CHE 106

COURSE OUTLINE

CHE106            Chemical Science Concepts
Course Number                          Course Title

3                        2
Credits Hours: lecture/laboratory

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

Prerequisites: MAT034

Required texts/other materials:
Criminalistics, An Introduction to Forensic Science
12th edition, 2015
Richard Saferstein
Pearson Prentice Hall

Revision date: September, 2016

Course Coordinator: Professor Helen Tanzini
tanzinih@mccc.edu

Information resources:

The library has a collection of books that students may use for reinforcement of the content being taught in this course.
Other learning resources:

Websites
1. FBI Forensic Science Communications  http://www.fbi.gov/
2. Cold Spring Harbor DNA Learning Center http://dnalc02.cshl.edu/home.html
3. The Genetics Learning Center University of Utah http://gslc.genetics.utah.edu/

Electronic Databases
1. FBI: CODIS (Combined DNA Index System) http://www.fbi.gov/hq/lab/codis/index1.htm
2. AFIS (Automated Fingerprint Identification System)

ChemDraw software – provided in the laboratory

Tutors - MCCC provides free tutoring in chemistry. The learning center is located on the second floor behind the bookstore. Students are accommodated on a walk in basis. Consult http://www.mccc.edu/student_services_learncenter_ww.shtml for tutor schedules.

Course goals (CG):

The student will be able to:

1. Demonstrate a working knowledge of chemical concepts and methods in chemistry, organic chemistry, biochemistry, and molecular biology (GE goals 2, 3, 4, 9  CS goals A, B, D, E)

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 (GE goals 1, 2, 3, 4, 9  CS goals A, B, D, E, F)

3. Connect forensic science with chemistry and formulate perspectives on issues influenced by these disciplines (GE goals 1, 9  CS goals A, B, F)

4. Develop laboratory skills in measurement, data collection, graphing, and analysis (GE goals 2, 3, 4  CS goals A, B, D, E, F)

General Education (GE) Knowledge Goals

**Goal 1.** Communication. Students will communicate effectively in speech and writing.
**Goal 2.** Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
**Goal 3.** Science. Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.
**Goal 4.** Technology. Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.
**Goal 9.** Ethical Reasoning and Action. Students will understand ethical issues and situations.

MCCC Core Skills (CS)

**Goal A.** Written and Oral Communication in English. Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.
**Goal B.** Critical Thinking and Problem-solving. Students will use critical thinking and problem solving skills in analyzing information.
**Goal D.** Information Literacy. Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.
Goal E. Computer Literacy. Students will use computers to access, analyze or present information, solve problems, and communicate with others.

Goal F. Collaboration and Cooperation. Students will develop the interpersonal skills required for effective performance in group situations.

Grading:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>3 lecture exams</td>
<td>45%</td>
</tr>
<tr>
<td>Prelab, lab activities, final project</td>
<td>35%</td>
</tr>
<tr>
<td>Quiz, homework, class work</td>
<td>20%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93 – 100%</td>
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<tr>
<td>A-</td>
<td>90 – 92%</td>
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<tr>
<td>B</td>
<td>87-89%</td>
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<tr>
<td>B-</td>
<td>80-82%</td>
</tr>
<tr>
<td>C</td>
<td>77-79%</td>
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<tr>
<td>C+</td>
<td>70-76%</td>
</tr>
<tr>
<td>D</td>
<td>60-69%</td>
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<tr>
<td>F</td>
<td>Below 60%</td>
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Questions on exams are taken from lecture, reading assignments, handouts, or other material presented. It is the students’ responsibility to be present at all exams. There are no regular makeup exams. A student who misses an exam must contact the instructor within 12 hours and provide a documented reason for the absence.

A student who misses an exam AND has contacted the instructor within the designated time period and provided documentation may be allowed to take an essay exam.

All lecture and lab assignments must be turned in at the beginning of class on the day that the assignment is due. Late assignments are not accepted.

The laboratory component of the course is critical to satisfying the objectives of the course. Laboratories cannot be made up. The grade for a missed lab is a zero. More than 3 lab absences results in failure in the course regardless of lecture performance. Late students have 2 points deducted from the lab. Students who miss the lab introduction will not be allowed to participate in the lab.

It is the student's responsibility to withdraw from the course and to do so by the college withdrawal deadline

Academic Integrity Statement:

Cheating of any kind is not tolerated. This includes copying papers or website information or presenting another person's work as one's own, looking at a student's paper during a test or quiz, looking at notes during an exam or quiz, obtaining information about an exam, quiz, or any other information that other students do not have and the instructor does not intend them to have, and talking during an exam or quiz. Other academic integrity violations include giving answers to or writing papers for another student, submitting a paper which includes words or the creative work of another without acknowledging the source, presenting another individual's work as your own, and falsifying data or bibliographic entries. Any observed instance of cheating is punishable by confiscation of the work and being assigned a grade of zero. All violations of academic integrity will be reported to the Academic Integrity Committee. For more information, consult the Student Handbook

Classroom Conduct
The college welcomes students into an environment that creates a sense of community pride and respect.

Attendance
It is a student’s responsibility to attend all classes. If a class meeting is missed for any reason, the student is responsible for all content covered, for announcements made in his/her absence, and for acquiring any materials that may have distributed in class. The instructor may not repeat announcements or distribute handouts more than once. More than 2 missed lectures may result in a lower grade for the course. Lab attendance is mandatory. More than three missed labs results in an F for the course regardless of the quality of the work done in the course.

Tardiness
It is expected that students will be on time for all classes. If a student walks into a class after it has begun, he/she will not disrupt other students. Students late for an exam may be denied the opportunity to take the exam. Students must be on time for lab and cannot participate in lab if the introduction to the laboratory is missed. This is for safety reasons.

Behavior
Students are expected to follow ordinary rules of courtesy during class sessions. Engaging in side conversations during class time is distracting to other students. The instructor has the right to eject a disruptive student from the class at any time. Turn off cell phones at the beginning of each class.

Syllabus

<table>
<thead>
<tr>
<th>Week</th>
<th>Chapter</th>
<th>Topic</th>
<th>Laboratory</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1, 2</td>
<td>Introduction</td>
<td>Laboratory Safety, Measurement</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Physical Evidence</td>
<td>Microscopy and hair analysis</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>General Chemistry</td>
<td>Periodic Table and molecular models</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>Organic Chemistry</td>
<td>Thin layer chromatography</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Exam 1</td>
<td>Gas Chromatography + ChemDraw</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Biochemistry</td>
<td>Fingerprinting</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>Fingerprints</td>
<td>Identification of unknown substances</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>Chemistry of Drugs</td>
<td>Synthesis of aspirin</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>(continued)</td>
<td>Isolation of DNA</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Exam 2</td>
<td>Autopsy</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>Toxicology</td>
<td>DNA fingerprinting</td>
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<tr>
<td>12</td>
<td>10</td>
<td>Toxicology</td>
<td>Serology</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>Molecular Biology</td>
<td>Final Project</td>
</tr>
<tr>
<td>14</td>
<td>13, 12</td>
<td>Serology</td>
<td>Oral Presentation</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Exam 3</td>
<td></td>
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The Instructor reserves the right to change the lecture and laboratory sequence and exam schedule
Unit I: Introduction  Chapters 1, 2, 3, 5, 6
The students will be able to:

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

Unit 2: Biochemistry, Fingerprints, Drugs  Chapters 6, 14, 9  (Course Goals 1, 2, 3, 4)
The students will be able to:

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

**Unit 3 Toxicology Chapters 10, 14, 9 (Course Goals 1, 2, 3, 4)**

1. Classify the main groups of poisons according to chemical structure and physiological effect (Course Goals 1, 3)
2. Compare and contrast the terms poison and toxic (Course Goals 1, 3)
3. Research a famous poisoning case (Course Goals 2, 4)
4. Explain the factors that influence the toxicity of a substance (Course Goals 1, 3)
5. Compare stationary phase and mobile phases with respect to a chromatography experiment (Course Goals 2, 4)
6. 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 (Course Goals 2, 4)
7. Analyze the GC data (chromatogram) obtained from alcohol analysis lab experiment and calculate the retention time of each component found in the alcohol mixture (Course Goals 2, 4)
8. Determine the percentage of each component of the mixture by calculating the area under each curve on the chromatogram (Course Goals 2, 4)
9. Interpret IR spectral data with respect to peak absorptions and organic functional groups (Course Goals 2, 4)
10. Complete a series of problems in the inheritance of ABO and Rh blood groups, hair types, and other single gene human traits (Course Goals 2, 4)
11. Differentiate between phenotypes and genotypes, genes, alleles and chromosomes, dominant and recessive traits, homozygous, heterozygous (Course Goals 1, 3)
12. Become proficient in following rules of DNA base pair complementation in determination of DNA sequence (Course Goals 1, 3)
13. Examine the role of gene expression in the use of DNA code to manufacture proteins from amino acid precursors (Course Goals 1, 3)
14. Place the advent of the PCR in the historical context of the Nobel Prize and impact on science (Course Goals 1, 3)
15. Examine various regions of sequence or length polymorphisms in the genome including VNTRs, SNPs, RFLPs, mitochondrial DNA, and STRs (Course Goals 1, 3)
16. Evaluate the use of DNA fingerprinting in forensics, paternity, evolutionary relationships and identifying inherited disorders and disease predispositions (Course Goals 2, 4)
17. Isolate DNA via centrifugation, denaturation, and precipitation (Course Goals 2, 4)
18. 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 (Course Goals 2, 4)
19. Investigate the significance of the CODIS (Combined DNA Index System) in identification and discuss ethical implications of government taking DNA at birth, for military, or prisoners (Course Goals 2, 4)
20. Determine important properties of blood antigens relevant to blood transfusion and blood typing including antigen/antibody agglutination and antiserum (Course Goals 1, 3)
21. Complete problems to determine paternity via blood group inheritance (Course Goals 2, 4)
22. Associate the presence of hemoglobin (blood) with peroxidase-like activity (Kastle-Meyer test) and the limitations of colorimetric tests that have cross-reactivity. (Course Goals 2, 4)