinism and describe the problem it can cause.
14. Define insulin shock.
15. Describe how hyperinsulinism and insulin shock can be treated.
16. Define the terms adipose tissue and depot fat.
17. Explain the advantage of storing chemical energy in the form of lipids instead of in the form of carbohydrates.
18. Compare and contrast carbohydrate and lipid reserves in man and indicate approximately how long each would last in a period of starvation.
19. Name the products of the digestion of lipids.
20. Describe, in general terms, what happens during the fatty acid cycle.
21. Explain why the fatty acid cycle is also called beta-oxidation.
22. Name and give the structures of the three major ketone bodies.
23. Describe, in general terms, how the ketone bodies are formed and discuss why they are formed in greater than normal amounts when effective insulin is missing.
24. Define and give the relationship between ketosis, ketonemia, ketonuria, acetone breath, and ketoacidosis.
25. Discuss why a lack of effective insulin can lead to a gluconeogenesis.
26. Discuss how either starvation or lack of effective insulin can lead to acidosis.
27. Explain the difference between the essential and the nonessential amino acids.
28. Describe the three main fates of amino acids in the body.

29. Describe the working of the nitrogen pool.
30. Explain what it means for an organism to be in a state of nitrogen balance.

Evaluation of Student Learning:

3 lecture exams	40%
Recitation	15%
Lab	20%
Final Exam	25%

93 – 100%	A	87- 89%	B	77-79%	C+	60-69%	D
90 – 92%	A-	83-86%	B	70-76%	C	Below 60%	F
		80-82%	B-				

Exams, recitation, and lab quizzes contribute to the points in the course. All assessments are selected to evaluate student understanding of the course student learning outcomes.