**PCC Math/Science Upward Bound Research Classes**

*Research Classes Goal: After completing the intermediate research class, high school students will be prepared to conduct research at Oak Crest under the direct supervision of a K-12 science teacher and under the mentorship of an Oak Crest research mentor.*

Plan: students in the program research track will take an introductory research class, followed by an intermediate research class, followed by a summer of research at Oak Crest

Students: rising sophomores and juniors in the PCC Math/Science Upward Bound program
Annual Class Time Commitment: 2-2.5 hrs/day, 4 days/wk, 5 wks total (40-50 hrs total)
Location: PCC classroom

Topics to Cover in the Introductory & Intermediate Research Classes:
1. reading, writing, and following lab procedures
2. scientific writing/vocabulary (e.g., summaries, conclusions, purpose of experiment, hypothesis, controls vs. variables, experimental design)
3. how to write in a lab notebook (table of contents, numbering pages, date, purpose of experiment, procedure, recording data, recording observations, conclusion of experiment, taking appropriate notes, recording appropriate results)
4. identify and use basic lab equipment and glassware (e.g., volumetric pipets, Erlenmeyer flasks, beakers, graduated cylinders, micropipets)
5. understanding dilutions and concentrations (e.g., preparing 1x from a 20x buffer, diluting 1:1, what is a 10% solution, molarity)
6. understanding algebraic concepts (e.g., solving for x, using equations such as $C_1V_1=C_2V_2$, $A=\varepsilon lc$, converting g/mL to molarity)
7. how to calculate averages and standard deviations; understanding how percentages work and how to calculate them
8. basic lab safety
9. knowing the metric system & metric measurements
10. unit conversions (e.g., converting μg to mg to kg)
11. basics of using Excel (entering data and calculating averages and standard deviations, making different kinds of bar graphs with error bars, plotting data and finding a best-fit curve and using the resulting equation for further calculations)
12. understanding and identifying what makes something a credible source of information in science
13. basics of DNA, RNA, proteins, enzymes, living things are made of cells
14. basics of chemistry (atoms, different kinds of bonds, chemical equations, reactants, products, balancing chemical reactions, stoichiometry, meaning of subscripts, concept of pH and acids and bases, concepts of solutions & 3 states of matter )
15. basic ideas behind chromatography and spectrophotometry
16. acting professionally (e.g., being reliable, dressing appropriately, proper email etiquette, etiquette with cell phones, texting)

**Pasadena City College**
**Math/Science Upward Bound**
**Summer 2013**
**Biology/Chemistry**
**Monday-Thursday, June 24-July 25, 2013**

**Instructor:** Lee Porter

**Contact Email:** Lee.a.p@dslextreme.com

## I. COURSE DESCRIPTION

This is a standards based course designed to review middle school chemistry concepts and introduce high school students to new concepts in chemistry. Coursework will include the scientific method, atomic and molecular structure, chemical bonding, stoichiometry, properties of acids and bases as well as basic laboratory equipment and procedures. At the end of the course we will examine the role of chemistry in the biochemical processes involved in biotechnology using the Bruce Wallace AMGEN Biotechnology kit.

## II. STUDENT PERFORMANCE OBJECTIVES:

1. Be respectful towards people and property.
2. Be prompt (on time) and *in your seat* when the bell rings.
3. Be prepared to learn by having your books and materials with you every day.
4. Be prepared by having your homework completed and ready to turn in at the beginning of each class.
5. During experiments, follow all laboratory safety rules and always follow the teacher's instructions.

## III. EVALUATION AND REQUIREMENTS:

1. **Attendance:** It is the student's responsibility to come to school regularly and participate to the *best* of their ability in class, every day. In the event that you will be arriving late or you are not able to attend a class, please email me ***and*** contact your study buddy to make sure you understand and do the assignments that are due next class. **There will be daily quizzes and weekly exams that cannot be made up If you are absent.**
2. It is the student's responsibility to turn in their work, completed and on time.
3. It is the student's responsibility to contact the instructor if they need to review a concept or an assignment. Please ask for assistance if you are struggling or need help: I want you to be successful.
4. **Laboratory Safety:** In order to ensure a safe and healthy environment for all students, it is imperative that all students follow laboratory safety rules and directions. *Students must pass a laboratory safety exam with **80% or higher** before they will be allowed to participate in laboratory experiments. This will be administered on the second day of class.*

**Grade Determination:** Points will be collected from multiple assignments, lab write ups, Cornell notes, class participation, quizzes and exams. There are **absolutely no extra credit** points in my class. Students who come to class, participate, do all of their work and turn it in on time will be able to pass this class. The grading scale is as follows:

| | | | | |
|---|---|---|---|---|
| 100 | – 90% | = | A | Excellence Overall; No Major Weaknesses |
| 89 | – 80% | = | B | Moderate Level of Understanding and Skills |
| 79 | – 70% | = | C | Greater than Minimum Level of Understanding and Skills |
| 69 | – 60% | = | D | Minimal Level of Understanding and Skills |
| 59 | – 0% | = | F | Far Below Minimum Level of Understanding and Skills |

**Gradable Content:**

| | |
|---|---|
| Exams & Quizzes | 50% |
| Labs | 25% |
| CW/HW | 25% |

## IV. ACADEMIC AND HONESTY CODE:

Do your own work. Cheating and plagiarism will be rewarded with a grade of zero for the assignment. Anyone participating or helping another person cheat will also receive the grade of zero for the assignment.

Consequences will be applied according to Pasadena City College Student Conduct and Academic Honesty policy.

## V. INSTRUCTIONAL MATERIALS:

**Textbook**: *Modern Chemistry*. Holt, Rinehart & Winston, 1999. (Provided by instructor)

**Supplies**: Students must bring the following materials to class everyday:

- Pencil
- Pen (blue/black)
- 3 ring binder with dividers
- Notebook paper
- Composition book (100 pages ruled)
- Ruler
- Safety glasses
- Scientific calculator

## VI. CLASS SCHEDULE AND SEQUENCE OF INSTRUCTION:

| Week | Day | TOPIC | RESOURCE Handout Book | PAGES | LABS/ACTIVITIES | Review New |
|---|---|---|---|---|---|---|
| 1 | 1 | Course Syllabus | H | | | |
| | | Lab safety | H | | | R |
| | | Basic lab equipment | H | | | R & N |
| | | Metric system | c.2-2 H | 33-38 | | R |
| | 2 | Lab Comp book | | | | |
| | | Calculations-Unit Conv, accuracy & precision, sig figs, rounding, Sci Not | c.2-2<br>c.2-3 H | 40-42,44-52 | | R |
| | 3 | Matter | c.1-2 | | Density | R |
| | | • Physical prop of matter, states of matter | c.1-2 | 10-12 | Observation lab | R |
| | | • Phase diagram | c.12 H | 381 | | R |
| | | • Chemical prop of matter, chem changes | c.1-2 | 12-13 | Misc chem rx | R |
| | 4 | Using the Periodic table | c.1-3 | | Prop of elements | R |
| | | • Families, periods | c.1-3 | 21-24 | | R |
| | | • Metals, non-metals, metalloids, noble gases | c.1-3 | 21-22 | | R |
| 2 | 1 | Atomic Theories | c.3-1 | 65-67 | Cons of Mass | R |
| | | Atomic structure-Proton, electron, neutron | c.3-2 | 70-74 | models | R |
| | | Atomic #,mass & Avogadro # | | | | N |
| | | • atomic #,atomic mass, atomic mass unit, avg atomic mass | c.3-3 H | 75-78 | | R |
| | | • Calc. avg atomic mass | c.3-3 H | 80 | | N |
| | | • mole | c.3-3 H | 81 | | N |
| | | • conversions | c.3-3 H | 81-85 | | N |
| | 2 | Periodic Table | | | | R |
| | | • Mendeleev & Mosley | c.5-1 | 123-125 | | R |
| | | • Families | c.5-2 | 132-138 | Flame tests | R |
| | | • Periodic properties | c.5-3 | 140-144,151 | React elements | R |
| | | Valence diagrams | c.5-3 H | 150 | | R |
| | 3 | Bonding | c.6-1 | | | R |
| | | • Ionic bonds | c.6-1,6-3 H | 161, 176-178 | | R |
| | | • Covalent bonds | c.6-1,6-2 H | 161-173 | | R |
| | | • Lewis dot structures | c.6-2 H | 170-2 | | R & N |
| | | • Metallic bonds | c.6-4 H | 181-182 | | R |
| | 4 | Chemical formulas | c.7 | | | R |
| | | • Subscripts & parenthesis | c.7-1 H | 203-4 | | R |
| | | • Ions & Polyatomic ions | c.7-1 H | 205, 210 | | N |
| | | Chemical names | c.7-1 H | 206—215 | | N |
| 3 | 1 | Calc formula mass | c.7-3 H | 221-222 | | N |
| | | Calc molar mass | c.7-3 H | 222-225 | | N |
| | | Calc % composition | c.7-3 H | 226-228 | | N |
| | 2 | Indicators of chemical rx | c.8-1 | 241-242 | Lab-survey of rx | R |
| | 3 | Chemical equations | c.8-1 H | 242-3 | | R |
| | | • Symbols | c.8-1 H | 244—50 | | R |
| | | • balancing | c.8-1 H | 250-254 | | R |
| | | • coefficients | c.8-1 H | 242,248,250,251 | | R |
| | 4 | Conc of solution, molarity | c.13-3 H | 412-415 | Serial dilution lab | N |
| | | Acids & bases | c. 15-1 | | | N |
| | | • Prop of acids, nomen. | c. 15-1 H | 454-5 | Household a/b | N |
| | | • Prop of bases | c. 15-1 | 457-8 | | N |
| | | • Strength | c. 15-1 | 460-1 | Using pH paper | N |
| 4 | 1 | pH | c.16 | | | N |
| | | • Ionization of water, calc $H^+$ & $OH^-$ | c.16-1 H | 481-4 | | N |
| | | • pH scale, calc pH | c.16-1 H | 485-491 | | N |
| | 2 | pH and titrations | c.16-2 H | | Using pH meter | N |
| | | • Indicators | c.16-2 | 493-5 | | N |
| | | • Titration | c.16-2 H | 497-501 | Graph pH chgs | N |
| | | • Calc $M_aV_a=M_bV_b$ | c.16-2 H | 502-503 | Titration lab | N |
| | 3,4 | AMGEN Labs | AMGEN | Lab 1, 2a | | N |
| 5 | 1-4 | AMGEN Labs | AMGEN | Lab 4a, 5, 6, 7 | | N |

Student/Parent Contract

Chemistry Ms. Porter

**Student Section:**

I have read, understand and agree to the rules and expectations stated in this document.

Student's Name (Print) Student's Signature Date

_____ _____ _____

**Parent Section:**

I have read, understand and agree to the rules and expectations stated in this document.

Parent/Guardian's Name (Print) Parent/Guardian's Signature Date

_____ _____ _____

Student must return this sheet, completed and signed, to the teacher by Tuesday, June 23, 2013.

**Upward Bound Math & Science, PCC**
**Summer Quarter 2013**
**Scientific Research Principles**

**Classroom: SV 29** **Instructor: Stephanie Bell**
**Class meets: Mon - Thurs 12:45 - 2:45pm** **Email: StephanieKBell@gmail.com**

**Course Outline**

| Week | Dates | Topics | Homework |
|---|---|---|---|
| 1 | June 24/27 | **Measurement and Experiment** | www.mathbench.umd.edu |
| 2 | July 1/3 | **Experiment Procedures** | www.mathbench.umd.edu |
| 3 | July 8/11 | **Biotechnology** | www.dnalc.org, www.mathbench.umd.edu, www.teachersdomain.org |
| 4 | July 15/18 | **Bioinformatics** | www.mathbench.umd.edu |
| 5 | July 22/25 | **Communications** | **Presentations** |

**Student Learning Outcomes**
Upon completion of this course, students will be able to:

a. To provide rich laboratory experiences that prepare you to do research at Oak Crest Research Institute
b. To practice scientific thinking skills
c. To practice laboratory and communication skills
d. To appreciate science and inquiry

**General Course Description**
This is a general course in scientific research. The main focus of this course is to learn basic laboratory skills, laboratory notebook upkeep, and to learn how to perform scientific research.

**Cell Phone Policy**
Cell phones will not be permitted in class. Please turn them off or on silent during class sessions. If you are caught texting you will be asked to leave the classroom for the remainder of the class session.

**Course Requirements**
Class participation in a discussion of each of the above topics is encouraged. Additional reading material will be assigned in the form of journal articles, and newspaper publications as deemed necessary (advance notice will be given). The final grade for the class will be based on the student's performance on laboratory notebooks, one writing assignment/term paper, homework, and a final presentation.

**Writing Assignment**
The writing assignment is as follows: discuss a scientific topic. References must be cited in an appropriate format (provided by instructor). Briefly describe the background of the case, the outcome, and discuss what forensic science techniques were used. Grading will be based on content, proper citations and grammar.

**Grading System**
The final grade for this course will be assessed based on combining the examination and assignment scores with the following scale:

| | | | |
|---|---|---|---|
| **A = 93-100%** | **B = 83-86%** | **C = 73-76%** | **D = 63-66%** |
| **A- = 90-92%** | **B- = 80-82%** | **C- = 70-72%** | **D- = 60-62%** |
| **B+ = 87-89%** | **C+ = 77-79%** | **D+ = 67-69%** | |

**Special Needs**
Please make an appointment with me as soon as possible, if you need course adaptations or accommodations due to a disability or have emergency medical information to share with me. Reasonable accommodation will be provided to any student with a disability who is registered with the Office of Students with Disabilities and requests needed accommodation.

**Academic Honesty**
At PCC, plagiarism is defined as the act of using ideas, words, or work of another person or persons as if they were one's own, without giving proper credit to the original sources. The following examples of plagiarism are intended to be representative, but not all-inclusive:
Failing to give credit via proper citations for other's ideas and concepts, data and information, statements and phrases, and/or interpretations and conclusions. Failing to use quotation marks when quoting directly from another, whether it be a paragraph, a sentence, or a part thereof. Paraphrasing the expressions of thought by others without appropriate quotation marks or attribution. Assembling parts from various works and submitting the synthesis or single paper as one's own creation. Representing another's artistic/scholarly works, such as musical compositions, computer programs, photographs, paintings, drawings, sculptures, or similar works as one's own.

# Intermediate Class: Rising Juniors

**Course Objectives:**
**This course was designed for rising juniors with one year of biology and one year of chemistry instruction. The goal of the course is to prepare students to conduct a research project in collaboration with mentors at Oak Crest Research Institute in the summer of 2014. The activities are selected to develop rigorous thinking and laboratory skills which students can apply in any research laboratory. Activities represent the skill set I observed students use in Summer Research Connection Oak Crest Institute 2013.**

**CONTENT focus is on developing experimental design skills:**
- **Experimental design (asking questions, making predictions, making observations, testable hypothesis, constant variables, experimental variable, control groups, experimental groups, data collection, data graphing, use of applicable formulas, drawing conclusions, making inferences, generating further questions)**
- **Keeping a laboratory notebook**
- **Making solutions**
- **Making valid comparisons**
- **Calculating reaction rates**
- **Practice using bioinformatics databases**
- **Practice lab safety**

**ACTIVITIES focus is on building laboratory skills:**
- **DNA Barcoding**
- **Laboratory safety**
- **Enzyme Activity**
- **Light Absorbance**
- **Serial dilution**
- **Gel electrophoresis**
- **Polymerase Chain Reaction**
- **Case Studies**
- **Measurement**
- **Graphing**
- **Data Analysis**
- **Spreadsheet**
- **Poster or PowerPoint presentation**

**ALL MATERIALS PRESENTED IN THE COURSE OUTLINE ARE PROVIDED IN ONE 3 RING BINDER AND WILL BE DELIVERED TO PCC UPWARD BOUND PROGRAM INTERIM DIRECTOR, PABLO CARREON, WHO WILL MAKE THEM AVAILABLE TO COURSE INSTRUCTOR, STEPHANIE BELL.**
**MATERIALS: WHERE'S EVERYTHING COMING FROM?**

## Items Interim Director Agreed to Purchase (Carolina Biological Supply)

1. *DNA Barcode Amplification and Electrophoresis Kit w CarolinaBlu Stain (with prepaid coupon) (Carolina item #RE-211386) $215.00*
2. *Guaiacol solution (Carolina item # 747903G) $9.50*

## Items to be Borrowed from BW Biotechnology Program / Amgen

*Materials Order Form submitted to Grace Montgomery June 19*

1. *Micropipetters 20P,200P,1000P*
2. *Tips*
3. *Gel Trays and Combs*
4. *Power Supply*
5. *Electrophoresis Chambers*
6. *Thermocycler*
7. *Water Bath*
8. *Dyes A,B,C,D for pipetting practice*

## Items to be Donated by D. Bravo

1. *Guaiacol solution – please return if not used. Loaning mine buys you time.*
2. *Lab notebooks x 8*
3. *pH indicator strips*
4. *Brine shrimp eggs with scoop, petri dishes*
5. *3 boxes toothpicks*

## Items to be provided/facilitated by Pasadena City College / Upward Bound

1. *Dissecting microscopes*
2. *Computer lab*
3. *Projector and projection screen*
4. *Spectrophotometer , cuvettes, instruction manual*
5. *Document Camera*
6. *pH Buffers 3,5,6,7,8,10*

Date: Monday June 24 Week 1 Measurement & Experiment

Objectives: Introduce course objectives
Introductions
Learn laboratory safety rules and lab housekeeping rules
Set up Lab Notebooks

Materials: Lab Notebooks for each student
Safety Rules handout
Safety Contract
Safety Quiz
Instructions for Setting Up Lab Notebook

Resources:

Activities:

1. Welcome and Introductions.

2. Icebreaker Activity. 20 mins

Students form pairs with someone new to them. They introduce themselves and share information about themselves, addressing the following:
Their favorite place
Their favorite activity
What they hope to get out of the Upward Bound program
Their name and high school
Each student then introduces his /her partner to the rest of the class.

3. The course objectives are
- To provide rich laboratory experiences that prepare you to do research at Oak Crest Research Institute.
- To practice scientific thinking skills
- To practice laboratory and communication skills
- To appreciate science and inquiry

4. Rules and Safety (Insert your rules here )
- Suggestions:
- Be responsible (complete your work, value your time)
- Behave professionally (no texting, goofing around)

- Laptop computer weeks 4 and 5
- Phone Camera and GPS are helpful
-

6. Laboratory Tour

Point out name and location of equipment, glassware, chemical storage.
Point out area to store books, backpacks. Keep aisles clear.
Discuss good housekeeping practices. Keep work areas clean and tidy.
Show the location and operating procedure of all safety equipment including the fist aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket.
Show where the fire alarm and the exits are located.
Demonstrate safe ventilation using fume hood.
Instruct on who to call in case of emergency.

7. Rules and Safety

- Go over General Rules on handout
- Rules and Safety Contract.
- Safety Test

8. Distribute composition books for student lab notebooks and the instructions for setting up the lab notebook. Set up Lab Notebook according to the instructions on handout *How To Set Up a Lab Notebook.*

9. On page 5, make a quick diagram of laboratory showing location of the fire blanket, the eye wash, the shower, the phone and the emergency number to call.

8. HOMEWORK: www.mathbench.umd.edu
Go to Measurement
Go to The Size of Things
Answer the questions and print

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Date: Tuesday June 25 Week 1 Measurement & Experiment

Objectives: Review How To Design an Experiment
Set up experiment: Effect of pH on Brine Shrimp Egg

Materials: Worksheet *How to Design an Experiment*
Brine shrimp eggs
petri dishes,
Three 500 ml solutions of pH 4, 7, 10
pH indicator strips
Overhead projector or document camera
Dissecting microscopes or hand lenses

Set Up: Solutions of pH 7, ph 4 and ph 10

Petri dishes, eggs, microscopes, pH indicator strips

**Resources:** Reading: 2 The Chemistry of Life (Review)

**Activities:**

1. Teach formal experimental design using the transparencies provided. Students follow along taking notes on their corresponding handout. This is the outline they will use to write pH/Brine Shrimp investigation into their lab notebook. 30 mins.

2. Lab Activity: *Effect of pH on brine shrimp egg survival.* Read lab hand out.

Follow Procedure, writing the experimental design in their lab notebook:

- Introduction, Question, Hypothesis
- Make qualitative and quantitative observations
- Make measurements of eggs, pH, volume
- Write a prediction and hypothesis
- Identify the experimental and control conditions (groups)
- Identify the independent and dependent variables
- Identify the constant variables

3. Set labeled petri dishes in an undisturbed location and clean up

4. Homework: www.mathbench.umd.edu
Go to Measurement
Go to Basic Lab Techniques
Answer questions and print

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**Date:** Wednesday June 26 Week 1 Measurement & Experiment

**Objectives:**
- Review How to Present Scientific Data and Numerical Data
- Review Metric Conversions, Scientific Notation, Significant Numbers
- Continue pH / Brine Shrimp Egg Investigation

**Materials:**
- Worksheet *How to Present Scientific Data*
- Handout *The Metric Scale*
- Worksheet *Metric Unit Conversions*
- Worksheet *Scientific Notation, Significant Figures*
- Dissecting microscopes

**Resources:**
- youtube video: powers of ten
- www.mathbench.umd.edu

**Activities:**

1.Teach How to Present Scientific and Numerical Data using the transparencies provided. Students follow along on their handout practicing graphing representational data. 30 min.

2. Observe brine shrimp eggs (they hatch on third day in solution). Write observations in lab notebook. Create a data table to use.

3. Review metric conversions and scientific notation with students. Practice working out problems . 3 Handouts: *"The Metric Scale", "Metric Unit Conversions", and "Scientific Notation, Significant Figures, Metric Conversions"*

4. Homework: www.mathbench.umd.edu
Go to Visualization
Go to A Graphing Primer
Answer questions and print

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**Date:** Thursday June 27 Week 1 Measurement & Experiment

**Objectives:**
- Complete Brine Shrimp Investigation
- Review Making Simple Dilutions

**Materials:**
- Dissecting Microscopes
- I ml pipettes, graduated cylinders, beakers, labeling tape

**Resources:**

**Set up:** Blue food coloring solution to use for practice dilutions.

**Activities:**

1. Complete *Effect of pH on Brine Shrimp investigation* (eggs should be hatched) Record a data table, a graph, inferences and conclusions, as well as further questions into lab notebook.

Note that students will have to decide on a method and a consistent criteria for counting surviving shrimp.

2. Review making simple dilutions, serial dilution and using C1 V 1 = C2 V2. Practice calculations using handout: *How to Make Simple Dilutions.* Use blue food coloring solution to practice using 1 ml pipettes & pumps. If time only permits one dilution, try the serial dilution.

3. HOMEWORK: www.mathbench.umd.edu
Go to Measurement
Go to Logs and pH
Answer and print

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| | |
|---|---|
| Date: | Monday, July 1 Week 2 Experiment Procedures |
| Objectives: | Simulate Enzyme Activity<br>Calculate Reaction Rate |
| Materials: | Handout *Investigating Enzyme Reaction Rates using Toothpickase*<br>Timers<br>3 boxes toothpicks<br>Calculators<br>A few turnips or radishes<br>Hydrogen peroxide |
| Resources: | Reading: 4 Cellular Energetics / Enzyme Kinetics (Review) |
| Set Up: | Recommended demo : liver catalase + hydrogen peroxide |

1. Introduce Enzymes and Their Function

The quickest way to introduce an ezyme is to demonstrate the action of the enzyme catalase found in animal tissues. Place a bit of fresh chicken or beef liver into a test tube or beaker containing some hydrogen peroxide. Wow!
The catalase (enzyme) converts the hydrogen peroxide (substrate) into water and oxygen gas (products). And releases noticeable heat. This demonstration supports tomorrow's lab which use the same reaction (but a different enzyme, peroxidase) to quantify the oxygen produced by the reaction.

2 Read the handout *Investigation Enzyme Reaction Rates Using Toothpickase*
Follow procedure for the Toothpickase Activity. Works well in pairs and can be finished in an hour.

3. As always, record investigation into lab notebook using the outline for an experiment.

4. Prepare for tomorrow's lab: *Investigation 13 Enzyme Activity*
There are Teacher and Student version of lab guide. Distribute now.
Gather the materials that will be needed: set up for 2 or 3 lab groups only.

5. Prepare: Read the Lab handout: *investigation 13 Enzyme Activity*. Follow instructions on Teacher page T218 for extracting peroxidase enzyme from the radishes or turnips . This is easy for students. Also follow instructions for diluting hydrogen peroxide. Students should calculate (C1V1=C2V2) and prepare.

4. Prepare: Read Teacher preparation closely. There are instructions for diluting the oxygen indicator guaiacol and the hydrogen peroxide and storing in refrigerator. At the end are instructions for setting up and using the spectrophotometer. Use of Spectrophotometer for light absorbance readings is recommended over making a peroxidase baseline assay or color chart. If you have time, the baseline assay requires a serial dilution and is good practice. Students need instruction on everything from pipetting to working in fume hoods and using spectrophotometer.

5. Homework:www.mathbench.edu
Go to Measurement
Go to Straight Lines/Standard Curves
Answer Questions Rate, Slope, Spectrophotometer, Calibration, Using Spectrophotometer

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**Date:** Tuesday July 2 Week 2 Experiment Procedures

**Objectives:** Develop Method for Measuring Peroxidase Action
Learn to use Spectrophotometer

**Materials**
*Investigation Enzyme Activity Teacher version*
*Investigation Enzyme Activity Student version*
Fresh turnips or radish: source of peroxidase
Hydrogen peroxide 3% soln
Spectrophotometer, Cuvettes
Test tubes (14 per group) and test tube racks
Guaiacol solution, an oxygen indicator
Vinyl gloves, safety goggles
1, 5, 10 ml Pipettes, pipette pumps
timers
pH Buffers 3, 5, 7, 9, 11 (or whatever range available, should be found in PCC chemical stockrooms

**Set Up:** Check fume hoods
Warm up spectrophotometer

1. Begin *Investigation; Enzyme Activity / Procedure 1*
   Set up next to fume hood and spectrophotomer. Students should know their roles and practice the sequence of steps before starting timed trials.
   Collect and graph data on timed reaction trials
   Calculate the slope and reaction rate
   Write analysis and conclusion
   Write the investigation (follow outline) into lab notebook

2. Continue to *Procedure 2: Determining Effect of pH on Enzyme Activity*
The same reaction is tested at different pHs. Set up Procedure 2 .

3. Students will need 20-30 mins to do Procedure 2 once it is set up. Do it if time permits. Otherwise, complete Procedure 2 tomorrow. As always, record investigation into lab notebook.

4. Homework: www. mathbench.umd.edu
Go to Cell Processes
   Go to Enzyme Kinetics (type Enzyme Kinetics into the search box if it doesn't appear).
      Answer the first two activities, print

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**Date:** Wednesday July 3 Week 2 Experiment Procedures

**Objectives:** Design and Conduct Your Own Investigation

**Materials** will vary: provide thermometers,
Concentrated enzyme,
Concentrated substrate

**Resources:** Teacher version Investigating Enzyme Action contains suggestions and shows graphs of expected results

**Set Up** Same as previous

**Activities:**

1. Complete *Procedure 2 : Determining Effect of pH on Enzyme Activity*

2. Begin last procedure: *Design and Conduct Your Own Investigation*

   suggestions: vary temperature, enzyme concentration, or substrate concentration.
   Decide on Question to Investigate
   Make a prediction and Hypothesis
   Write out a procedure

Show Question and Procedure to Instructor for approval

3. Proceed to follow the approved procedure. Write up investigations in lab notebook

4. Clean up.

5. No Class Tomorrow! Happy Independence Day!

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Date: Monday July 8 Week 3 Biotechnology

Objectives: Review function & importance of DNA
Collect, document and identify specimens
Introduce DNA used as a 'barcode" to identify species

Materials: Lab Guide: *Using DNA Barcodes to Identify Teacher version*
Lab Guide: *Using DNA Barcodes to Identify Student version*
See page 27
Digital camera or iphone camera

Resources: Lee Porter is excellent consultant. She has done this lab.
www.dnalc.org Dolan DNA Learning Center
Reading: 6 Molecular Genetics (DNA, PCR, Electrophoresis Review)

Set Up: See page 26 & 27 Lab Guide Instructor Pre-lab Preparation and Pre-lab Set Up

Activities

1. introduce DNA Barcoding with short videos DNA Barcoding 101 and DNA Barcoding Project NYC found on DNA Learning Center website www.dnalc.org

2. Read Student Lab Instructions p 5-7: Introduction (aloud) and Lab Flow I

3. Read Methods p 8- 9 . Follow *Protocol 1 Collecting, Documenting a Specimen.* Discuss a strategy to collect specimens (plant ? animal? both?) to barcode and the site of collection (campus? home? both?). It is helpful to collect specimens around a "theme" or "question", such as " Which native plant species can be found on the PCC campus?" . Once a strategy is decided, collect specimens.

5. Photograph specimen in its natural environment using smartphone. Collect tissue samples into Ziploc sandwich bag, a fresh new leaf for plants and/or fresh animal tissue size of a pencil eraser. Photo document students working through various stages of DNA Barcoding lab so that they can use the photos in their powerpoint presentation. This task could be assigned to a student shutterbug.

6. Take the GPS coordinates of latitude, longitude where specimens were collected using phone and record into lab notebook.

5. Begin new entry in lab notebook: DNA barcoding to identify plant or animal species. Write a brief introduction, and question you could answer using this method. Make a prediction, hypothesis, and write down today's protocol (procedure)

6. Homework: www.dnalc.org
DNA Learning Center.
View: DNA Barcoding 101 short video

www.mathbench.umd.edu
Do this: Measurement Basic Lab Techniques "Choose your weapon, Read your weapon, Can you read this pipette?, Review" . How to set/read micropipetters.

www.teachersdomain.org
Type "using a micropipette" into the search box. View 8 min video.

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**Date:** Tuesday, July 9 Week 3 Biotechnology

**Objectives:** Isolate DNA from collected plant or animal tissue

**Materials:** Lab Guide: *Using DNA Barcodes to Identify Teacher version*
Lab Guide: *Using DNA Barcodes to Identify Student version*
Handout *An Introduction to Volumetrics and Micropipetting*
See Materials list Lab Guide *Using DNA Barcodes* page 28.
Included in Carolina Kit RE211386

**Resources:** www.dnabarcoding101.org
Consult with Lee Porter. She is very helpful.

**Set Up:** See page 26-28 Lab Guide Instructor Pre-lab Preparation and Pre-lab Set Up for setting up instructions.

**Activities:**

1. Practice micropipetting skills. Follow procedures and excercises in handout An Introduction to Volumetrics and Micropipetting. 20 min.

2. Once students can micropipette, begin Lab *Using DNA Barcodes.* Follow *Protocol II. Isolate DNA from plant or animal tissue.* Try to photo document.

3. Write procedure into lab notebook the protocol for DNA isolation and describe the purpose of Isolating DNA.

4. Note to Instructor: READ through Lab Guide: *Using DNA Barcodes to Identify Teacher version* closely and carefully. The next two days (PCR and gel electrophoresis) require extensive preparation and on-the-spot problem solving and creativity.

Homework: www.dnalc.org

Go to Resources
Go to Biology Animation Library
Go to Polymerase Chain Reaction (two versions)

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**Date:** Wednesday July 10 Week 3 Biotechnology

**Objectives:** Amplification of isolated DNA by Polymerase Chain Reaction (PCR)

**Materials:** Lab Guide: *Using DNA Barcodes Teacher version*
Lab Guide: *Using DNA Barcodes Student version*
See materials list on pg 26 and pg 29 Lab Guide
Digital camera /phone camera

**Resources:** www.dnabarcoding101.org
Consult Lee Porter beforehand about PCR & Gels
www.dnalc.org video clip on PCR

**Set up:** See pages 26 and 28 -29 Lab Guide Instructor Pre-lap Preparation and Pre-lab Set Up

**Activities:**

1. Prepare DNA samples for amplification. Read and Follow *Protocol III Amplify DNA using PCR.* Try to photo document.
In brief, you will need to:
Prepare each student's DNA sample for the PCR reaction. Label tubes with an assigned number. Record their arrangement inside thermocycler.
Program thermocycler to run all the DNA samples together
Load all of student's the PCR reactions into the thermocycler
Run the thermocycler program that amplifies DNA

2. The program takes about 2 hours and its ok to eave DNA samples running as the thermocycler can be programmed to keep the samples cold overnite at 4 degrees C

3. Students write in their lab notebook the protocol and describe the purpose of amplifying DNA using PCR.

4. Prepare 2 or 3 gels for electrophoresis. Store in Ziploc bags, refrigerate. Students can help mix and pour gels into trays.

5.. Homework: www.dnalc.org
Go to Resources
Go to Biology Animation Library
Go to Gel Electrophoresis

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| | | |
|---|---|---|
| Date: | Thursday June 11 | Week 3 Biotechnology |
| Objectives: | Visualize the results of PCR using Gel Electrophoresis | |
| Materials: | Lab Guide:Using DNA Barcodes Teacher version<br>Lab Guide: Using DNA Barcodes Student version<br>See page 26 and pages 30-32 Lab Guide for all materials needed.<br>Digital or phone camera. Try to photo document | |
| Resources: | www.genewiz.com sequencing services | |
| Set Up: | Lab Guide: See pages 30 -32 for Instructor Pre-lab Preparation and Pre-lab Set Up<br>Lots to prepare on gel electrophoresis day | |

Activities:

1. Follow *Protocol Analyze PCR Products By Gel Electrophoresis*
Prepare 5 microliter of PCR results to load and run on gels as directed.
In brief students will:
Use 5 microliters of their 25 microliters of DNA to run on the gel. Gel shows if PCR reactions worked, in other words, do they have a good amount of DNA. All plant samples should show the same size of amplified DNA and all animal samples should be the same size. Examine the sample gel photo for how the samples should be loaded into the gel. After the electrophoresis, the gels must be stained for some time and then destained for more time. Its only then that they can be illuminated (Carolina stain may require a white light transilluminator)
(Amgen can provide ethidium bromide for staining and a UV light illuminator) Illuminate and photograph the gels.

4. Print one photograph of the gels per student, one for teacher, one for GeneWiz . Label the samples in the gel photograph. See sample page 14.

5.Write the protocol into lab notebook Describe the purpose of visualizing DNA by gel electrophoresis.

6. Use the remaining 20 mcroliter of PCR product (amplified DNA called the amplicon) for sequencing by Genewiz. Each students can be assigned a number to label their two PCR tubes like this "1F" and "1R", for Forward and Reverse sequence. Each PCR tube should contain 10 microliters of their amplified DNA. Follow the Lab Guide instructions pages 33 -35.

7. Go to www.GENEWIZ.com to register and place a sequencing order. The Kit comes with prepaid coupon that pays for sequencing samples. Print a copy of the order form to mail with samples.

8. SHIP SAMPLES (two per student Forward and Reverse sequences) and a copy of the ORDER FORM, A PHOTOGRAPH OF THE LABELED GEL AND THE COUPON.

9. Try to ship Thursday or Friday so sequence can be available Monday. Use FedEx, or local drop box (where? free?) . They can be reached at 1-877-436-3949

10. The day of loading, running, staining, photographing gels is always long and a little crazy. Sorry. It gets better in the coming days.

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**Date:** Monday July 15 Week 4 Bioinformatics

**Objective:** Use National Center Biotechnology Information to integrate lab experience with online bioinformatics resources
Nucleotide sequence comparisons

**Materials:** Lab Guide: *Using DNA Barcodes Teacher version*
Lab Guide: *Using DNA Barcodes Student version*
DNA sequence of sample submitted to GeneWiz
Computer with internet

**Resources:** www.ncbi.nlm.nih.gov

**Set Up:** Computer lab

**Activities**

1. Follow Lab Guide: *DNA Barcodes Protocol Bioinformatics pages 16 -18.* Students should be given the nucleotide sequence of their specimen DNA. This will be sent to the email the instructor provided when filling out the sequencing order form at www.genewiz.com

2. Check instructor email. GeneWiz sends the sequences you requested to your (instructor) email.

3. Get onto computers and log on to www.ncbi.nlm.nih.org. Go to BLAST. Select nucleotide BLAST. Follow instructions to upload the sequence GeneWiz sent. Continue to follow BLAST procedure. Save and print BLAST results for lab notebook and powerpoint presentation.

4. Write the protocol in your lab notebook and describe the nucleotide Basic Local Alignment Search Tool and describe the purpose of doing a nucleotide BLAST with your plant or animal DNA.

5. Homework: www.mathbench.umd.edu
Go to Probability and Statistics
Go to BLAST and (Im)probability

Answer Questions
Print

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**Date:** Tuesday July 16 Week 4 Bioinformatics

**Objectives:** Use DNA Subway to integrate lab experience with online bioinformatics resources
Identify plant or animal species
Identify family tree (phylogenetic) relationships

**Materials:** Lab Guide: *Using DNA Barcodes Teacher version*
Lab Guide: *Using DNA Barcodes Student version*
Computer, internet

**Resources:** www.dnasubway.org
www.youtube.com DNA Subway Overview &Tutorial
http://dnasubway.iplantcollaborative.org

**Set Up:** Computer Lab

**Activities:**

1. Follow Protocol Identify Species an Phylogenetic Relationships Using DNA Subway in Lab Guide pages 18 – 24

2. Create a DNA Subway Project and Upload DNA Sequence,
View and Build Sequences
Pair Forward and Reverse Reads
BLAST Your Sequence
Add Sequences to Your Analysis
Analyze Sequences: Select and Align
Analyze Sequences: Create a Phylogenetic (Family) Tree

3. Take it as far as you can. Save and Print results for lab notebook and for powerpoint presentation.

2. Write in lab notebook your procedure and describe the purpose of Subway BLAST.

**Date:** Wednesday July 17 Week 4 Bioinformatics

**Objectives:** Complete BLASTS, Identify Species
Complete Homeworks

**Materials:** Lab Guide: *Using DNA Barcodes Teacher version*
Lab Guide: *Using DNA Barcodes Student version*
Computer, internet

**Resources:** NYC Barcode Project at www.dnalc.org

**Set Up:** Computer Lab

**Activities:**

1. Today can be a "catch up" day if DNA sequences arrived later rather than sooner.

2. Students record the results of their nucleotide BLAST and their DNA Subway BLAST in their notebook Do they concur? Have they identified their specimen by species or genus? Have they answered their Question? They can paste the BLAST results that they printed out into their lab notebooks and write their inferences and conclusions and further questions.

3. Show the video of the NYC students conducting a DNA Barcoding project. Discuss what is interesting about the project and the students. Was this a good story? What made this a good story? Try to capture the essence of telling a compelling story in their presentation.

4. Get into groups that will each create a powerpoint presentation of the DNA Barcode Investigation conducted in class. The group will design a slideshow presentation telling the story of its own DNA Barcode Investigation. Begin discussion and decide what they need to do and how they are going to do it. Consider distributing the powerpoint handouts at this time.

4. Instructor can check and score lab notebooks while students work.

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**Date:** Thursday July 18 Week 4 Data Analysis

**Objective:** Creating excel spreadsheets
Graphing, creating a standard curve
Graphing, calculating mean and standard deviation

**Materials:** Handout *Tutorial #1Creating spreadsheet, graphing, creating standard curve*
Handout *Tutorial #2 Graphing, calculating mean and standard deviation*
Handout *Tutorial #3 Graphing with standard error bars.*
Computer, internet

**Resources:** Microsoft excel 2007 - 2010

**Set Up:** Computer lab

**Activities:**
1. Using Tutorials #1, #2, #3 as a guide, students will create an excel spreadsheet, graph a standard curve and calculate the mean and standard deviation. Print.

2. Students apply spreadsheet skills to collect class data from DNA Barcode Investigation into an Excel Spreadsheet that will be used in their powerpoint presentation.
   - Review the data collected during the DNA Barcode investigation.
   - Discuss what data is important (plant, animal, genus, species, primers, etc)
   - Discuss how to organize important data into a data table / spreadsheet.
   - Class is in consensus about what data and how to best present it.
   - Class create one excel spreadsheet for compiling the entire class data set.
   - Individual students type their own data directly into spreadsheet.
   - Save the class spreadsheet for use in powerpoint presentation next week.
   - They will collect class data from DNA Barcode into an Excel Spreadsheet that all students createAfter designing a data table, use it to

5. Homework: www.mathbench.umd.edu
Go to Probability and Statistics
   - Go to Bar Graphs and Standard Errors
     - Answer questions / use as reference

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**Date:** Monday July 22 Week 5 Communication & Presentation

**Objectives:** Design a powerpoint presentation of the DNA Barcode Investigation (Microsoft)

**Materials:** Handout *How To Make a Basic Powerpoint Presentation*
Handout *How To Make an Effective PPT Presentation*
Handout *How To Give a Good Presentation*
Computers, Internet

**Resources:** www.office.microsoft.com/powerpoint/create
http://llc.mtsac.edu/handouts/powerpoint.pdf

**Set Up:** Computer Lab

**Activities:**

1. Review and discuss the handouts provided:
   How to Make an Effective Powerpoint Presentation
   How to Make a Basic PowerPoint Presentation (MS 2010)

3. In groups, begin to outline a series of nine to twelve slides that tell the story of their DNA Barcode project . Limit yourself to the most important points and follow the suggestions provided. Divide up the work of creating slides so each student has 2-4 slides to create.

4. Homework: Work on slideshow slides

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**Date:** Tuesday July 23 Week 5 Communication & Presentation

**Objectives:** Learn How to Give a Good Presentation

**Materials:** Handout *How To Give A Good Presentation*
Handout *Attitude and Body Language*

**Resources:**

**Set Up:** Computer Lab

**Activities:**

1. Read and discuss the handouts *How to Give a Good Presentation* and *Attitude and Body Language*

2 Assemble slides in logical sequence and run through the slideshow repeatedly making improvements to the slides.

3. Write and practice script for the slideshow presentation

3. Homework: Complete slideshow slides

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**Date:** Wednesday July 25 Week 5 Communication & Presentation

**Objectives:** Practice Making and Presenting a Powerpoint Presentation

**Materials:** Laptop Computer, Projector

**Resources:**

**Set Up:** Laptop Computer, Projector

**Activities:**

1. First half of class, continue to assemble and improve slideshow presentation.

2. Use second half of class for practice presenting their presentation. Give students feedback on script, slides, body language.

3. Homework: Practice, Practice.

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**Date:** Thursday July 26 Week 5 Presentation

**Objectives:** Present DNA Barcode Project Presentation

**Materials:** Laptop Computer, Projector

**Resources:**

**Set Up:** Laptop Computer, Projector

**Activities:**

1. Each group gives their presentation

2. Refreshments are served

3. Final closing acknowledgments and reminders.

4. Enjoy the rest of the summer!

MSUB Summer Institute at OakCrest

Goal: The overall goal is to get students interested in science and research as well as give them a snap shot of what it is to work in this field and evaluate themselves to meet the requirements. They will learn what laboratory research is and do it.

Duration: 5 weeks, Monday through Thursday 11:30 - 2:30 (~ 3 hrs), total of 60 hrs

Week 1: Orientation, Laboratory rules, Safety, Unit conversions, Serial dilutions (math)

Week 2 and 3

**Basic lab skills:**

- Time management in lab
- Taking lab notes
- Micro pipetting with accuracy
- Excel
- Data analysis (scatter plot data with best fit line and $R^2$ value to check accuracy)
- Using analytical balance
- Using Biological hoods

**Learning routine skills:**

- Prepare serial dilutions
- Using a Spectrophotometer and making sense of the results
- DNA methods
- PCR
- gel electrophoresis
- SDS gels
- bacterial fermentation
- experimental design

**Final 2 weeks**: Based on the progress and strength of the group, the group will be encouraged to design their own experiment using the skills learned, either to test a hypothesis or evaluate and analyze an experimental procedure. Final assignment will be a presentation of the experiment that was designed and conducted with the analysis of the data and experimental procedure.

**Pasadena City College**
**Math/Science Upward Bound, Summer 2015**

**Research Methods at Oak Crest Institute of Science**
**Monday-Thursday, June 22-July 23, 2015**

**Instructor:** Lee Porter

**Contact Email:** Lee.porter@emuhsd.org

## I. COURSE DESCRIPTION

This is a course designed to introduce students to research methods in science and give students an opportunity to work in a research laboratory with research scientists. Coursework will include laboratory safety, the scientific method and experimentation (excel, experimental design, data analysis, lab notes, time management), basic laboratory skills (pipetting, using electronic balances, using biological hoods/sterile technique, using a spectrophotometer), work with DNA and proteins, and perform bacterial fermentation.

## II. STUDENT PERFORMANCE OBJECTIVES:

1. Be respectful towards people and property.
2. Be prompt (on time) and *in your seat* when the bell rings.
3. Be prepared to learn by having your books and materials with you every day.
4. Be prepared by having your homework completed and ready to turn in at the beginning of each class.
5. While at Oak Crest Institute, follow all laboratory safety rules and regulations and always follow the teacher's instructions as well as the instructions given by Oak Crest scientists.

## III. EVALUATION AND REQUIREMENTS:

1. **Attendance:** It is the student's responsibility to come to school regularly and participate to the *best* of their ability in class, every day. In the event that you will be arriving late or you are not able to attend a class, please email me ***and*** contact your study buddy to make sure you understand and do the assignments that are due next class. **There will be quizzes and weekly exams that cannot be made up if you are absent.**
2. It is the student's responsibility to turn in their work, completed and on time.
3. It is the student's responsibility to contact the instructor if they need to review a concept or an assignment. Please ask for assistance if you are struggling or need help: I want you to be successful.
4. **Laboratory Safety:** In order to ensure a safe and healthy environment for all students, it is imperative that all students follow laboratory safety rules and directions as well as the regulations at Oak Crest Institute of Science.

**Grade Determination:**

Points will be collected from multiple assignments including laboratory practice and performance, laboratory note book entries, quizzes, exams and a final presentation. There will weekly quizzes and one weekly exam. There are **absolutely no extra credit** points in this class. Students who come to class, participate, do all of their work and turn it in on time will be able to pass this class.

**Grading Scale:**

The grading scale is as follows:

| | | | | |
|---|---|---|---|---|
| 100 – 90% | = | A | Excellence Overall; No Major Weaknesses |
| 89 – 80% | = | B | Moderate Level of Understanding and Skills |
| 79 – 70% | = | C | Greater than Minimum Level of Understanding and Skills |
| 69 – 60% | = | D | Minimal Level of Understanding and Skills |
| 59 – 0% | = | F | Far Below Minimum Level of Understanding and Skills |

**Gradable Content:**

| | |
|---|---|
| Exams & Quizzes | 25% |
| Lab | 25% |
| CW/HW | 25% |
| Research Project | 25% |

## IV. ACADEMIC AND HONESTY CODE:

Do your own work. Cheating and plagiarism will be rewarded with a grade of zero for the assignment. Anyone participating or helping another person cheat will also receive the grade of zero for the assignment.

Consequences will be applied according to Pasadena City College Student Conduct and Academic Honesty policy.

## V. INSTRUCTIONAL MATERIALS:

**Textbook**: Excerpts from: *Biotechnology: Science for the New Millennium*. Paradigm Publishing Inc. 2012. (Copies provided by instructor)

**Laboratory Manual**: Excerpts from: *Biotechnology: Laboratory Manual*. Paradigm Publishing Inc. 2012. (Copies provided by instructor)

**Supplies**: Students must bring the following materials to class everyday:

- Pencil
- Pen (blue/black)
- 3 ring binder with dividers
- notebook paper
- Scientific calculator
- Composition book (100 pages ruled)

## VI. CLASS SCHEDULE AND SEQUENCE OF INSTRUCTION:

| Week | TOPIC |
|---|---|
| 1 | Course Syllabus & Orientation |
| | Basic Information: |
| | Metric system |
| | Lab Comp book |
| | Calculations-Unit Conv, accuracy & precision, sig figs, rounding, Sci Not |
| 2 | Basic laboratory skills: |
| | Using a pipet, Using a balance, Micro pipetting |
| | training for additional laboratory equipment |
| 3 | Routine Skills: |
| | Spectrophotometer, DNA methods, PCR, gel electrophoresis |
| | Protein methods, SDS gels |
| 4 | Additional Skills: |
| | bacterial fermentation, excel |
| | experimental design, data analysis, lab notes, time management |
| 5, 6 | Based on the progress and strength of the group, using the skills learned, the students will be encouraged to design their own experiment, either to test a hypothesis or evaluate and analyze a experimental procedure |