CHE 106

COURSE OUTLINE

Course Number	Course Title	Credits
CHE106	**Chemical Science Concepts**	**3**

Class Hours: 2/2 Lecture/Lab/Other	**Prerequisites:** MAT 037 or MAT 042 Minimum C grade	**Implementation Spring 2023**

Catalog description:

Fundamental topics in chemistry and biology are introduced utilizing forensics to explore basic chemical concepts. Topics include general, organic, and biochemistry, and molecular biology. Lab experiments integrate case-study analyses and modern instrumentation with techniques in enzymology, chromatography, chemical synthesis, chemical identification, microscopy, fingerprinting, DNA analysis, and serology. Prepares the student for informed engagement in society by providing scientific knowledge on which attitudes and opinions can be developed

General Education Category:
Goal 3: Science

Course coordinator:
Helen Tanzini
tanzinih@mccc.edu

Required texts/other materials:

Chemical Science Concepts Laboratory Manual Helen V. Tanzini, Fifth edition, MCCC, 2021

Course Student Learning Outcomes (SLO):

Students will be able to:

1. Demonstrate a working knowledge of chemical concepts and methods in chemistry, organic chemistry, biochemistry, and molecular biology (ILG 3)
2. Apply the scientific method by formulating a hypothesis, developing an action plan, collecting and evaluating data. Develop skills in observation, organizing and analyzing data, synthesizing information, and communicating conclusions orally and in writing (ILG 1,3,11)
3. Connect forensic science with chemistry and formulate perspectives on issues influenced by these disciplines (ILG 1, 3, 11)
4. Develop laboratory skills in measurement, data collection, graphing, and analysis (ILG 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 [Supports SLOs 1,2,3,4]

Learning Objectives

The student will be able to:

1. Define forensic science and Locard's Principle "Every contact leaves a trace".
2. Discuss truth, fact, certainty, possibility, and probability with respect to science and forensics
3. Examine a crime scene photo to engage in preliminary case assessment, hypothesis construction, and formulation of an analytical plan
4. Begin chain of custody to store and classify evidence including proper handling, documentation, collection, custody, preservation, analysis, interpretation, and reporting.
5. Examine the use of toxicology, microscopic examination, photography, rigor mortis, and DNA analysis in the determination of time, manner, and cause of death
6. Discuss the difference between generation of data in a controlled setting, such as a scientific experiment, and use of evidence from uncontrolled crime scenes
7. Read a Sherlock Holmes short story. Write an essay detailing logic techniques and current forensic inquiry and techniques.
8. Compare and contrast the three states of matter and illustrate chemical and physical properties of substances
9. Give examples of elements, compounds and mixtures
10. Describe periodic table: groups, periods, representative and transition elements, metal, nonmetal, metalloid. Give examples of each and predict formulas of compounds formed from the elements by using the periodic table.
11. Explain how atoms are held together to form a compound
12. Balance a chemical equation
13. Define concentration
14. Compare and contrast acidic, basic and neutral substances
15. Define pH and predict the pH of common substances e.g. Blood, urine
16. Evaluate various substances and rank them as organic or inorganic
17. Explain why carbon is a unique element
18. Compare the structures of two compounds and describe the relationship between them as isomers, identical or different, non-isomeric substances
19. Classify organic substances according to functional group
20. Define heterocyclic compound and assess the hazards and benefits of this class of compound to human life
21. Illustrate how monomers combine to form polymers
22. Use wet chemistry techniques (filtration, solubility) to separate substances Evaluate data obtained from the following analytical methods: Infrared Spectroscopy (IR), Gas-liquid (GC), Thin Layer (TLC), and Paper Chromatography

Unit 2: Biochemistry, Fingerprints, Drugs [Supports SLOs 1,2,3,4]

The students will be able to:

1. Describe the structural features present in carbohydrates, proteins, lipids and nucleic acids
2. Define enantiomer and relate the "handedness" property to biomolecules and drugs
3. Explain how amino acids combine to make a protein
4. Describe how specialized proteins called enzymes speed up reactions
5. List the major classes of lipids and explain how they fit the definition of a lipid)
6. Examine the DNA polymer and its composition of nucleotide bases, architecture of the double helix, and containing the code for proteins
7. Review the terms and concepts: drug, psychological dependence, physical dependence, narcotic, poison, analgesic, hallucinogen, depressant, stimulant, and steroid
8. Discuss types of abused drugs with respect to the chemical nature of the compound and its physiological effects
9. Discuss controversy surrounding the legalization of THC as a medicine
10. Examine the isolation of drugs from plants including *Cannabis*, *Papaverm*, ergot, *Erythroxylon*, and plants used in the manufacture of alcohol.
11. Compare normal effects of testosterone with effects of synthetic steroids
12. Review Schedules I – V of the Controlled Substances Act
13. Observe cuticle, cortex, medulla, and root properties using compound light microscopy and differentiate between human and animal hair
14. Evaluate factors that produce skin color including the genetic inheritance of skin pigment and cells responsible for melanin production
15. Investigate effect of burns and abrasions on friction ridges and underlying dermal papillae
16. Hypothesize about the weakness of positive hair comparison which can stem from incomplete hairs, featureless hairs, and large intra sample variation of hair
17. Examine chemicals found in 1 microgram of material left by a fingerprint and perspiration including fatty acids, amino acids, urea, inorganic salts
18. Create, develop, and enhance single and ten print visible, patent, and latent fingerprints using conventional and magnetic powders, tape, and ninhydrin methods and classify fingerprint aspects as whorls, arches or loops
19. Discuss the AFIS (Automated Fingerprint Identification System)
20. Evaluate role of insect, carnivore, rodent, and microbial scavengers in the decomposition of tissue
21. Evaluate the nature of the burial and its effects on decomposition including depth of burial, aqueous vs. soil environment, temperature, compaction, pH

Unit 3 Toxicology [Supports SLOs 1,2,3,4]

The students will be able to

1. Classify the main groups of poisons according to chemical structure and physiological effect Compare and contrast the terms poison and toxic
2. Research a famous poisoning case
3. Explain the factors that influence the toxicity of a substance
4. Compare stationary phase and mobile phases in a chromatography experiment
5. Develop an unknown sample along with standard samples in order to assess the purity of the unknown and to identify the unknown substances and calculate the Rf value (ratio to front) of the spots on a developed TLC plate
6. Analyze the GC data (chromatogram) obtained from alcohol analysis lab experiment and calculate the retention time of each component found in the alcohol mixture
7. Determine the percentage of each component of the mixture by calculating the area under each curve on the chromatogram

8. Interpret IR spectral data: peak absorptions and organic functional groups
9. Complete a series of problems in the inheritance of ABO and Rh blood groups, hair types, and other single gene human traits
10. Differentiate between phenotypes and genotypes, genes, alleles and chromosomes, dominant and recessive traits, homozygous, heterozygous
11. Become proficient in following rules of DNA base pare complementation in determination of DNA sequence
12. Examine the role of gene expression in the use of DNA code to manufacture proteins from amino acid precursors
13. Place the advent of the PCR in the historical context of the Nobel Prize and impact on science Examine various regions of sequence or length polymorphisms in the genome including VNTRs, SNPs, RFLPs, mitochondrial DNA, and STRs
14. Evaluate the use of DNA fingerprinting in forensics, paternity, evolutionary relationships and identifying inherited disorders and disease predispositions
15. Isolate DNA via centrifugation, denaturation, and precipitation
16. Utilize the Innocence Project website to analyze a case in which DNA evidence can be used to support innocence and interpret DNA fingerprints from forensic cases
17. Investigate significance of the CODIS (Combined DNA Index System) in identification and discuss ethical implications of government taking DNA at birth, for military, or prisoners
18. Determine important properties of blood antigens relevant to blood transfusion and blood typing including antigen/antibody agglutination and antiserum
19. Complete problems to determine paternity via blood group inheritance
20. Associate the presence of hemoglobin (blood) with peroxidase-like activity (Kastle-Meyer test) and the limitations of colorimetric tests that have cross-reactivity.

Evaluation of Student Learning:

3 lecture exams	45%
Prelab, lab activities, final project	35%
Quiz, homework, class work	20%

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, homework, in-class graded activities, and lab exercises contribute to the points in the course. All assessments and graded activities are selected to evaluate student understanding of the course student learning outcomes.