Academy for Allied Health and Sciences

at Plainfield High School

Plainfield High School
in partnership with
JFK-Muhlenberg-Snyder Schools
Union County College
Lincoln Technical Institute
Rutgers University

MEDICAL MATHEMATICS CURRICULUM

University of Medicine and Dentistry of New Jersey
(IDST-1400)

Table of Contents

Course Philosophy

Medical Math

This course will provide a review of basic mathematical calculations and will instruct the learner on how to convert equivalents from one system to another and accurately mix and measure drugs. Emphasis will be places on how these techniques are used in the administration of medications for patient use. The course will provide students the opportunity to develop understandings and a command of mathematics in an environment that provides both affective and intellectual growth.

This goal will be accomplished in conjunction with the NJ Core Curriculum Content Standards and the standards set forth by the Howard Hughes Medical Institute in Conjunction with the Association of American Medical Colleges Scientific Foundations for Future Physicians to provide opportunities and learning experiences that will encourage all students to:

- learn to value mathematics
- become confident in the ability to do mathematics
- become mathematical problem solvers
- learn to communicate mathematically

Our aim can be achieved by placing an emphasis on developing students' problem solving and reasoning abilities by giving the students concrete examples through the use of manipulatives, by encouraging the use of calculators and computers in appropriate situations, and by incorporating cooperative learning into our teaching strategies. The use of real-life problems will be incorporated to provide the important link of mathematics to everyday situations. Integration of mathematical topics with other subjects will encourage students to relate information and increase the retention of the material learned.

The overarching goal of this curriculum is "to provide greater flexibility in the premedical curriculum that would permit undergraduate institutions to develop more interdisciplinary and integrative science courses, as recommended in the BIO 2010 report. By focusing on scientific competencies rather than courses, undergraduate institutions will have more freedom to develop novel courses to achieve the desired competencies without increasing the total number of instructional hours in the sciences in the face of continuing increases in medically relevant scientific knowledge. Achieving economies of time spent on science instruction would be facilitated by breaking down barriers among departments and fostering interdisciplinary approaches to science education. Indeed, the need for increased scientific rigor and its relevance to human biology is most likely to be met by more interdisciplinary courses.

Competencies may be achieved in different ways by a variety of courses or educational experiences. This should release the student from specific course requirements, but it will require each institution to identify the instructional means by which the necessary competencies can be gained. The committee recognizes that some colleges and universities

have already implemented many of the report's recommendations and other institutions are beginning to develop a competency-based approach to learning as well as an integrated curriculum.

The focus on competencies, rather than courses, for admission to medical school will require a new approach to assessment, uncoupling specified prerequisite courses from the desired outcomes of premedical education. Further, assessment of the newly defined scientific competencies must be credibly and reliably accomplished by the Medical College Admission Test (MCAT®) exam." (AAMC-HHMI)

"The desired outcome of the medical education process should be scientifically inquisitive and compassionate physicians who have the motivation, tools, and knowledge to find the necessary information to provide the best and most scientifically sound care for their patients. As such, the medical school curriculum should be integrated across disciplines and repeatedly emphasize the importance and relevance of the sciences basic to medicine." (AAMC-HHMI)

***Refer to Appendix B for description of learning styles that are addressed in the activities listed in the curriculum (e.g., AR, AS, CR, CS).*

Course Goals

1. Communicate mathematically through written, oral, symbolic, and visual forms of expression

2. Understand the interrelationships of mathematical ideas and the roles that mathematics plays in other disciplines and in life

3. Use calculators, computers, manipulatives, and other mathematical tools to enhance mathematical thinking and understanding

4. Develop the ability to pose and solve mathematical problems in mathematics, other disciplines, and everyday experiences

5. Develop reasoning ability and become self-reliant, independent mathematical thinkers

6. Demonstrate high levels of mathematical thought through experiences, which extend beyond traditional computation, algebra, and geometry and out to allied health sciences

7. Develop an understanding of patterns, relationships, and functions and use them to represent and explain real world phenomena

AAMC-HHMI Overarching Principles:

1. The practice of medicine requires grounding in scientific principles and knowledge, as well as understanding how current medical knowledge is scientifically justified, and how that knowledge evolves.

2. The principles that underlie biological complexity, genetic diversity, interactions of systems within the body, human development, and influence of the environment guide our understanding of human health, and the diagnosis and treatment of human disease.

3. Curiosity, skepticism, objectivity, and the use of scientific reasoning are fundamental to the practice of medicine. These attributes should permeate the entire medical education continuum.

4. Modern medicine requires the ability to synthesize information and collaborate across disciplines.

5. Effective clinical problem solving and the ability to evaluate competing claims in the medical literature and by those in medical industries depend on the acquisition, understanding, and application of scientific knowledge and scientific reasoning based on evidence.

6. It is essential not only to read the medical and scientific literature of one's discipline, but to examine it critically to achieve lifelong learning. These activities require knowledge and skills in critical analysis, statistical inference, and experimental design.

7. Medical professionals should demonstrate strong ethical principles and be able to recognize and manage potential conflicts of interest.

8. Application of scientific knowledge in medicine requires attention both to the patient as an individual and in a social context.

9. The effective practice of medicine recognizes that the biology of individual patients is complex and variable and is influenced by genetic, social, and environmental factors.

10. Decision making in medical practice involves uncertainties and risks.

11. Scientific matters can and should be communicated clearly to patients and the public, taking into account the level of scientific literacy of these audiences and understanding the intellectual and emotional responses to medical diagnoses and therapies.

12. Specific communication skills that students should master and apply to the fields of medicine and scientific inquiry include the ability to:

- write logically and with clarity and style about important questions across disciplines;
- articulate persuasively, both orally and in writing, focused, sophisticated, and credible thesis arguments;
- be able to use the methodologies that particular disciplines apply for understanding and communicating results effectively;
- approach evidence with probity and intellectual independence; and
- use source material appropriately with scrupulous and rigorous attribution.

Outline of Content Areas

1. Career Paths and Medical Math Essentials
2. Algebra
3. Measurement Systems and Conversion Procedures
4. Dilutions, Solutions, and Concentrations
5. Drug Dosages and Intravenous Calculations
6. Linear Equations, Graphing, and Variation
7. Exponential and Logarithmic Functions
8. Geometry
9. Charts, Tables, and Graphs
10. Introductory Biostatistics
11. Trigonometry
12. Appendix A. Problem-based Learning: Medical Math Applications in Clinical Case Studies

I. Why Study Medical Math: Professional Purpose and Career Applications (why medical math is not on UMDNJ test, but the math basics are)

A. Objectives: The student will be able to

1. Define each of the health care professions which require a unique set of measurement/calculation standards, and explain/identify the importance of each measurement system (apothecary; metric, household system ;…) (9.4.12.H.2, 3, and 4)
2. Explain the necessity of obtaining accurate measurements in the health care professions (9.4.12.H.2,3, and 4)
3. Perform basic unit conversions from one measurement system to another.
4. Provided a unique unit of measurement classify the specific system which that unit belongs to and explain its similarity, or differences, to units in other measurement systems. (F-IF.1-2)
5. Discuss the professional partnerships amongst pharmacists, pharmacologists, medicinal chemists, pharmacy technicians, clinical laboratory technicians, and microbiologists. (9.4.12.H.3-4)
6. Provide solutions to a clinical scenario (case study presentation) with respect to applications of one of the health care systems of measurement (i.e.-apothecary; household; metric). (9.4.12.H.3-4)
7. Report on the professional qualifications and mathematical skills required of one of the health care professionals studied in the introductory unit.
8. Present a current event which is related to an aspect of the professional duties of one of the healthcare professionals introduced in this unit.
9. Add, subtract, multiply, and divide integers
10. Understand division involving zero
11. Add, subtract, multiply, and divide fraction
12. Work with unit rates
13. Convert between improper fractions and mixed numbers
14. Add, subtract, multiply, and divide mixed numbers and improper fractions
15. Simplify complex fractions
16. Evaluate expressions using the order of operations
17. Add, subtract, multiply, divide, and round by decimals
18. Write fractions as decimals
19. Convert fractions and mixed numbers to percents
20. Convert between decimals, fractions, and percents
21. Evaluate expressions that contain percents
22. Read Roman numerals
23. Determine the numerical value of Roman numerals

B. Activities:

1. Students will be offered a list of project themes related to the application of the systems of measurement to a particular task performed by a health care professional. Presentation will be structured and delivered to the class audience according to the instructor's project rubric. (CS, CR, AS, AR)
2. Students will design a debate discussion which compares and contrasts the similarities and unique characteristics of each of the medical measurement systems. Students will be given clinical thought questions (patient care scenarios) prior to the debate in order to organize their arguments. Students will be evaluated both on their interpretation of which measurement system best addresses a patient's health care needs and how that measurement system would provide medical results. Instructor will provide rubric for organization and presentation. (CS, CR, AS)
3. Instructor will assign a few students each unit to report on their understanding of the clinical case scenario presented each unit (objective number 6 above).
4. Instructor will prepare questions for the group prior to their class discussion as a guide for the group's presentation. Discussion may be opened to the class after the initial review and explanation of the case by the selected student panel. Panel will rotate to different students each unit. May be used as a starter activity or closing activity. (CS, CR, AS)
5. Mathematical Skill Lab Activity (Unit 1). Students will be asked to convert units for a given dosage of a medication, and with the resulting amount make a conversion to at least 2 other units in a third system of measurement. Thought questions provided by the instructor will guide the student in selecting the most appropriate system for measurement and the correct respective units. (CS, CR, AS)
6. Interdisciplinary Activity: Students will be challenged to select two different body systems which they have learned in previous biology and anatomy/physiology coursework. From each system they will select two important organs and provide the names of 2-3 classes of medication used to treat illnesses of that organ and explain what would be the best units and system of measurement to properly administer medication to the organ site.
   (CS, CR, AS)

C. Evaluation:

1. Assigned reading
2. Health care journal abstracts (reporting and explanation)
3. Unit exam
4. Unit quizzes

5. Conversion/calculation skills lab 6.
   Unit I project
7. Discussion/feedback from the clinical case problem
8. Discussion/feedback from the unit 1 interdisciplinary activity

D. Resources:

1. *Mathematics for Health Science: A Comprehensive Approach* by Joel R. Helms, published by Delmar Cengage, copyright 2010
2. Related health care journal abstracts (i.e.- journal ***Pharmacy, Medicinal Chemistry)***
3. Algebra/Chemistry reference textbooks (as per instructor)
4. Handouts/Review Guides
5. Instructor's portfolio of clinical math skills problem based case studies
6. Instructor's portfolio of mathematical reference tables/equations

II. Algebra (Sig Figs not on test)

A. Objectives: The student will be able to:

1. Understand reciprocals (A-CED, A-REI)
2. Combine like terms (A-CED, A-REI)
3. Solve simple linear equations and check the solution (A-CED, A-REI)
4. Understand the commutative, associative, and distributive properties (A-CED, A-REI)
5. Solve mixture problems (A-CED, A-REI)
6. Solve rational equations and check the solution (A-CED, A-REI)
7. Solve formulas for a given variable (A-CED, A-REI)
8. Evaluate formulas given variable values (A-CED, A-REI)
9. Solve simultaneous equations (A-CED, A-REI)
10. Solve problems using ratios and proportions (N-RN)
11. Solve percent problems by translating into an equation (N-RN)
12. Solve percent problems using proportions (N-RN)
13. Know and work with the following rules for exponents: (N-RN)
    I. product rule
    II. quotient rule
    III. power rule
    IV. power rule for fractions
    V. negative exponent rule
14. Understand that the exponent rules do not apply when adding (N-RN)
15. Understand that the rules for exponents apply only when the bases are the same (N-RN)

16. Convert standard numbers into scientific notation
17. Convert numbers in scientific notation into standard notation
18. Simplify expressions given in scientific notation
19. Determine how many significant digits are in a given number
20. Understand precision and accuracy, particularly when adding and multiplying
21. Use the scientific calculator to evaluate expressions

B. Activities:

1. Teacher lecture, demonstrations, modeling and discussions based on topics in Algebra and supplemental materials. (CS)
2. Students will work in pairs to analyze characteristics of teacher-supplied scenarios where they will write equations for perimeter, area, and volume for simple 2D and 3D geometrical shapes. (CR)
3. Students will graph equations in coordinate systems and use graphic calculators to verify. (CS)
4. Students will work to explore graphs of power functions on Excel and write conclusions about graphs of functions with even or odd powers. (AS)
5. Students will work in pairs to construct linear models from real-life situations. (CS)
6. Students will watch the movie Power of Tens and explore very large and very small dimensions in the universe. This can be found using google (AR)
7. Interdisciplinary Activity: Students will explore how rates (in connection with ratio and proportion) help in solving real-life problems, such as finance, science, and sports. (CS, CR, AS, AR)

C. Evaluation

1. Assigned readings.
2. Unit exam
3. Unit quizzes
4. Unit II projects
5. Discussion/feedback from clinical case problem.
6. Discussion/feedback from Unit II interdisciplinary activity.

D. Resources

1. *Mathematics for Health Science: A Comprehensive* Approach by Joel R. Helms, published by Delmar Cengage, copyright 2010
2. Related health care articles and websites.

3. DVD *Power of Tens* or online at www.powersof10.com
4. TI-84 graphing calculators
5. Computers and algebraic software

III. Measurement Systems and Conversion Procedures (highly featured in UMDNJ test)

A. Objectives: The student will be able to:

1. Simplify and interpret units using dimensional analysis
2. Perform conversions within the metric system using the horizontal format
3. Perform conversions within the metric system using dimensional analysis
4. Convert between metric and non-metric systems using dimensional analysis.
5. Convert between metric and non-metric systems using proportions (when appropriate).
6. Become familiar with the apothecary and household systems. (9.4.12.H.1-4)
7. Perform conversions within and between the apothecary and household systems. (9.4.12.H.1-4)
8. Perform temperature conversions between Celsius and Fahrenheit. (A-CED, A-REI)
9. Perform temperature conversions between Celsius, Fahrenheit, and Kelvin. (A-CED, A-REI)

B. Activities:

1. Teacher lecture, demonstrations, modeling and discussions based on different measuring apparatus. (CS)
2. Students will work in pairs to measure length, mass, and volume for typical items in metric and non-metric units. (CS)
3. Students will perform unit conversion among the metric units and between metric and non-metric units. (CS)
4. Students will perform unit conversion among Celsius, Fahrenheit, and Kelvin temperature systems. (CS)
5. Interdisciplinary Activity: Students will convert among metric and non-metric, apothecary, and household systems, typically used in the health industry. (AR, AS, CR, CS) (ACSM - American college of sports medicine). Convert between units that are the same amount of energy.
6. Students will estimate various containers for volumes in standard, metric, and apothecary and then find the actual volume in metric. Students will then convert from metric to standard to apothecary. (AR, AS, CR, CS)

C. Evaluation

1. Assigned readings.
2. Unit exam
3. Unit quizzes
4. Unit III projects
5. Discussion/feedback from clinical case problem.
6. Discussion/feedback from Unit III interdisciplinary activity.
7. Presentation of problems using document projector/whiteboard

D. Resources

1. *Mathematics for Health Science: A Comprehensive* Approach by Joel R. Helms, published by Delmar Cengage, copyright 2010 2.

Related health care articles and websites.

3. TI-84 graphing calculators
4. Rulers, measuring tapes, beakers, graduated cylinders, scale, triple-beam balance

IV. Dilutions, Solutions, and Concentrations (on UMDNJ test)

A. Objectives: The student will be able to:

1. Define diluent and concentrate (9.4.12.H.1)
2. Solve single dilution problems using the fundamental formula: parts concentrate + parts diluents = total volume (A-SSE 1-3; A-CED 4; A-REI 3; 9.4.12.H.(5).6)
3. Determine final concentrations using the fundamental formula: original concentration X dilution = final concentration (A-SSE 1-3; A-CED 4; A-REI 3; 9.4.12.H.(5).6)
4. Determine what dilution was performed (A-SSE 1; A-CED 4; A-REI 3; 9.4.12.H.(5).6)
5. Solve dilution problems using the formula: V_1 X C_1 = V_2 X C_2 (A-SSE 1; A-CED 4; A-REI 3; 9.4.12.H.(5).6)
6. Rearrange variables in a formula as required by given application problems (A-CED 4)
7. Solve problems involving percent weight per unit weight, %w/w (A-SSE 1; A-CED 4; A-REI 3; 9.4.12.H.(5).6)
8. Solve problems involving percent volume per unit volume, %v/v (A-SSE 1; A-CED 4; A-REI 3; 9.4.12.H.(5).6)

9. Solve problems involving percent weight per unit volume, %w/v (A-SSE 1; A-CED 4; A-REI 3; 9.4.12.H.(5).6)
10. Define normal saline solution (9.4.12.H.1)
11. Use scientific calculators to do all calculations (MP 5)
12. Identify health and medical applications of dilutions, solutions and concentrations (9.4.12.H.2)
13. Read and evaluate authentic sources pertaining to dilutions, solutions and concentrations and be able to cite textual evidence to support their analysis (R1-1; RST-10; 9.4.12.H.16)

B. Activities

1. Teacher lecture and modeling of unit objectives. (CS)
2. Students will work in pairs to solve problems involving dilutions, solutions, and concentrations. Pairs of student will present their problems and solutions and explain their process to the class. (AS, CS)
3. Students will complete lab activity: serial dilution of food coloring dye from http://test.teachengineering.org/view_activity.php?url=http://test.teachengineering.org/collection/drx_/activities/drx_dilution/drx_dilution_activity4.xml to gain hands on experience with mixing dilutions. (CR)
4. Students will read "Homeopathy: The Ultimate Fake" found at http://www.quackwatch.org/01QuackeryRelatedTopics/homeo.html which discusses the effectiveness of homeopathic treatments and their connection to dilutions of minerals. Students will write a reaction paper indicating their acceptance or rejection of the conclusions of the paper and give appropriate supporting evidence. (AS)
5. Students will create and present a presentation in which groups detail the uses of dilutions, concentrations, and solutions in the medical field as well as in personal real life uses (AS, AR, CR)

C. Evaluations

1. Teacher-created quizzes 2.
Teacher-created unit test
3. Reaction paper as evaluated from rubric
4. Presentation graded via rubric

D. Resources

1. *Mathematics for Health Science: A Comprehensive Approach,* by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Whiteboard and markers

3. Computer with projector
4. Microsoft PowerPoint
5. Lab supplies: 2 per group 500 ml plastic or glass containers; 4 - 8 per group 15-50 ml clear plastic or glass vials; 1 per group pipette, graduated cylinder, water. Food coloring dye enough for all to share.
6. Internet access or copies of "Homeopathy: The Ultimate Fake"

V. Drug Dosages and Intravenous Calculations

A. Objective: The student will be able to

1. Read and interpret drug orders (9.4.12.H.2)
2. Read and interpret drug labels (9.4.12.H.1)
3. Calculate drug orders using dosage formula (9.4.12.H.16)
4. Calculate drug orders using proportions (F-IF.1)
5. Calculate drug orders using dimensional analysis (F-IF.1-2; 9.4.12.H.3; 9.4.12.H.6)
6. Identify the volume of medication contained in a syringe (F-IF.1-2; 9.4.12.H.2-3)
7. Calculate the volume needed to satisfy a particular order (F-IF.1-2; 9.4.12.H.2-3)
8. Calculate the volume of reconstituted medication that is required when the medication is supplied in powdered form (F-IF.1-2; 9.4.12.2,3,5)
9. Determine whether an in-stock vial contains enough medication to fill an order (F-IF.2; 9.4.12.2, 3, 5)
10. Perform intravenous calculations using the formula, proportions, and dimensional analysis (F-IF.4-5; 9.4.12.H.2,3,4)
11. Perform intramuscular calculations using the formula, proportions, and dimensional analysis (F-IF.1,2; 9.4.12.H.2, 3, 4)
12. Perform titration calculations using a step-by-step process (F-IF.1, 2; F-IF.7.e)
13. Perform titration calculations using dimensional analysis (F-IF.1, 2; F-IF.7.e)
14. Calculate drug dosages based on body weight (F-IF.1, 2; 9.4.12.H.2-3)
15. Determine whether a physician's order is appropriate (9.4.12.H.3, 4, 5 and 8)

B. Activities:

1. Working in small groups, students will be provided information concerning the amount, route of administration, and type of medication which a patient requires. Each group will be required to produce a medication order, based on the given information. Students in the group will explain the information

that they came up with for the order and the importance of each unit notation and the amount. (CS, CR, AS)

2. Students will design and create their own drug and drug label. A description of the drug, its uses, side effects, ingredients, and other necessary information must be included. (AS, AR, CS)
3. Students will be provided the results of a physical examination and asked to evaluate the data to determine the proper dosage of medication required for a given body mass in kg and height in meters. (CS, CR, AS)
4. Students will be given information concerning the administration of an I.V. medication. Students must titrate the dosage to a given set of specifications that allow for different rates of administration and distribution. (CS, CR)
5. Students will use dimensional analysis to change the titration of a given medication from one set of units of concentration to another. (CS)
6. Students will perform an acid-base titration using phenolphthalein in order to create a specific pH solution from an unknown concentration of acid and a known concentration of base. (CS, CR)

C. Evaluation:

1. Assigned reading
2. Health care journal abstracts (reporting and explanation)
3. Unit exam
4. Unit quizzes
5. Conversion/calculation skills lab
6. Unit V project
7. Discussion/feedback from the clinical case problem
8. Discussion/feedback from the unit 1 interdisciplinary activity
9. Lab questions/lab procedure

D. Resources:

1. *Mathematics for Health Science: A Comprehensive Approach,* by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Related health care journal abstracts (i.e.- journal Pharmacy, Medicinal Chemistry)
3. Algebra/Chemistry reference textbooks (as per instructor)
4. Handouts/Review Guides
5. Instructor's portfolio of clinical math skills problem based case studies
6. Instructor's portfolio of mathematical reference tables/equations
7. Acid/Base titration lab supplies

VI. Linear Equations, Graphing, and Variation

A. Objectives: The student will be able to

1. Plot ordered pairs on the coordinate plane (G-GPE)
2. Identify the four quadrants (G-GPE)
3. Understand slope and its relationship to rate of change (G-GPE)
4. Determine the slope of a line given its graph (G-GPE)
5. Determine the slope given two points (G-GPE)
6. Graph a linear equation using the slope and y- intercept (G-GPE) 7.
Graph a linear equation using the slope and y- intercept (G-GPE)
8. Read and interpret both linear and nonlinear graphs (G-GPE)
9. Solve direct variation problems (A-CED, A-REI)
10. Solve inverse variation problems (A-CED, A-REI)

B. Activities:

1. Teacher lecture, demonstrations, modeling and discussions based on topics in Algebra and supplemental materials. (CS)
2. Students will work in pairs to draw a line through a point using the given slope. (AR)
3. Students will work in pairs to find the slope of a line connecting two given points. (CS)
4. Students will work in pairs to find the equations for real-life applications such as the cost of taking a taxi certain miles and the combination of buying two different fruits with fixed amount of money and graph the equations. (CR)
5. Interdisciplinary Activity: Students will explore how equations help in solving real-life problems, such as finance, science, and sports. (AR, AS, CR, CS)

C. Evaluation

1. Assigned readings.
2. Unit exam
3. Unit quizzes
4. Unit VI projects
5. Discussion/feedback from clinical case problem.
6. Discussion/feedback from Unit VI interdisciplinary activity.

D. Resources

1. *Mathematics for Health Science: A Comprehensive Approach,* by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010 2.

Related health care articles and websites.

3. TI-84 graphing calculators
4. Computers and geometric and algebraic software

VII. Exponential and Logarithmic Functions

A. Objectives: The student will be able to

1. Understand functions and function notation (F-IF.1; F-IF.2, F-IF.3)
2. Apply the vertical line test (F-IF.1)
3. Graph inequalities (A-REI.12, A-REI.3)
4. Understand the behavior of exponential functions (A-CED.1, A-CED.2)
5. Graph exponential functions (F-IF.8.b, F-IF.9)
6. Solve applications involving exponential growth (F-IF.9, F-LE.1.a, F-LE.1.c)
7. Solve applications involving exponential decay (F-IF.9, F-LE.1.a, F-LE.1.c)
8. Define logarithm (base 10) and know it's properties (FA-REI.11, F-BF.5)
9. Determine logarithmic values without using a calculator (FA-REI.11, F-LE.4)
10. Determine logarithmic values using a calculator (FA-REI.11)
11. Expand and condense logarithmic expressions (FA-REI.11)
12. Expand and condense natural logarithmic expressions (FA-REI.11)
13. Use applications of logarithms to determine the pH of a solution (FA-REI.11, F-IF.7.e)
14. Use applications of logarithms to determine the H^+ concentration given the pH (FA-REI.11)
15. Use applications of logarithms to calculate the absorbance and transmittance (FA-REI.11)

B. Activities:

1. Using a pencil or straight edge over a variety of shapes on graph paper determine if each shape is a function (CR, CS)
2. Provide students with graph paper and two different colored pencils to shade inequalities and determine the solution set (CR, CS)
3. Opener: Have students discuss the differences between an epidemic and a pandemic. Have students bring to school an article about a disease with time and spread data that they have found on line. Use these articles to

guide a discussion about exponential spread of illness over time and what that means in society (CR, AR)

4. Opener: Would you like a penny a day every day for the rest of your life or a penny doubled each day for two months? Why? (CR, CS)
5. Using a calculator and the formula for exponential growth have students pick a variety of start points and determine after 10 iterations how big the population will grow as it doubles over time (CR, CS)
6. Opener: How strong is an earthquake? How are earthquakes measured? What's the difference between a 4.0 and 7.0 earthquake (CR, AR)
7. Application: Use pH test strips to test the acidity or alkalinity of a variety of solutions compared with water (CR)
8. Have a variety of liquids with known absorbance and transmittance on your desk. Ask students to predict based on one or two samples what the absorbance or transmittance might be in relative terms. What information might I need to calculate absorbance and transmittance of light? Then introduce the formula and how it works in calculations. (CR, CS, AR, AS)

C. Evaluation:

1. Assigned reading
2. Health care journal abstracts (reporting and explanation)
3. Unit exam
4. Unit quizzes

D. Resources:

1. *Mathematics for the Health Sciences: A Comprehensive Approach*, by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Related health care journal abstracts (i.e.- journal Pharmacy, Medicinal Chemistry)
3. Algebra/Chemistry reference textbooks (as per instructor)
4. Handouts/Review Guides
5. Instructor's portfolio of mathematical reference tables/equations

VIII. Geometry

A. Objectives: The student will be able to

1. Define line, line segment, angle, ray, vertex, right angle, obtuse angle and acute angle (G-CO.1, G-CO.9)
2. Solve problems that involve complimentary and supplementary angles
3. Determine the measure of the missing angles of two intersecting lines (G-CO.9)

4. Determine the area and perimeter of several geometric figures (G-GPE.7)
5. Use the sector formula for circles (G-C.5)
6. Calculate the area and circumference of a circle (G-C.5, G-C.1, G-C.2)
7. Determine the volume of several geometric figures (G-GMD.1)
8. Understand the difference between area, volume and perimeter (G-CO.9, C-CO.10, G-GPE.7)
9. Understand what units are appropriate for area, volume and perimeter (G-MG.1)
10. Calculate the surface area of several geometric figures (G-MG.1)
11. Determine weight and volume given density (G-MG.2)

B. ***Activities:***

1. Pneumonic: Use your left hand to make the letter c for complementary then open your hand to see that from the thumb to index finger is 90 degrees. (CS, AR)
2. Have each student break a piece of spaghetti into 3 pieces without instruction. Some students will be able to make a triangle and some will not. Make conjectures about why or why not. Then, using a protractor to form a triangle from three pieces of spaghetti and measure the angles. (CR, AR)
3. Work in pairs to draw polygons and circles on graph paper. Make conjectures about formulas for calculating perimeter and area of polygons, and circles, which are based on approximate values, obtained by counting grid boxes. Rulers, protractors, graph paper, and compasses are used. (CR, AR)
4. Do a canned food drive, ideally around the holidays. As a project have students find the area of each surface, complete surface area, volume and perimeter of each surface. Award points based on the number and variety of shapes of objects. (CR, CS)
5. Students will read excerpts from Flatland by Edwin A. Abbott. Class will compare and contrast two-dimensional figures with three-dimensional figures.(AS, AR)
6. Using Geometer's Sketchpad software make conjectures about lines, points, and circles. Determine if conjectures prove to be true in all cases. (CR, AR)
7. On the graphing calculator students will enter a program to convert from degrees to radians. They will then make a new program to convert from radians to degrees. They will use the programs to check answers to given problems. (CR, CS)

8. Write a report on the connections between architectural designs for buildings and geometric figures (involving triangles and their angles). (AS, AR, AS)
9. Work in pairs to make conjectures about circles having to do with properties of inscribed and circumscribed circles. Rulers, protractors, and compasses are used. (CR, AR)
10. Have students collect data (or locate data from a printed source) and construct a circle graph for the data. (CR, AR)
11. As a research project, have students investigate uses of inscribed angles that carpenters or builders use. (AS, CS)
12. As a research project, have students graph ergonomic body positions for a variety of activities. For example, correct angles for working at a computer, walking, sitting at a desk, etc…What are optimal body positions and corresponding physical distances for your specific body. How high should your chair be? (CR, CS, AS)
13. Have students read http://www.articledoctor.com/physical-therapy/inclinometer-and-physical-therapy-859 and then discuss new tools physical therapists use to measure. (CR, CS, AS)

C. Evaluation:

1. Assigned reading
2. Unit exam
3. Unit quizzes
4. Discussion/feedback
5. Teacher made quizzes/tests and textbook homework problems.
6. For shapes' activity, students will share their way of categorizing the shapes with the class by presenting on board/overhead for class discussion and teacher evaluation.
7. For conjecture activity, students will produce a written report of their experiments, observations and their predictions. Predictions will later be discussed for validity.
8. Write up and orally present conclusions from area conjecture activities to class for discussion.
9. Students will prepare written reflections on Flatland including conjectures concerning space measurements beyond three dimensions.

D. Resources:

1. *Mathematics for the Health Sciences: A Comprehensive Approach*, by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Related health care journal abstracts (i.e.- journal ***Pharmacy, Medicinal Chemistry)***

3. Algebra/Chemistry reference textbooks (as per instructor)
4. Handouts/Review Guides
5. Instructor's portfolio of mathematical reference tables/equation
6. Geometer's Sketchpad
7. Graphing Calculator

IX. Charts, Tables and Graphs

A. Objectives: The student will be able to

1. Understand why a sample must represent its population (S-IC.1, S-IC.2, S-IC.3)
2. Create a frequency distribution table from a data set (S-ID.5)
3. Read and interpret tables, line graphs, bar charts and pie charts (F-IF.4, F-IF.5, F-IF.6, F-IF.7, S-ID.1, S-ID.6)
4. Construct a line graph from a table (S-ID.1, S-ID.7)
5. Construct a bar chart from a table (S-ID.1) 6.

Construct a pie chart from a table (S-ID.1)

B. *Activities:*

1. Opener: How many people do I need to ask to see if this is a good class? Use discovery discussion to get to optimal sample size and what that means in context. (CR)
2. Gummy bear launch: Students launch gummy bears at a variety of angles to collect data, create a scatterplot based on launch angle, find a line of best fit using a graphing calculator, and manually. Data can also be input into Microsoft Excel http://www.chicagoscienceinthecity.org/GummiLessonPlan.pdf (CR, CS)
3. Opener: Make a bar chart: Line students up by height in the front of the classroom. If there are any duplicates put them in a row. Then make a chart with intervals. Either have students decide on their own intervals, or do 6 inch intervals to see how the frequency distribution fits into the bar chart and what it would look like if this data was recorded on paper. (CR, CS)
4. Have students print articles from the New England Journal of Medicine on a topic they are interested in. Have them look at the data, interpret the data, and put it into appropriate graph format. (CR, CS, AS)

C. Evaluation:

1. Assigned reading
2. Health care journal abstracts (reporting and explanation)

3. Unit exam
4. Unit quizzes

D. Resources:

1. *Mathematics for the Health Sciences: A Comprehensive Approach*, by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Related health care journal abstracts (i.e.- journal ***Pharmacy, Medicinal Chemistry)***
3. Algebra/Chemistry reference textbooks (as per instructor)
4. Handouts/Review Guides
5. Instructor's portfolio of mathematical reference tables/equations
6. For Bears in Space: Mini catapult launcher (2 tongue depressors secured at one end with an elastic band, and a pencil put between them), paper, protractor, pencil, measuring tape, safety goggles, Gummy Bears, target (box of sand, piece of paper with target drawn on), marking tape, data sheets, penny

X. Introductory Biostatistics

A. Objectives: The student will be able to

1. Calculate the measures of central tendency: mean, median, and mode of a data set using formulas, statistical functions on a graphing calculator, and Excel spreadsheet software (MP.5; S-ID.2; S-ID.4)
2. Recognize that extreme values will greatly affect the mean but will not greatly affect the median (S-ID.2)
3. Recognize a bimodal distribution for a dataset (S-ID.3)
4. Calculate a measure of spread: standard deviation using a formula, the statistical function on a graphing calculator, and Excel spreadsheet software (S-ID.2)
5. Understand the significance of the normal distribution (S-MD.6)
6. Understand and apply the Empirical Rule to find probabilities from normal distributions (S-MD.4)
7. Calculate and use the z-score to calculate the standard deviation of a normal distribution using a formula (S-ID.4)
8. Calculate the percentile rank for a given score using a formula
9. Distinguish between populations and samples (S-IC.1)
10. Explain placebo and placebo effect. Describe how to design an experiment with human subjects that will account for the placebo effect. (S-MD.7; 9.4.12.H.19; 9.4.12.H.(5).2)

11. Analyze standard medical lab test results and understand how the normal range is calculated (S-MD.7)
12. Define epidemiology and its extension of statistical procedures to public health issues

B. Activities

1. Teacher lecture and modeling of unit objectives. (CS)
2. Students will work in pairs to analyze scenarios and identify the population of interest and the sample. (AS)
3. Given biostatistical datasets, students will use graphing calculators and Excel software to calculate measures of central tendency and spread. (CS)
4. Students will use z-scores to calculate standard deviations and determine how unusual a particular data point is. (AS)
5. Students will devise a research question involving human subjects and design an experiment to address that question. (AR)
6. Students will examine actual standard lab test results showing patients results compared to the normal range. Students will discuss how the normal range is calculated and why a single number is not used as the norm. (AS)
7. Interdisciplinary Activity: Students watch clips (or the entire movie) *And The Band Played On* about the discovery of the AIDS epidemic and the reaction of the scientific community. Whole class discussion to follow viewing addressing the biological, statistical, political, economic, and ethical issues of the AIDS epidemic in the 1980s. Students will also discuss how the next pandemic might be better handled. (AR, AS, CR, CS)

C. Evaluations

1. Teacher-created quizzes 2.
Teacher-created unit test
3. Unit X project
4. Discussion/feedback from clinical case study
5. Discussion/feedback from unit interdisciplinary activity

D. Resources

1. *Mathematics for Health Science: A Comprehensive Approach*, by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Whiteboard and markers
3. Calculators
4. Computer lab
5. Microsoft Excel, PowerPoint

6. DVD and the Band Played On

XI. Trigonometry

A. Objectives: The student will be able to:

1. List the perfect square roots between 1 and 100
2. Use a calculator to compute square roots to two decimal places (MP.5)
3. Use the Pythagorean Theorem to determine the length of a missing side of a right triangle (G-SRT.8)
4. Use the relationships of angles and legs for 30-60-90 and 45-45-90 right triangles to solve problems. (G-SRT.6)
5. Recognize a 3-4-5 triangle as a Pythagorean triple (G-SRT.6)
6. Determine whether two triangles are similar by comparing their corresponding angles and sides (G-SRT.2)
7. Determine the value of sine, cosine, tangent, secant, cosecant, and cotangent for given angles of 30-60-90 and 45-45-90 triangles (G-SRT.6; G-SRT.7; G-SRT.8; F-TF.3)
8. Determine the value of sine, cosine, tangent, secant, cosecant, and cotangent for given angles of any right triangle using a calculator (G-SRT.11)
9. Use trigonometry to solve problems related to medical issues (MP.4; MP.7; 9.4.12.H.2)
10. Understand the cyclical behavior of the sine and cosine functions (F-TF.5)
11. Recognize the basic shapes of the sine and cosine graphs as periodic or waves (F-TF.5)
12. Read a technical article, critique its content, and write a persuasive. stating their position supported by credible evidence. (RH.1; RH.6; RH.8; WHST.1; WHST.2)

B. Activities

1. Teacher lecture and modeling of unit objectives. (CS)
2. Students will work in pairs to solve medical problems using trigonometry. (CS, AS)
3. Students will read the article *"Biorhythms"* from the Skeptic's Dictionary at http://www.skepdic.com/biorhyth.html. Students will critique the science, or lack thereof, associated with biorhythms and assess their own beliefs and opinions on the subject supported by credible evidence and write a persuasive paper. (AS)
4. Students will read the article *"Cycles of Life"* from http://www.minnesotamonthly.com/media/Minnesota-Monthly/August-2007/Cycles-of-Life/. Students will compare the science, or lack thereof, in

this article as opposed to the "*Biorhythms"* article above. Students will write a paper judging the article's scientific validity. (AS)

6. Students will view online animation at http://www.sumanasinc.com/webcontent/animations/content/bloodpressure.html illustrating the flow of blood through the heart and how to measure blood pressure. Students will recognize the variation of blood pressure as a trigonometric function. (CR)

C. Evaluations

1. Teacher-created quizzes
2. Teacher-created unit test
3. Unit XI project
4. Discussion/feedback from clinical case study

D. Resources

1. *Mathematics for Health Science: A Comprehensive Approach*, by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Whiteboard and markers
3. Calculators
4. Computer
5. Projector
6. Internet access

Appendix A

Problem based Learning: Medical Math Applications in Clinical Case Studies

A. Objectives: The student will be able to

1. Describe the reasons for the selection of a respective system of measurement to aid in the conversions and calculations for a given medication dosage (F-IF.1,2); (9.4.12.H.2, 3)
2. Explain the nature of the disease process in the clinical case, and provide the names of the classes of medication used to treat the pathology in question (9.4.12.H.3, 4)
3. Provide the routes of administration of the medication required in a given clinical case (i.e.- I.M., I.V) (9.4.12.H.3, 4)
4. Explain the reasons for proper calculation of dosage for a given medication. (9.4.12.H.2,3, and 4)
5. Provide at least one adverse side effect of the medication in question if (a) the dosage is excessive; or (b) the dosage is inadequate. (F-IF.1-2); (9.4.12.H.2, 3, and 4)
6. Provided the appropriate apothecary references, write the abbreviation for the dosage and route of administration selected for a given medication (9.4.12.H.2-3)
7. Briefly explain the differences in effect of the medication depending on the route of administration selected (9.4.12.H.3-4)
8. Explain the normal structure and functioning of the organs, and organ systems which are presented in the clinical case from previous course work in biology, chemistry, physics, and anatomy & physiology (9.4.12.H.3-4)

B. Activities:

1. Students will be assigned, in groups, a series of clinical case studies during each unit of study in this course. Students will provide a review and discussion of the case with an emphasis on important aspects of measurement calculation methods, dosage determination, and the route of administration of the drug. Instructor will provide rubric for guidance and assessment. (CS, CR, AS)
2. Students will prepare a PowerPoint presentation which will discuss and highlight important considerations which health care professionals must be made aware of in the calculation of the proper dosage. Adverse effects of improper calculation of dosage and improper administration of the drug will be emphasized. (CS, CR. AS)

3. The instructor will offer, as an option for the marking period projects, students the choice of comparing and contrasting similarities in different unit case studies-the mechanisms of action of the various classes of drugs studied and to profile their changing efficacy with changes in dosage concentration and route of administration. Students will use a minimum of three different clinical cases presented in class to demonstrate their understanding of drug metabolism based on dosage, administration techniques, and target organ(s), and/or system(s).
   The instructor will provide a rubric for guidance and assessment.
4. Students will be assigned to present a clinical case from a medical/health professions journal publication to the class. The student will address important aspects of the case presentation including: (1) drug dosage; (2) methods of administering the drug; (3) target organ and effects; (4) system of measurement used and calculation; and (5) adverse effects associated with the drug presented. Instructor will provide rubrics for guidance and assessment.

C. Evaluation:

1. Assigned clinical case studies
2. Health care journal abstracts (reporting and explanation)
3. Conversion/calculation skills
4. Discussion of anatomy and physiology 5.
Discussion of abnormalities in the case
6. Discussion/feedback from the clinical case problem 7.
Discussion/feedback from the respective unit themes

D. Resources:

1. *Mathematics for the Health Sciences: A Comprehensive Approach*, by Joel R. Helms, published by Delmar Cengage Learning, copyright 2010
2. Related health care journal abstracts (i.e.- journal ***Pharmacy, Medicinal Chemistry)***
3. Algebra/Chemistry reference textbooks (as per instructor)
4. Handouts/Review Guides
5. Instructor's portfolio of clinical math skills problem based case studies
6. Instructor's portfolio of mathematical reference tables/equations

APPENDIX B

Acronyms for Learning Styles

The Concrete Random Learner (CR)

The concrete random learning preference is characterized by and experimental attitude and accompanying behavior. CR learners get the gist or ideas quickly and demonstrate the ability to make intuitive leaps in exploring unstructured problem solving experience sometimes they also have insights and make leaps in structured situations. Then they are chided for not: showing their work of jumping to conclusions.

Concrete random learners utilize the trial-and-error in acquiring information. They do not like cut-and-dries procedures that deny then opportunities to find answers in their own ways. They do not respond well to teacher intervention in their dependent efforts. They work well independently or in small groups.

CR instructional preferences- mini-lecture, games, simulation, open ended activities, brainstorming.

The Concrete Sequential Learner (CS)

The concrete sequential leaning preference is characterized by the propensity to derive information through direct, hands on experience. CS learners exhibit extraordinary development of their five senses. They appreciate order and logical sequence of the if- then, premise-conclusion variety. They like touchable, concrete materials. In a biology class, a plaster model handled by the teacher would be insufficient for these learners. They want to have the real thing to take apart themselves. The CS learners prefer step-by-step directions when confronted with a learning situation. They not only look for directions but they follow them. They like clearly ordered presentations and a quiet atmosphere.

CR instructional preferences- Checklists, charts, practical problems, computer programs, outlines, demonstrations

The Abstract Sequential Learner (AS)

The abstract sequential learning preference is characterized by excellent decoding abilities with written, verbal, and image symbols. AS learners have a wealth of conceptual" pictures" in their minds against which they read, hear, or see in graphic and pictorial form. They possess and like to use reading, listening, and visual translation skills. A symbol or picture is worth a thousand words to them.

These learners prefer a presentation that has substance, is rational and is sequential in nature. They are able to extract the main ideas from a logical presentation. They learn well form authorities and like vicarious experiences.

AS instructional preferences - lecture, note taking, writing reports, individualized study, instructional media

The Abstract Random Learner (AR)

Abstract random learners are distinguishable by their attention to human behavior and a capacity to sense and interpret "vibrations". They are attuned to nuances of atmosphere and mood. They associate the medium with the message and tie a speaker's manner, delivery, and personality to the message being conveyed. In doing so, they evaluate a learning experience as a whole.

Abstract act random learners prefer to receive information in an unstructured manner and therefore like group discussions, activities which involve multi-sensory experiences, and busy environments. They prefer freedom from rules and guidelines. They seem to gather information and delay reaction; they organize material through reflection to get what they want.

AR instructional preferences- group work, music, poetry, short reading or lecture with discussion, personalized examples role play, journals.