TAMALPAIS UNION HIGH SCHOOL DISTRICT
LARKSPUR, CA

Course of Study

HONORS BIOMEDICAL SCIENCE 1-2

I. INTRODUCTION

Honors Biomedical Science 1-2 is a year-long upper division life science course. Content is taken from the biological sub-discipline molecular biology. The non-lab/lecture component reflects typical course work in upper division college molecular biology courses. The lab component often reflects post-graduate level work. Honors Biomedical Science should be recognized as a college level course taught in a secondary school. As such, the intended audience are students with college-level academic skills who are interested in molecular biology, including those interested in pursuing post-secondary education in the areas of pre-med, pre-vet, virology, microbiology, biomedical science, biomedical engineering, and other molecular biology related degree programs.

Individual molecular biology topics include:

- Biomolecular structure, function, and chemistry
- Viral structure, "life cycle", and chemistry
- Molecular pathways of the human immune system, and signaling pathways related to cell division and tumor development
- Prokaryotic and eukaryotic genetics to include protein synthesis and gene expression in both cell types – to include epigenetics for eukaryotes
- Genetic engineering
- DNA amplification
- Quantitative analysis of enzymes, marker proteins, and DNA
- Neurobiology, cognitive development, degenerative neurological conditions

Course Goals:

- To offer a rigorous college level opportunity for those students who have an interest in a course that mirrors the content of molecular biology based post-secondary programs
- Provide real-life, off campus experiences in the fields of medicine, and biomedical research (private and public)
- Provide access to biotechnology opportunities in the form of lab work integral to the curriculum - with respect to this goal the intent is to provide highly advanced lab experiences that meet industry, clinical, and research level expectations
- In both lab and non-lab opportunities the priority is to give students a tangible advantage when entering college and/or the post-grad work force
- In-depth understanding and application of the state Content Standards in Biology, Chemistry, and Investigation and Experimentation

This course addresses the following Tam 21st Century goals:

1. Students: Provide an environment supporting academic, social and emotional growth and success and opportunities for student choice.
2. Instruction: Provide a program that prepares students for graduation and provides opportunities for student growth, development and post-secondary options.

This course addresses the following Student Learning Outcomes:

1. Communicate articulately, effectively, and persuasively when speaking and writing.
2. Read and analyze material in a variety of disciplines.
3. Use technology as a tool to access information, analyze and solve problems, and communicate ideas.
5. Apply mathematical knowledge and skills to analyze and solve problems.
6. Demonstrate scientific literacy.
12. Demonstrate school-to-work/post-secondary transition skills and knowledge.

II. STUDENT LEARNING OUTCOMES

A. **Students will:**

1. Read, comprehend, and apply information written and presented with college students, college graduates, and/or professionals as the target audience
   - **Indicator a:** Regularly read approved research-based journal articles and write an original abstract
   - **Indicator b:** Using prescribed formats, summarize and organize information derived from readings assigned from the textbook, journals, laboratory background readings, and technical publications
   - **Indicator c:** Prepare for and participate in lecture and discussion sessions
2. Apply in a real-world setting content knowledge learned from non-laboratory activities
   - **Indicator a:** Use state-of-the-art, industry grade biomolecular analysis equipment, materials, and protocols, to perform authentic qualitative lab activities
   - **Indicator b:** Lab practicums administered under exam conditions
3. Analyze and present data
   - **Indicator a:** Using established protocols and expectations for authentically derived data, data is to be presented, explained, and discussed using prescribed written lab report formats
4. Successfully work in a collaborative setting
   - **Indicator a:** Demonstrate through actions during lab activities that individual contribution is productive, supportive and equitable

Indicator b: Contribute to research based group portfolios and/or presentations

5. Organize and review multi-topical and complex material associated with molecular biology
   Indicator a: Prepare for and take written exams no more than three times in a given semester
6. Progressively immerse themselves in one or more careers related to the content reflected in the biomed program
   Indicator a: Research and present an in-depth profile and analysis of an approved career to include a series of interviews with experts in both the related pre-professional preparation programs and the career itself
   Indicator b: Participate in an approved internship culminating in a formal written report, and visual presentation of the internship.
   Indicator c: Participate in class-wide case studies of individuals as it relates to their career; including their academic and professional preparation

B. Students will cover the following State Science Content Standards:
Standards that all students are expected to achieve in the course of their studies are unmarked. Standards that all students should have the opportunity to learn are marked with an asterisk (*).

Chemistry
Reaction Rates

8.a. Students know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time
8.b. Students know how reaction rates depend on such factors as concentration, temperature, and pressure
8.c. Students know the role a catalyst plays in increasing the reaction rate

Organic Chemistry and Biochemistry

10.a. Students know large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits
10.b. Students know the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
10.c. Students know amino acids are the building blocks of proteins.
10.f.* Students know the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins

Biology/Life Sciences
Cell Biology

1.a. Students know cells are enclosed within semi permeable membranes that regulate their interaction with their surroundings

1.b. Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings

1.c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

1.h. Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple pre-cursors.

Genetics

4.a. Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.

4.b. Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.

4.c. Students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

4.d. Students know specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.

4.e. Students know proteins can differ from one another in the number and sequence of amino acids.

4.f.* Students know why proteins having different amino acid sequences typically have different shapes and chemical properties.

5.a. Students know the general structures and functions of DNA, RNA, and protein.

5.b. Students know how to apply base-pairing rules to explain precise copying of DNA during semi conservative replication and transcription of information from DNA into mRNA.

5.c. Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.

5.d.* Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.

5.e.* Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

Physiology

9.i. Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

10.a. Students know the role of the skin in providing nonspecific defenses against infection.

10.b. Students know the role of antibodies in the body's response to infection.

10.c. Students know how vaccination protects an individual from infectious diseases.

10.d. Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.

10.e. Students know why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.

10.f.* Students know the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.

Investigation and Experimentation

1.a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

1.b. Identify and communicate sources of unavoidable experimental error.

1.c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

1.d. Formulate explanations by using logic and evidence.

1.e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.

1.f. Distinguish between hypothesis and theory as scientific terms.

1.j. Recognize the issues of statistical variability and the need for controlled tests.

1.n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

III. UNITS OF INSTRUCTION

A. Major Units of Instruction

1. Biomolecular Structure and Function (de-emphasize nucleic acids for now)
2. Microbiology (aseptic technique, sub-culturing, Gram staining)
3. Human Immune System
4. Cancer (causes and growth, including the genetics of cancer)
5. Viral Structure and Chemistry
6. Nucleic Acid Structure, Function, and Chemistry
7. Gene Expression and Regulation
8. Genetic Engineering
9. Polymerase Chain Reaction
10. Neurobiology (cognitive development, degenerative conditions, and cancer of the brain)

B. Enduring Understandings and Essential Questions

- ***Although nothing living is below the organization of the cell, the molecules of life and the chemistry they participate in are the driving force for all physical and chemical characteristics of life.***
- ***At the molecular level, what explains life, cellular communication, disease, abnormalities, evolution, and dying?***

C. Knowledge and Skills

Successful students in this course must:

1. Read and write scientifically at an upper division college level
2. Have excellent time management skills
3. Be goal orientated
4. Be self motivated
5. Work well individually and in a team
6. Be able to prepare, in advance as homework, for industry level lab work
7. Have a solid foundation in biology, and chemistry (at the AP Chemistry level)
8. Be proficient mathematically at least at the pre-calculus level

D. Student Assessment

Grading Policies: The following grading policy will be given to students at the beginning of the course in writing.

1. Grades are based on the total points earned divided by the total points offered. This point system runs the entire semester (quarter grades are not averaged together).
2. What is graded: two midterms per semester, one quiz per semester, a final exam for the fall semester, one independent project per semester, a group portfolio research project, regular writing assignments (abstracts), and written lab reports.
3. Assessments will not be curved.
4. At times class wide extra credit opportunities will be offered.
5. Late assignments will not be accepted unless prior arrangements have been made, and then only under the most compelling circumstances.
6. If an absence is excused for any due date you must see me on your first day back to arrange another due date.

Letter Grade Example: A+(98-100); A(94-97); A-(90-93)

IV. METHODS AND MATERIALS

A. Methods

1. Readings
2. Lectures and discussions
3. Multimedia to include web-based applications and tutorials
4. Hands-on laboratory activities
5. Field work
6. Independent research
7. Individual and peer reflection and feedback
8. 3D modeling
9. Peer-to-peer collaboration

B. Materials

1. Assigned text
2. Survey, and professional journals
3. Technical manuals
4. Industry generated primers
5. Computer and web based applications and tutorials
6. Biotechnology hardware and disposable materials, media, and reagents

This course uses the Board-approved textbook and supplementary books:
Biology, Campbell

C. Technology

1. Computer based presentation hardware
2. Software: presentation, digital video editing, graphics and visual effects, web design, web-based applications, spreadsheet, word-processing
3. Biotechnology to include hardware and reagent preparation
4. Assisted culturing and identification of microorganisms
5. Video: digital and analog
6. CD-ROM and DVD based presentations and tutorials

D. Suggested Instructional Time Allocation

Fall Semester

1. Career Exploration: student project outside of class time covering 12 weeks
2. Microbiology to include biomolecular structure and function, sterile/aseptic lab protocols, bacterial differentiation, growth and metabolism, and quantitative analysis: eight weeks
3. Immune System: three weeks
4. Cancer: four weeks
5. Viruses: five weeks
6. Student Presentations: one week

Spring Semester

1. Job Shadow/Internship Project - student project outside of class time assigned during week one and due in parts during the last three weeks of the semester.
2. Structure, Chemistry, and Function of DNA: five weeks
3. Genetic Engineering: two weeks
4. Gene Regulation and Expression (prokaryotic and eukaryotic): three weeks
5. Polymerase Chain Reaction: six weeks
6. Neurobiology: three weeks
5. Student Presentations: two weeks cumulative

Hands-on lab work accounts for 40 percent of instructional time reflected as a year long average.

V. ANCHORS OF STUDENT WORK

Cornerstone Assessments:

• Lab Reports • Projects • Exams • Regular Writing Assignments (abstracts)

VI. TROUBLE-SHOOTING GUIDE

Lab equipment must be maintained and serviced on a regular basis. New lab activities must be dry-run at least a year in advance. New lab protocols require extensive and time consuming research and drafting. The process of writing the student version of any new lab should also begin at least a year in advance. Securing sources and funding for industry grade reagents and disposables require much advance planning. All curricular materials must be updated regularly. The world of molecular biology is ever changing. The course must remain current.

VI. COURSE ASSESSMENT

Formal student feedback will be sought and collected each semester. Grade distribution data reflecting semester grades, project grades, and exam grades will be prepared each year as well. Both of these indicators will be used to determine how well the needs of students as a group are being met; and how well students are performing as a group.

VII. GENERAL INFORMATION

Honors Biomedical Science 1-2 is a pair of five (5) credit courses with a weighted GPA open to students who have met the prerequisites.

A. Prerequisites

To be eligible for enrollment in Honors Biomedical Sciences 1 students must:

- Have completed a year of Chemistry or Honors Chemistry, earning a grade of A- or higher in each semester of Chemistry, or B- or higher in each semester of Honors Chemistry
- Earn at least a score of 75% on the entrance test - see the **TUHSD Information for Students and Parents** handout for details

** It is strongly recommended that Honors Biomedical Science students be concurrently enrolled in, or have completed, AP Chemistry. The Biochemistry taught in Honors Biomedical Science is best learned with a chemistry background commensurate with the content found in AP Chemistry.*

B. Requirements Met

This course may be used as elective credit towards graduation.

Honors Biomedical Science is approved by the UC and CSU systems as a "d" lab science.

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