Syllabus
Chem 102

Introduction to General, Organic, and Biological Chemistry

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Lectures: Tue, Thu, and Fri 2:00-3:15 PM
PS 130

All lecture slides will be posted on Blackboard

Text: Chemistry, An introduction to General, Organic, and Biological Chemistry, 12th edition (Pearson)
Timberlake

Office hours at CSL 322: Mondays 8:30-10:00
Tuesdays 8:30-10:00
Alternative times may be arranged by appointment.

Prerequisites: High School Chemistry

Course description.

This course gives an overview of the concepts in general, organic, and biological chemistry that are necessary to understand human biochemistry and pharmacology. These include measurements, use and conversion of units, significant figures, chemical bonding, stereochemistry, acidity, functional groups, thermodynamics, carbohydrates, lipids, nucleotides, nucleic acids, amino acids, proteins, enzymes, and metabolic pathways.

Learning outcomes:

Define the term chemistry and identify substances as chemicals. Describe the activities that are part of the scientific method. Master math concepts used in chemistry: place values, positive and negative numbers, percentages, solving equations, interpreting graphs, and writing numbers in scientific notation.

Use metric or SI units in measurement, including length, volume, mass, temperature, and time. Distinguish measured or exact numbers and determine the number of significant figures in a measured number. Adjust calculated answers to give the correct number of significant figures. Use the numerical values of metric prefixes. Write and use conversion factors. Calculate the density, the mass, or volume of a substance.

Distinguish pure substances and mixtures. Identify the states, the physical, and chemical properties of matter. Interconvert temperatures of different scales. Distinguish potential and kinetic energy and convert between units of energy (calculate the kilocalories (kcal) or kilojoules (kJ) for a food). Use specific heat to calculate heat loss or gain. Describe the changes of state between solids, liquids, and gases; calculate the energy involved.

Focusing on elements relevant to biology, write the correct symbol for a given element; write the correct name for a symbol. Use the periodic table to identify the group and the period of an element; identify the element as a metal, a nonmetal, or a metalloid. Describe the electrical charge and location in an atom for a proton, a neutron, and an electron. Given the atomic number and the mass number of an atom, state the number of protons, neutrons, and electrons. Determine the number of protons, electrons, and neutrons in one or more of the isotopes of an element; calculate the atomic mass of an element using the percent abundance and mass of its naturally occurring isotopes. Given the name or symbol of one of the first 20 elements in the periodic table, write the electron arrangement. Use the electron arrangement of elements to explain the trends in periodic properties.

Describe the nature of alpha, beta, positron, and gamma radiation. Write balanced nuclear equations for radioactive decay. Describe the detection and measurement of radiation. Calculate the amount of radioisotope remaining after one or more half-lives. Describe the use of radioisotopes in medicine. Describe the processes of nuclear fission and fusion.

Write the symbols for the simple ions of the representative elements. Using charge balance, write the correct formulas for ionic compounds. Given formulas and correct names for ionic compounds. Given the formulas and names of molecular compounds. Use electronegativity to determine the polarity of a bond. Predict the three-dimensional structure of a molecule, and classify it as polar or nonpolar. Describe the attractive forces between ions, polar covalent molecules, and nonpolar covalent molecules.

Use Avogadro's number to determine the number of particles in a given number of moles. Calculate the molar mass for a given substance; use molar mass to convert between grams and moles. Write a balanced chemical equation from the formulas of the reactants and products for a reaction; determine the number of atoms in the reactants and products. Classify reactions as combination, decomposition, single replacement, double replacement, or combustion. Define the terms oxidation and reduction; identify the reactants that are oxidized and that are reduced. Use mole-mole factors from balanced chemical equations to calculate the number of moles of reactants or products in the reaction. Use mole-mole and molar mass factors to carry out mass calculations for reactions. Describe exothermic and endothermic reactions and factors that affect the rate of a reaction.

Describe the kinetic molecular theory of gases and the units of measurement used for gases. Use the pressure-volume relationship (Boyle's law), the temperature-volume relationship (Charles's law), the temperature-pressure relationship (Gay-Lussac's law), the combined gas law, Avogadro's law, and Dalton's law of partial pressures in calculations regarding gasses.

Describe the formation of a solution and identify the solute and solvent in a solution. Identify solutes as electrolytes or nonelectrolytes. Define solubility and distinguish unsaturated and saturated solutions. Identify a salt as soluble or insoluble. Calculate the concentration and the amount of a solute in a solution. Describe the dilution of a solution and calculate the final concentration or volume of a diluted solution. Identify a mixture as a solution, a colloid, or a suspension. Describe how the number of particles in a solution affects the osmotic pressure of a solution.

Name and identify Bronsted-Lowry acids and bases. Write equations for the ionization of acids and bases. Use the concept of reversible reactions to explain acid-base equilibrium. Use Le Chatelier's principle to determine the effect on equilibrium concentrations when reaction conditions change. Use the ion product for water to calculate the $[H_3O^+]$ and $[OH^-]$ in an aqueous solution. Calculate the pH or the H_3O^+ concentration of a solution. Write balanced equations for reactions of acids and bases. Calculate the molarity or volume of an acid from titration information. Describe the role of buffers in maintaining the pH of a solution.

Identify properties characteristic of organic or inorganic compounds. Write the IUPAC names and draw the condensed structural and skeletal formulas for alkanes and cycloalkanes. Write the IUPAC names for alkanes with substituents and draw their condensed structural and skeletal formulas. Identify the properties of alkanes and write a balanced chemical equation for combustion. Identify structural formulas as alkenes, cycloalkenes, and alkynes, and write their IUPAC names. Draw the condensed structural formulas and give the names for the cis-trans isomers of alkenes. Draw the condensed structural formulas and give the names for the organic products of addition reactions of hydrogenation and hydration of alkenes. Describe the bonding in benzene; name aromatic compounds and draw their skeletal formulas.

Give the IUPAC and common names for alcohols and phenols; give the common names for thiols and ethers. Draw their condensed structural or skeletal formulas. Describe the classification of alcohols; describe the solubility of alcohols in water. Write the IUPAC and common names for aldehydes and ketones; draw the condensed structural formulas. Describe the solubility of aldehydes and ketones in water. Write balanced chemical equations for the combustion, dehydration, and oxidation of alcohols. Write balanced chemical equations for the oxidation and reduction of thiols, aldehydes, and ketones.

Classify a monosaccharides based on the number of carbons and the presence of a carbonyl as an aldehyde or a ketone. Identify chiral and achiral carbon atoms in organic molecules. Use Fischer projections to draw the D or L stereoisomers for glucose, galactose, and fructose. Draw and identify the Haworth structures for monosaccharides. Identify the products of oxidation or reduction of monosaccharides; determine whether a carbohydrate is a reducing sugar. Describe the monosaccharide units and linkages in disaccharides. Describe the structural features of amylose, amylopectin, glycogen, and cellulose.

Give the IUPAC and common names for carboxylic acids; draw their condensed structural formulas or skeletal formulas. Describe the solubility, ionization, and neutralization of carboxylic acids. Give the IUPAC and common names for an

ester; write the balanced chemical equation for the formation of an ester. Draw the condensed structural formulas for the products from acid and base hydrolysis of esters. Give the common names for amines; draw the condensed structural formulas when given their names. Classify amines as primary, secondary, or tertiary. Describe the solubility, ionization, and neutralization of amines. Give the IUPAC and common names for amides and draw the condensed structural formulas for the products of formation and hydrolysis.

Describe the classes of lipids. Draw the condensed structural formula for a fatty acid and identify it as saturated or unsaturated. Draw the condensed structural formula for a wax or triacylglycerol produced by the reaction of a fatty acid and an alcohol or glycerol. Draw the condensed structural formula for the product of a triacylglycerol that undergoes hydrogenation, hydrolysis, or saponification. Describe the structure of a phospholipid containing glycerol or sphingosine. Describe the structures of steroids. Describe the composition and function of the lipid bilayer in cell membranes.

Classify proteins by their functions. Give the name and abbreviations for an amino acid and draw its ionized structure. Draw the condensed structural formula for an amino acid at pH values above or below its isoelectric point. Draw the condensed structural formula for a peptide and give its name. Describe the primary structure for a protein. Describe the secondary, tertiary, and quaternary structures for a protein; describe the denaturation of a protein. Describe enzymes and their role in enzyme-catalyzed reactions.
Describe the effect of temperature, pH, and inhibitors on enzyme activity.

Describe the bases and ribose sugars that make up the nucleic acids DNA and RNA. Describe the primary structures of RNA and DNA. Describe the double helix of DNA and the process of DNA replication. Identify the different types of RNA; describe the synthesis of mRNA. Describe the process of protein synthesis from mRNA. Describe some ways in which DNA is altered to cause mutations. Describe the methods by which a virus infects a cell.

Describe three stages of catabolism and the role of ATP. Give the sites and products of digestion for carbohydrates, triacylglycerols, and proteins. Describe the components and functions of the coenzymes NAD^+, FAD, and coenzyme A. Describe the conversion of glucose to pyruvate in glycolysis and the subsequent conversion of pyruvate to acetyl-CoA or lactate. Describe the oxidation of acetyl-CoA in the citric acid cycle. Describe electron transport and the process of oxidative phosphorylation; calculate the ATP from the complete oxidation of glucose. Describe the metabolic pathway of B oxidation; calculate the ATP from the complete oxidation of a fatty acid. Describe the reactions of transamination, oxidative deamination, and the entry of amino acid carbons into the citric acid cycle.

Lecture schedule		
Date	**Topic**	**Reading**
Tu Aug 25	Introduction; Chemicals; Scientific method	Ch. 1 pp. 1-6
Th Aug 27	Math skills; Units	Ch. 1/2 pp. 7-25
Fr Aug 28	Measured and Significant Numbers; Significant Numbers and Calculations; Prefixes and equalities; conversion factors; Problem solving with unit conversions; Density	Ch. 2 pp. 26-56
Tu Sept 1	Classification of matter; States and properties of matter; Temperature; Energy	Ch. 3 pp. 57-73 Ch. 3/4 pp. 73-100
Th Sept 3	Specific heat; Changes of state; Elements and symbols; Periodic table	Ch. 4 pp. 101-111 Ch. 4/5 pp. 119-138
Fr Sep 4	The atom; Atomic and mass numbers	Ch. 5 pp. 138-164
Tu Sept 8	Isotopes; Electron energy levels	Ch. 4 pp. 111-118
Th Sept 10	Periodic trends; Natural radioactivity	Ch. 4 pp. 119-133
Fr Sept 11	Nuclear reactions; Measuring radiation; Half life; Medical applications	Ch. 5 pp. 134-164
Tu Sept 15	Ions; Formulas; Naming ionic compounds	Ch. 6 pp. 165-177
Th Sept 17	Polyatomic ions; Molecular compounds	Ch. 6 pp. 177-188
Fr Sept 18	Electronegativity; Shapes and polarity; Attractive forces	Ch. 6 pp. 189-210
Tu Sept 22	Mole; Molecular mass calculations; Equations for chemical reactions	Ch. 7 pp. 211-222
Th Sept 24	Types of reactions	Ch. 7 pp. 222-234
Fr Sept 25	Oxidation-reductions reactions; Mole relationships; Mass calculations; Properties of gasses	Ch. 7/8 pp. 235-258
Tu Sept 29	Midterm 1: Chapters 1-6	
Th Oct 1	Pressure and volume; Temperature and volume; Temperature and pressure; Combined gas law; Volume and moles; Partial pressure	Ch. 8/9 pp. 258-283
Fr Oct 2	Solutions; Electrolytes	Ch. 9 pp. 283-290
Tu Oct 6	Solubility; Concentration; Dilution	Ch. 9 pp. 290-304
Th Oct 8	Properties of solutions; Acids and bases	Ch. 9/10 pp. 305-325
Fr Oct 9	Strengths of acids and bases; Acid-base equilibrium	Ch. 10 pp. 326-335
Tu Oct 13	Ionization of water; pH scale; Reactions of acids and bases	Ch. 10 pp. 336-349
Th Oct 15	Buffers; Organic compounds; Alkanes	Ch. 10/11 pp. 349-365

Fr Oct 16	Alkanes with substituents; Properties of alkanes	Ch. 11 pp. 365-374
Tu Oct 20	Alkenes and alkynes; Cis-trans isomers; Addition reactions	Ch. 11 pp. 375-385
Th Oct 22	Aromatic compounds; Alcohols; Phenols	Ch. 11/12 pp. 386-403
Fr Oct 23	Thiols; Ethers; Properties of alcohols; Aldehydes	Ch. 12 pp. 404-410
Tu Oct 27	Ketones; Reactions of Alcohols and Thiols	Ch. 12 pp. 410-418
Th Oct 29	Reactions of Aldehydes and Ketones; Carbohydrates; Chiral molecules	Ch. 12/13 pp. 419-438
Fr Oct 30	Fisher projections; Haworth structures; Chemical properties of Monosaccharides	Ch. 13 pp. 439-452
Tu Nov 3	Midterm 2: Chapters 7-12	
Th Nov 5	Disaccharides; Polysaccharides	Ch. 13 pp. 452-471
Fr Nov 6	Carboxylic acids; Properties of Carboxylic acids	Ch. 14 pp. 472-480
Tu Nov 10	Esters; Hydrolysis of esters; Amines	Ch. 14 pp. 481-493
Th Nov 12	Amides; Lipids; Fatty acids	Ch. 14/15 pp. 494-514
Fr Nov 13	Waxes and Triglycerols; Chemical properties of Triglycerols	Ch. 15 pp. 515-527
Tu Nov 17	Phospholipids; Sterols; Cell membranes	Ch. 15 pp. 528-550
Th Nov 19	Proteins and Amino acids; Amino acids as acids and bases; Primary structure	Ch. 16 pp. 551-562
Fr Nov 20	Secondary, Tertiary, Quaternary Structure; Enzymes	Ch. 16 pp. 563-574
Tu Nov 24	Factors affecting enzyme activity; Bases and Nucleotides; Primary structure of Nucleic acids	Ch. 16/17 pp. 575-596
Th Nov 26	Thanksgiving break	
Fri Nov 27	Thanksgiving break	
Tu Dec 1	The Double helix; RNA; Genetic code; Protein synthesis; Mutations;	Ch. 17 pp. 597-610
Th Dec 3	Viruses; Metabolism and ATP; Digestion;	Ch. 17/18 pp. 610-630
Fr Dec 4	Coenzymes; Glycolysis; Citric acid Cycle	Ch. 18 pp. 631-643
Tu Dec 8	Electron transport chain; Oxidation of Fatty acids; Degradation of Amino acids	Ch. 18 pp. 643-672
Th Dec 10	Midterm 3: Chapters 13-18 Question session	

Lab schedule	
Week of Aug 24	Significant figures, scientific notation worksheet
Week of Aug 31	Solubility
Week of Sept 7	Specific heat (Tuesday, Wednesday, Thursday sections)
Week of Sept 14	Flame test, spectra, absorbance of light
Week of Sept 21	Magnesium oxide
Week of Sept 28	Introduction to acids and bases
Week of Oct 5	Titration part A
Week of Oct 12	Titration part B
Week of Oct 19	Synthesis of aspirin
Week of Oct 26	Molecular structure worksheet
Week of Nov 2	Properties and preparation of esters and soap
Week of Nov 9	Specific heat (Monday sections only)
Week of Nov 16	Determination of protein concentration
Week of Nov 23	Thanksgiving
Week of Nov 30	Enzyme catalysis
Week of Dec 8	Check out

For some of the laboratory exercises you will need a non-programmable calculator (e.g., TI-30Xa or Casio fx-300ms plus), Matches or butane lighter, safety glasses and an apron (available at the Bookstore).

Homework: Mastering chemistry

Go to www.pearsonmylabandmastering.com sign up for the course

To sign up you will need:

- An email address
- The course ID: MCCHEMISTRY04529
- An excess code or credit card

Homework will be assigned weekly.

Homework will count for 120 out of the possible 1000 points in this course

Exams

Midterms: Tuesday, September 29: (Chapters 1-6)
Tuesday, November 3: (Chapters 7-12)
Thursday December 10: (Chapters 13-18)

Final: Tuesday, December 15, 1:00-3:00 pm: (Chapters 1-18)

Bring a blue scantron (20788 or SC882-E) with you to each of the exams.

Grading

Homework	120 points
Labs 12 labs, 1 worksheet (15 points each) drop lowest grade	180
Midterm 1	150
Midterm 2	150
Midterm 3	150
Final	250
Total	1000 points

Letter grades	
90 % and above	A
80-89.9 %	B
70-79.9 %	C
60-69.9 %	D
below 60%	F

Slides will be posted on blackboard. However, remember that the slides do not contain a comprehensive overview of the material.

You will need a non-programmable calculator during the exams and some of the laboratories (e.g., TI-30Xa or Casio fx-300ms).

No cell phone use will be permitted during exams.

The final exam will be comprehensive.

Students with disabilities: If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services.