TAMALPAIS UNION HIGH SCHOOL DISTRICT
Larkspur, California

Course of Study

Ecology

I. INTRODUCTION

Ecology is an upper-division advanced biology program for primarily 11th and 12th graders. It is designed to expose students to the complexity of interactions in the natural world though laboratory study, biological fieldwork and sampling. As an upper division course, it is designed to prepare students for postsecondary study in science by providing students with a more in-depth exploration of specific topics from biology as well as earth and physical science as applied to ecology.

The course builds upon the biological and geological foundations developed in Integrated Science 1-4 by spiraling topics and key themes and extending the students' understanding to a higher conceptual level. The course is an excellent compliment to issues addressed in the Environmental Science program. Curriculum consists of the following units: Introduction to Ecology, Soil Biology, Agriculture and Ecology, Plant Biology, Field Biology, Community Ecology, Animal Ecology.

This course is field and laboratory-based, using experimental studies, ecological field work and testing as major instructional methodologies. Ecology stresses application of data gathering and interpretation during the preparation of individual research projects.

This course addresses the following Tam 21st Century goals:
- Permitting students to act responsibly in an ever changing and increasingly complex socio-economic environment.
- Preparing students to be problem solvers by increasing their responsibility and independence through project-based learning.
- Creating meaningful school-to-career opportunities and/or experiences.

This course addresses the following TUHSD 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.
#5: Apply mathematical knowledge and skills to analyze and solve problems.
#6: Demonstrate scientific literacy.
#7: Demonstrate knowledge of the global environment and its resources.
#10: Analyze and propose solutions to contemporary issues.
#12: Demonstrate school-to-work/post-secondary transition skills and knowledge.

This course is designed to help students attain the state subject Content Standards.

II. STUDENT LEARNING OUTCOMES

A. **Students will:**

Each of the following outcomes is referenced to state Science Content Standards.

1. Conduct soil tests for macronutrients and use results to assess the health of a habitat. (Chem 5d, I & E 1a)
2. Create compost systems and identify the role of decomposition in the process. (Bio 6d,e, 7a-d)
3. Identify plant structures and functions on a microscopic and macroscopic level. (I & E 1a)
4. Describe the evolution of plants. (Bio 7a, c, d, 8a-d)
5. Create and cultivate an ecology garden. (ES 4a, b, 8, I & E 1a, l, m)
6. Design, set-up, collect data, and analyze botanical experiments. (I & E a-n)
7. Present and debate issues of agriculture as they apply to the health of the biosphere, lithosphere, atmosphere, and hydrosphere.(ES 4 a, b, 7a-d)
8. Describe the role of natural selection in the evolution of behavior. (Bio 8a-d)
9. Observe and analyze animal behaviors including foraging, mating systems, and parental care. (Bio 7a, c, d)
10. Compare populations using sampling techniques including harvest/dimension analysis, transects, mark and recapture. (Bio 6a-g, I & E 1a-g)
11. Sample microbial populations. (I & E 1a-g)
12. Identify the parameters that lead to diversity in an ecosystem. (Bio 6e-g)
13. Observe the process of succession in an ecosystem. (I & E 1a-g)
14. Create a comprehensive portfolio addressing the cultural history, geology, and biology of a local ecosystem. (ES 9a, I & E 1a-n)
15. Identify the positive and negative role humans play in ecosystems. (I & E 1m)
16. Participate in environmentally sound practices such as conservation and habitat preservation/restoration. (ES 9a, I & E 1m)
17. Communicate information about relevant environmental issues in oral, written, and/or multimedia formats. (I & E)
18. Demonstrate high level critical thinking skills in analyzing data, forming hypotheses, designing laboratory and field research, and developing conclusions to scientific inquiry. (I & E)
19. Report the results of field work in a scientific paper that will encompass hypothesis, procedures, observations, data analysis, conclusion, and error analysis. (I & E)
20. Given articles containing conflicting points of view on a socially relevant, local/global environmental issue, interpret the data and present your own conclusions orally and in writing. (I & E)
21. Make at least one non-written presentation of opinions or research findings which will be critiqued by other students using criteria developed by the class with teacher assistance.
22. Maintain an on-going portfolio of work demonstrating progress towards outcomes.

B. **Students will cover the following state subject Content Standards:**

Chemistry

5. **Acids and Bases** Acids, bases and salts are three classes of compounds that form ions in water solutions as a basis for understanding this concept:

d. Students know how to use the pH scale to characterize acid and base solutions.

Biology

6. **Ecology** Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

a. Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.

b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.

c. Students know how fluctuations in population size in an ecosystem are deter-mined by the relative rates of birth, immigration, emigration, and death.

d. Students know how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.

e. Students know a vital part of an ecosystem is the stability of its producers and decomposers.

f. Students know at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.

g.* Students know how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.

7. **Evolution (Population)** The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

a. Students know why natural selection acts on the phenotype rather than the genotype of an organism.

c. Students know new mutations are constantly being generated in a gene pool.

d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.

8. **Evolution (Speciation)** Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

a. Students know how natural selection determines the differential survival of groups of organisms.

b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.
c. Students know the effects of genetic drift on the diversity of organisms in a population.
d. Students know reproductive or geographic isolation affects speciation.
e. Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.

Earth Sciences

4. Energy in the Earth System Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:
a. Students know the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
b. Students know the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.

7. Biogeochemical Cycles Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept:
a. Students know the carbon cycle of photosynthesis and respiration and the nitrogen cycle.
b. Students know the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.
c. Students know the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.
d.* Students know the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

8. Structure and Composition of the Atmosphere Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life.

9. California Geology The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
a. Students know the resources of major economic importance in California and their relation to California's geology.

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

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.
b. Identify and communicate sources of unavoidable experimental error.
c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
d. Formulate explanations by using logic and evidence.
e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
f. Distinguish between hypothesis and theory as scientific terms.
g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
h. Read and interpret topographic and geologic maps.
i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
j. Recognize the issues of statistical variability and the need for controlled tests.
k. Recognize the cumulative nature of scientific evidence.
l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
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).

C. **Students will cover the following content as covered on the state Standard Tests and/or High School Exit Exam:**
Content from the Content Standards (see B above) that appears on the Standard Tests will be covered. Students in Ecology will have already prepared for the High School Exit Exam as part of their completion (or concurrent enrollment) in Integrated Science.

IV. UNITS OF INSTRUCTION

Semester 1 units:

A. Introduction to Ecology

1. **Enduring Understandings and Essential Questions:**
Understanding(s): Students will understand that…
Ecology is the study of plants, animals, and non-living factors in the environment.

Essential Question(s):
What is ecology and how is it studied?

2. **Knowledge and Skills:**
Student will know…
ecology is the study of interacting plants, animals, and abiotic factors
basic ecology sampling techniques.
Students will be able to…
quadrat sampling.
field journal note-taking.
garden tool use.

3. **Student Assessment:**
Homework, laboratory and field work, quiz, midterm, final exam (also see V).

B. Soil Biology

1. **Enduring Understandings and Essential Questions**
Understanding(s): Students will understand that…
healthy soil is made up of living and non-living components and is the basis of most life on earth
Essential Question(s):
How is soil made and how is it important?

2. **Knowledge and Skills:**
Student will know…
the components of soil and its importance and place in an ecosystem.
Students will be able to…
characterize soil and its components
conduct soil tests
build compost

3. **Student Assessment:**
Homework, laboratory and field work, quiz, midterm and final exam (also see V).

C. Agriculture and Ecology ("Issues of Agriculture")

1. **Enduring Understandings and Essential Questions**
Understanding(s): Students will understand that…
Agriculture is the source of all human food and has significant impacts on the earth's ecosystems.
Essential Question(s):
What are the impacts of agriculture on the earth's ecology?

2. **Knowledge and Skills:**
Student will know…
the global impact of various agricultural techniques.
how to differentiate between industrial and organic agriculture.
Students will be able to…
use scientific research techniques.

3. **Student Assessment:** Homework, laboratory and field work, presentation/debate, final exam (also see V).

D. Plant Biology ("Botanical Adaptations")

1. **Enduring Understandings and Essential Questions**

Understanding(s): Students will understand that…

Plants have evolved a wide range of adaptations to survive across planet earth.

Essential Question(s):

How do plants survive, reproduce and grow?

How have plants adapted to the to earth's many environments? How can we encourage plants to survive in our own environment?

2. **Knowledge and Skills:**

Student will know…

the basic botany and identify parts and functions of flowers, leaves, stems, and seeds.

examples of pollination, germination, and dispersal techniques used by plants.

how to use botanical knowledge to cultivate a garden.

examples of plant adaptations including: photosynthetic pathways, food storage structures, etc.

Students will be able to…

dissect plants and identify their basic structures.

use basic gardening techniques: seed selection, amending, sowing, plant care.

use scientific research techniques.

3. **Student Assessment:**

Homework, laboratory and field work, Seed Germination Project, Plant Profile Illustration, test, final exam (also see V).

Semester 2 units:

A. Field Biology

1. **Enduring Understandings and Essential Questions:**

Understanding(s): Students will understand that…

Humans have an immense impact on ecosystems: both positive and negative. These impacts are better understood through biological field work.

Essential Question(s):

What is required to create a garden ecosystem?

What actions can humans take to benefit an ecosystem?

2. **Knowledge and Skills:**

Student will know…

how to use ecological knowledge to create a garden community.

consider and identify human impacts and possibilities for positive action in ecological communities.

Students will be able to…

conduct garden experiments.

use a field journal for note-taking.

use scientific research techniques.

identify examples of environmental stewardship.

3. **Student Assessment:**

Homework, laboratory and field work, Ecology in Action report, Garden Experimentation, final exam (also see V).

B. Community Ecology

1. **Enduring Understandings and Essential Questions:**
   Understanding(s): Students will understand that…
   A community exists due to complex interactions amongst plants, animals, and the environment. Ecologist learn about communities through various sampling techniques.
   Essential Question(s):
   What are the important characteristics of populations and communities?
   What factors have helped create the Point Reyes community?
2. **Knowledge and Skills:**
   Student will know…
   how to use basic ecology sampling techniques.
   the important components of populations.
   the important components of communities.
   Students will be able to…
   complete a detailed study of a community.
   sample communities using a transect.
   sample communities using a quadrat.
   sample microbial communities.
   use a field journal for note-taking.
   use scientific research techniques.
3. **Student Assessment:**
   Homework, laboratory and field work, Point Reyes report, test, final exam (also see V).

C. Animal Ecology

1. **Enduring Understandings and Essential Questions:**
   Understanding(s): Students will understand that…
   Animal behaviors help organisms survive and are the result of genetic and environmental influences.
   Essential Question(s):
   How does natural selection drive evolution and behavior?
   What behaviors are important to animal survival?
2. **Knowledge and Skills:**
   Student will know…
   animal behaviors and their importance in survival.
   Students will be able to…
   make careful behavioral observations
3. **Student Assessment:**
   Homework, laboratory and field work, test, final exam (also see V).

IV. METHODS AND MATERIALS

A. Methods

This is a hands-on, lab and project oriented course in which field study and lab work will encompass 50% of the course work. Instruction will employ a combination of guided discussion, demonstration, reading, inquiry and inductive teaching strategies. Students will be expected to complete in-depth research reports, field/lab experiments, scientific debates, oral and multimedia presentations, and individual/group investigations. Field study and analysis is an integral part of this course.

B. Materials

Since this is a course which stresses original research and field studies, primary source materials will be extensively used in conjunction with an Ecology textbook. Students will also use a variety of professional laboratory materials and equipment.

This course uses the Board-approved textbook and supplementary books:
Elements of Ecology (Smith, 2003)

C. Technology

Student will use appropriate technology as relevant to lab and field study work. Students will have exposure to current technology used in environmental agencies. Students will be proficient in using horticultural tools.

In addition, students will be expected to use computer technology and internet resources in preparation of reports and presentations.

D. School to Career Goals

Lessons will focus on real world application. Students will be asked to make explicit connections between class work and the larger community through research and writing. Multiple representatives from various ecology-related fields will be invited to present in class and on field trips. Students will meet and interact with these representatives at numerous occasions throughout the school year. In addition, internship and other applications of ecology will be offered regularly as extension activities to interested students.

E. Suggested Instructional Time Allocation

Semester 1 units (18 weeks):
Introduction to Ecology (2 weeks).
Soil Biology (4 weeks).
Agriculture and Ecology (4 weeks)
Plant Biology (4 weeks).

Semester 2 units (20 weeks):
Field Biology (6 weeks)
Community Ecology (8 weeks)
Animal Ecology (6 weeks)

Within units noted above, instructional time will be allocated as follows:
50% Hands-on field and laboratory work and analysis (often in groups)
15% Textbook study
15% Independent research (computer, library, etc.)
10% Teacher lecture
5% Field trips and guest speakers
5% Student assessment and presentation

V. ANCHORS OF STUDENT WORK

Grading criteria and a course syllabus
Grading criteria and a course syllabus will be provided at the start of each semester with overview of units and cornerstones of units (see below). Grades will be determined based on this approximate breakdown:
20% Homework
45% Laboratory work and reports, field work, projects
20% Quizzes, tests, midterm
15% Final examination

Semester 1 key assignments:
Introduction to Ecology: Using a Field Journal, Garden Quadrats
Soil Biology: Ecosystem Productivity Laboratory, Composition of Soil Laboratory, Slide Ranch Field Trip, Soil Testing Laboratory
Agriculture and Ecology: Winter Crop Experiment, Seed Germination Laboratory Experiment, Seed Dissection Laboratory, Agricultural Field Trip
Plant Biology: Flower Dissection Laboratory, Flower and Seed Collection Field Work, Botanical Structures Laboratory,

Semester 1 unit assessments:
Introduction to Ecology: Ecology Review and Preview
Soil Biology: Soil Testing, Quiz
Agriculture and Ecology: Winter Crop experiment, Issues of Agriculture presentation and debate, Midterm Examination
Plant Biology: Seed Germination Laboratory Report, Botanical Illustration, Unit test
Final Examination

Semester 2 key assignments:
Field Biology: Garden Quadrats, Winter Crop Experiment, Garden Community Plan Field Experiment, Garden Harvest Activity
Community Ecology: Population Survey Laboratory Experiment, Mark and Recapture Laboratory Experiment, Plate Count Laboratory Experiment, Transect Field Experiment
Animal Ecology: Natural Selection Laboratory, Gull Behavior Observation Field Experiment, Zoo Behavior Observations Field Experiment, Behavior Observations Field Work, Earthworm Behavior Laboratory, Brine Shrimp Behavior Laboratory

Semester 2 unit assessments:
Field Biology: Ecology in Action Report, Garden Community Experimentation
Community Ecology: Garden Community presentations, Unit test
Animal Ecology: Behavior Observation Journal, Unit test
Final Examination

Course cornerstone (Semester 2):
Point Reyes Ecology Report

VI. TROUBLE-SHOOTING GUIDE

In addition to a traditional science classroom, Ecology teachers will need to secure an area on campus where students can grow plants and conduct plant experimentation. Teachers will also need access to materials and tools needed for the long-term cultivation of plants. Since Ecology is a field-based science, it is also recommended that teachers arrange at least one off-campus field trip each semester. Other needs are similar to a typical life science class (textbooks, basic laboratory supplies: glassware, measurement tools, incubators, etc.). Teachers will need the support of their school administration to address all of these needs.

VII. ASSESSMENT

A. Student Assessment

Students will be given the grading criteria and course expectations, preferably in writing, at the beginning of the course.

Students will be graded on the basis of traditional exams, projects, presentations, and quizzes. Each student will maintain portfolios of work (in binders) which will enable student and teacher to assess progress over the semester and year. These portfolios will include evidence of work on the student outcomes listed above. In addition, students will maintain field journals that document research, data collection, and analysis.

B. Course Assessment

Teachers will review student logs and portfolios. Teachers will review feedback from students as part of the course assessment effort. Students will submit unit evaluations and written feedback. Community mentors will provide written feedback on both internships and projects. Course assessment should be group-based rather than individual-based.

VIII. GENERAL INFORMATION

Ecology is a 10 credit course open to students who have completed Integrated Science 1-4. (With instructor's approval and completion of Integrated Science 1-2, may be taken concurrently with Integrated Science 3-4).

A. **Prerequisites**

Students must have completed Integrated Science 1-4. With instructor's approval and completion of Integrated Science 1-2, may be taken concurrently with Integrated Science 3-4. In addition, students must have completed or be enrolled in Advanced Algebra (or equivalent) or receive special teacher permission.

B. **Requirements Met**

This course may be used as elective credit towards graduation but does not meet any specific graduation requirement.

This course is accepted towards the "D" requirement for UC admissions. It is also accepted for CSU credit.

Drafted: 5/19/03
Revised 2/4/05
Revised 5/6/09
Updated 12/10