Summer 2015 Campus Courses

June 15-19, 2015

CSCI 591 Computer Science in the Classroom: An Introduction to Computational Thinking
Instructor: John Paxton, Computer Science Department, MSU-Bozeman

Textbook requirement: Materials provided by instructor.
Course Information:
Class: MTWRF 8:00 am to 5:00 pm
Location: EPS 254

Course Description:
The course examines the computing field and how it impacts the human condition. Exciting ideas and influential people are introduced. A gentle introduction to computational thinking using the Python programming language is provided. The course also introduces participants to robotic platforms.

June 22-26, 2015

BIOE 520 Understanding and Managing Animal Biodiversity in the Greater Yellowstone Ecosystem
Instructor: Jay Rotella, MSU Ecology Department (vita on file)

Textbook requirement: Materials provided by instructor.
Course information:
Class: M 8:30 am to 12 Noon; Lunch break; Afternoon Field Trip 1:00 to 5:00 pm
Location: Lewis Hall, Room 304
Field Trips: TWRF 8:00 am - 5:00 pm

Course Description:
The Greater Yellowstone Ecosystem is a dramatic setting composed of lands that vary widely in terms of their elevation, soils, habitat features, & animal diversity, as well as in terms of land ownership, land use, and wildlife management. This course is designed to explore how animal diversity is distributed across the Greater Yellowstone Ecosystem (GYE), why such a distribution exists, & the consequences of those distributions to animal conservation. To gain a better understanding of the causes & consequences of spatial patterns of biodiversity, we will explore a variety of locations in Yellowstone National Park and its surrounding National Forests, Wildlife Refuges, and private lands.

This course will have the following components for studying animal conservation in the GYE in today's changing world:

1. Who are the animals of the GYE? Field identification, species ecology and life histories, and species-specific habitat needs.
2. How are species distributed across the GYE? Where is diversity high versus low? Why might such patterns exist?
3. How well do the distributions of species overlap with (a) existing National Park lands, (b) other wildlife reserve lands, and (c) private lands?
4. How can we use knowledge of such patterns to conserve diverse species of wildlife in the GYE?

The course builds foundations in morning lectures, discussion, quizzes and lab exercises. Field trips include visits to diverse habitats in Yellowstone National Park and surrounding lands, techniques of animal identification, and in-depth discussion of key topics in the course. Field trips seek to build an understanding of the unique challenges of and innovative strategies for managing diverse species in a complex and changing world.
Physical Fitness Requirement: Field trips require walking up to 2 miles on moderate slopes on established trails.

PSPP 548 Flowering Plants of the Northern Rocky Mountains

Instructor: Robyn Klein, MSU Plant Sciences and Plant Pathology Department (vita on file)

Textbook requirement:
Author: Harris, James and Harris, Melinda
Title: Plant Identification Terminology: An Illustrated Glossary
Publisher: Spring Lake Publishing
ISBN: # 978-0964022164
Textbook available through the MSU Bookstore.
Course Information:
Class: MT 9:00 am - 4:00 pm; Location: Plant Growth Center, Room 214
Field Trips: WRF 9:00 am - 4:30 pm

Course Description:

A field oriented study of the flowering plants of Montana with an emphasis on plant keying skills. Objectives are 1) to identify the parts of flowering plants and become familiar with botanical terms, 2) to learn morphological characteristics of common plant families, 3) to learn how to use a plant key to successfully identify flowering plants, 4) to apply plant identification skills to the classroom. Discussion will emphasize application of these skills and botanical texts to the classroom.

Physical Fitness Requirement: Field trips require walking up to 2 miles on moderate slopes.

PHSX 401 Physics by Inquiry I (1st week of 2 weeks

Instructor: Greg Francis, MSU Physics Department (vita on file)

Textbook Requirement:
Author: McDermott and Shaffer
Title: Physics by Inquiry, Volume 1 & 2
Publisher: Willey
ISBN: #9780471548706
Textbook available through the MSU Bookstore.
Course Information:
Class: MTWRF 9:00 am to 5:00 pm
Location: AJM Johnson Hall, Room 121

Course Description:

Physics 401 is entirely laboratory based. Instead of absorbing facts from a lecture, the students make observations and build scientific models to account for their observations. The course emphasizes the development of basic concepts and reasoning skills, and efforts are made to actively engage students in the learning process. Staff-to-student ratio is of necessity high (two instructors for approximately 20 students), and interactions with staff are through Socratic dialog: the instructors do not give answers, but help the students to find their own. Available computer technology is utilized as appropriate. Physics 401 will begin with a series of activities/observations that will lead to the development of a scientific model for DC electric circuits. The students will be able to solve both qualitative and quantitative problems involving very complicated circuits containing batteries and bulbs. For example, they will be able to rank the brightness of the identical bulbs without relying on the rote use of equations.

The in-service teachers will also use shadow plots to develop a model for the relative motion of the earth and sun during the course of the semester. They will also make careful observations of the moon, and from their observations piece together a model to explain the phases of the moon.

The curriculum used will be the Physics by Inquiry modules developed by the Physics Education Group at University of Washington. This curriculum is based on two decades of research on student misconceptions. Each activity is designed to elicit those misconceptions known to block learning, and to allow the student to confront and resolve the difficulties. Students are often presented with several opportunities to confront the same misconception in increasingly rich contexts to insure that they are completely free of the misconception. This teaching approach has a three-fold advantage when used with future teachers: 1) They come away from the class with a clear understanding of the physics based on their own experience; 2) They acquire an awareness of those difficulties with which their future students are likely to be struggling; 3) Most importantly, they acquire a self-confidence in their ability to do science, to face unknown situations and find their own answers. Their teaching will be free of references to higher authority. They will be able to predict the time of the high tide (a skill more useful in other states) by looking at the phase of the moon and using their model. And it will be their model because they will build it for themselves, from the ground up.

June 22-27, 2015

GEO 521 Dinosaur Paleontology I

Instructor: Dan Lawver, Doctoral Candidate, Department of Earth Sciences, MSU-Bozeman (vita on file)

Textbook requirement: Materials provided by instructor.
Course Information:
Class: MTWRF Depart Monday 8:00 am for Field Camp at Makoshika State Park
Location: Meet van at MSU Strand Union Building, South Entrance

Course Description:

This course is designed as an introduction to the geology and dinosaur paleontology of the Hell Creek Formation of eastern Montana. The Hell Creek Formation has long been known for its diverse dinosaur taxa, including Tyrannosaurus rex and Triceratops, as well as exposures of the iridium layer associated with dinosaur extinction 65 million years ago. The combination of slide presentations, labs, and daily hiking in Makoshika State Park will provide both background information and "hands-on" learning experience. Techniques covered during the class include interpretation of sedimentary environments, taphonomy, and fossil collection and preparation. This course will integrate many aspects of biology, physical geology, paleogeography, and tectonics.

Two transportation options are available: 1. Vans will leave from the Strand Union Building (south entrance) on the MSU campus at 8 a.m. Monday morning and drive to Makoshika State Park near Glendive, MT. Approximately driving time is seven hours. 2. Participants may drive their own vehicles and meet Monday, June 22nd 4pm at the Lion's Club facility, Sleepy Hollow Lodge within Makoshika State Park. Lunch will be provided on travel days. The facilities include individual cabins that are rustic but completely furnished and accommodate 4 to 6 students, a lodge where meals will be provided, and a separate shower house with toilet facilities. Students should furnish their own bedding and personal items such as towels, shower shoes, etc. Special dietary requirements should be noted on the registration form. Students should have appropriate hiking boots and be prepared for rain and cool weather. Additional required items include backpack, field notebook and pencils, and water containers (3-4 liters total capacity).

Physical fitness requirements: The course requires moderate to strenuous outdoor physical activity. Students are expected to walk several miles, often in relatively steep terrain without established hiking trails. Temperatures are often in the 90°F range. Please contact the instructor before signing up for this class if you have concerns about the required physical fitness level and your ability to meet these requirements.

June 27, 2015

ERTH 594 Geology Seminar: Geology of Mars

Instructor: Dave Lageson, Professor of Geology, MSU Earth Science Department (vita on file)

Segments of this course will involve hands-on interpretation of geologic (geomorphic) features on Mars. Therefore, students should come prepared with a few basic drawing and coloring supplies:

- Colored pencils and/or colored markers
- Mechanical pencil and eraser
- Ruler
- Notebook paper (for taking notes and/or making sketches)

Course Information:
Class: Sat 8:00 am to 5:00 pm
Location: Gaines Hall 143 (Lab Gaines Hall 140)

Course Description:

This course will focus on the planetary evolution and geology of the Red Planet, Mars. Mars has intrigued astronomers and geologists since long before the invention of the telescope, when its distinctive red color inspired ancient Greeks and Romans to name it the God of War (Greek – Ares). The surface of Mars is geologically variable and includes one of the largest volcanoes in the solar system (Olympus Mons), an incredibly deep and long canyon system that dwarfs the Grand Canyon (Valles Marineris), polar ice caps, a low basin in the northern hemisphere that may have been the floor of an ancient ocean (Borealis Basin), dune fields, and dendritic stream channel systems, to name a few. Mars has been the subject of intensive planetary exploration, with both orbiting spacecraft and surface rovers, often with the objective of determining if microbial life did (or does) exist on the planet's surface. Therefore, we will also explore scientific theories for planetary habitability and the origin of life on Earth and other planets and moons, within and outside of our solar system. New data and images from NASA's Mars Science Laboratory (Curiosity Rover) will be incorporated into this one-day course.

June 27-28, 2015

MB 591 Project Microbe (1 cr)
Instructors: Mark Young and Rachel Whitaker, MSU Microbiology Department
Course Information:
Class: 8am – 5pm
Location: TBD
This two day course will expose students to a range of microbiology topics and curriculum materials they can incorporate into their secondary science classroom. Students will experience the classroom activities, reflect on them, and discuss how these activities could be modified for their classroom and students. At the end of the course, students will present their modifications and share how they plan to use the curriculum materials and student activities. Topics will include: 1) the story of how the tree of life model changed over time and related concepts about the nature of science, 2) the scale and diversity of microbes, 3) constructing Winogradsky columns and modeling the nutrient cycling between microbes, 4) variety of microbes and their roles in and on the human body, and 5) effects of antibiotics on the human microbiome.

June 29-July 3, 2015

BIOE 523 Wildlife Ecology of the Northern Rocky Mountains
Instructor: Dave Willey, MSU Ecology Department (vita on file)
Textbook requirement: Materials provided by instructor
Course Information:
Class: M 8:00 am - 5:00 pm
Location: Lewis Hall, Room 407
Field Trips: Depart 6:00 am Tuesday for 3 nights, Return Friday
Course Description:
The course is designed as an introduction to the Ecology of the Rocky Mountains as showcased within Yellowstone National Park. The Park may well be one of the few intact wild ecosystems in the lower 48 states. The course content will include principles and techniques for studying wildlife populations in the field. This course will also focus on large mammalian and avian wildlife populations that occupy terrestrial ecosystems within the Northern Rocky Mountains. The course will have the following components:

1. Examine key principles of ecology, particularly population ecology, and review fundamental connections among species, populations, communities, and ecosystems.
2. Use the platform of ecology to discern methods to study wildlife responses to human disturbances (e.g., habitat loss, increased urban development and encroachment in wilderness, and global warming).
3. Explore contemporary issues of wildlife management within the Northern Rockies (e.g., wolf reintroductions in Yellowstone National Park).

This course will be based in the wildlife lab on MSU's campus on Monday. During Tuesday through Friday, the course will be field-based. We will leave Bozeman on Tuesday and return to Bozeman on Friday mid-day. We will camp for three nights during the week and cook our meals at campsites. Transportation will be provided by the MSU motor pool (vans) - no personal vehicles permitted (no exceptions).
A maximum of 10 students are allowed to take this course. To enroll in this campus summer field course, email the MSSE Office (dianap@montana.edu) and ask to be added to the waiting list.

Students are expected to provide the following minimum equipment for their camping needs:
1. One- or two-person, light-weight, non-bulky tent (no big, heavy "family" tents – we won't have room for these); team up with another student to share a two-person tent if possible
2. Sleeping bag and pad (no bulky air mattresses)
3. Basic cooking equipment + utensils (team-up with another student) – no big Coleman stoves or lanterns (bring small, lightweight, back-packing equipment)
4. Minimal clothing for one week (layers for hot and cold weather)
5. Largest can available of bear "pepper-spray" (active ingredient = capsaicin)
6. Personal toiletries, sunglasses, hat, daypack, water bottle, sunscreen, camera, field notebook and pen, etc.

7. Food for 1 day (we will restock food supplies on a daily basis, or as needed)
8. Large coolers will be provided for perishable food. **(see next page for physical fitness requirements)**

Physical Fitness requirements: The course requires moderate outdoor physical activity. Students are expected to walk several miles, often in relatively steep terrain without established hiking trails. Please contact the instructor before signing up for this class if you have concerns about the required physical fitness level and your ability to meet these requirements.

LRES 557 Thermal Biology in Yellowstone Park (Co-listed as MB 547)

Instructors: Brent Peyton PhD, MSU Department of Chemical & Biological Engineering; Christine Smith, MSU Thermal Biology Institute

Textbook requirement: Students to purchase book from instructor ($20).
Course Information:
Class: MRF 9:00 am – 5:00 pm
Location: Gaines Hall 143 (classroom), Gaines Hall 249 (lab)
Field Trip: WR Depart Wednesday 8 am, Return Thursday 6 pm (Tent camping*)
Location: Meet van at MSU Strand Union Building, South Entrance

Course Description:

This course will provide a survey of the ecology of important organisms common in thermal habitats of Yellowstone National Park, including a review of different life forms and the physical and chemical habitats that define their environment. The course is structured to provide (1) a basic understanding of the ecology of a variety of life forms in thermal habitats, (2) a survey of observational techniques and hands-on activities appropriate for science educators, and (3) a field trip to visit and characterize several geothermal habitats environments. Fundamental principles of thermal biology will be emphasized during lectures and methods of chemical, physical and biological analyses will be emphasized during the laboratory component while on the MSU campus. A two day field trip to Yellowstone National Park (that includes camping in the park*) will include discussion, sampling and characterizing diverse geothermal habitats.

Course Outline:
1) Introduction: Ecology of Thermal Environments
2) Chemical and Physical Properties Important in Geothermal Systems
3) Microbial and Viral Diversity in Thermal Habitats
4) Fungi, Algae, and Plants; Eukaryotes in Thermal Environments
5) Field Experience: Observe, describe and characterize diverse geothermal environments.

*Tents and sleeping pads will be provided. Students will need to bring a sleeping bag. Sleeping bags are available for rent at the ASMSU Outdoor Recreation department by visiting http://www.montana.edu/outdoorrecreation, or by phone at (406) 994-3621.

Physical Fitness Requirement: Field trips will require walking distances of up to 5 miles with moderate slopes and will involve being in the field for the majority of the day. Weather may vary!

ERTH 516 Northern Rocky Mountain Geology

Instructor: Dave Lageson, MSU Earth Science Department (vita on file)

Textbook requirement: Materials provided by instructor.
Course Information:
Class: MTWRF Daily Field Trips, Departure 8:00 am
Location: Meet van at MSU Strand Union Building, South Entrance

Course Description:

This course will investigate the geological history and evolution of the Northern Rocky Mountain region. Topics to be covered will include local stratigraphy, the Laramide and Sevier orogenic events, volcanism in and around Yellowstone National Park, earthquake activity within the Intermountain Seismic Belt, and many more. Daily field trips from campus will provide "hands-on learning" in some of the best-exposed, classic geologic localities in the Rocky Mountains. The course will integrate many aspects of physical geology, historical geology, geomorphology, structural geology, seismology, volcanology, and tectonics in a manner that is relevant and applicable to the region surrounding Montana State University.

Physical fitness requirements: In order to study the geology of the greater Yellowstone region in the field, this course will involve outdoor physical activity. Students are expected to hike in moderate mountainous terrain in order to accomplish course goals, namely hands-on field experience with geologic observations and interpretations.

Interested students should **contact Diana in the MSSE office to register for the course** and to communicate their ability to meet the physical fitness requirements for the course. Please email Diana at dianap@montana.edu.

PSPP 591 Plants, People, and Health
Instructor: Robyn Klein, MSU Plant Sciences and Plant Pathology Department (vita on file)
The following book is recommended:
Author: James Green
Title: The Herbal Medicine-Maker's Handbook: A Home Manual
Publisher: Clarkson Potter/Ten Speed/Harmony
ISBN: 9780895949905
http://www.barnesandnoble.com/w/the-herbal-medicine-makers-handbook-james-green/1111611314?ean=9780895949905
Course Information:
Class: MTWRF 9 am-4 pm
Field Trips: T 10:45 am-1:00 pm
Location: Plant Growth Center, Room 214
Course Description:
This interdisciplinary course investigates how plants and people intersect, with a focus on the current popular and scientific interest in using plants and their compounds for health and medicine. The subject will be applied to ethnobotany, botany, and phytochemistry. Enhancing the links between the natural world and the classroom can bring meaning to all the science and instill an interest in the investigation of plants and their uses.

The course will have the following components:
1. Application to Ethnobotany: relationships between people, flora, and environment.
2. Application to Botany: plant defense, co-evolution, chemical communication.
3. Application to Phytochemistry: plant biosynthetic pathways for secondary compounds and classes of plant compounds.
4. Application to Chemistry: making herbal products from plant material.

Laboratory: The last day will be spent with hands-on experience making some herbal products to enhance the learning opportunity.

PHSX 401 Physics by Inquiry I Continuation (2nd week)

July 6-10, 2015

EDCI 575 Symposium in Science Education
Instructor: Peggy Taylor, MSU IPSE Department (vita on file)
Textbook requirement: None
Course Information:
Class: MTWRF 7:00 am to 5:00 pm
Location: Reid Hall, Rooms 101, 102
Course Description:
Each Master of Science in Science Education (MSSE) student, under the guidance of her or his graduate committee, identifies and completes a science education capstone project. Each project is designed to provide experience and information that aids our understanding of science teaching-learning or science curriculum. The capstone project topic is identified during the student's graduate program and relates to science education in the student's educational setting or provides the student with a science research experience that can be connected to the student's educational setting. The capstone project links multiple courses in the student's program of study in both the core and science content areas. A student begins the capstone in the fall of the final year by submitting a brief proposal to his/her advisors.

The results of each student's capstone project are summarized in a written, professional paper completed by mid-term of the final summer session. In addition, during the final summer session of a student's graduate program each student presents their capstone project to their committee, their classmates, and other interested persons at the Symposium in Science Education.

BIOE 591 Land Use Issues in the Greater Yellowstone Ecosystem

Instructor: Jerry Johnson, MSU Political Science and Ecology Departments (vita on file)

Textbook requirement: Materials provided by instructor.
Course Information:
Class: M 8:00 am to 12:00 noon
Location: Lewis Hall 407
Field Trips: M 1:00 pm to 5:00 pm, TWRF Field Trip: 8:00 am to 6:00 pm

Course Description:

This course will lay the groundwork for an understanding of the legal and political basis for scientific management of natural resources on public and private lands in the Greater Yellowstone Ecosystem. Readings, field visits and skill-building exercises will equip science educators with the social context of complex ecological issues.

Issues facing policy makers in complex administrative jurisdictions like the Greater Yellowstone Ecosystem require a consideration of the social, legal and economic environment as well as understanding the scientific questions. Both are necessary if society is to successfully address issues like recovery of endangered species, rural sprawl, or wildfire. The laws that govern the development of the vast storehouse of natural resources in the West are based in a time some call the era of the "Lords of Yesterday". They are the product of a more freewheeling period of our economic and political history. They include water law, hardrock mining law, timber and grazing, and the designation of Yellowstone National Park in 1872. These laws play a direct role in how and why the resource agencies manage public lands in the West.

Today, economic, social, and political changes are sweeping the West. The emergent New West is often in conflict with the Old as extractive industry gives way to tourism, retirees, and a service-based economy. While the impacts of our extractive history are well understood, those resulting from rapid land use and social change are less so; from employment patterns to politics, the new west is different from the old.

LRES 569 Ecology of Invasive Plants in the Greater Yellowstone Ecosystem

Instructor: Bruce Maxwell, MSU Land Resources and Environmental Science Department (vita on file)

Textbook requirement: Materials provided by instructor.
Course Information:
Class: MTWRF 8 am to 5 pm
Location: ABS Hall Room 238 from 8 am to 11 am; ABS 234 from 12 Noon to 5 pm
Field Trips: M-F

Course Description:

This five day course includes 3 days in the field making measurements on exotic invasive plants at a range of sites from the Gallatin Valley to the Gallatin National Forest and 2 days analyzing the data and using simulation models to explore plant invasiveness. The focus of this course is to directly involve students with testing methodology for monitoring the invasive potential of several exotic species in otherwise pristine mountain environments.
The questions that we will examine are:

1. Can we detect change in non-indigenous plant populations that will allow us to judge them as invasive?
2. What should be the criteria for determining if a non-indigenous plant species can have a significant impact on the ecosystem?
3. What should be the criteria for determining if a non-indigenous plant species can have a significant impact on the ecosystem?

Students will read the most current theories on what makes species invasive and what conditions invite or detour non-indigenous plant species. At least 1/3 of the field time will be used to discuss how these theories apply to our system.
Data analysis will place each student with a computer and include the use of Excel software. Small groups will be created and each group will analyze a different portion of the field data. Integration of field ecology into K-12 classes will be discussed throughout the course.

CHMY 594 Science Lab Safety and Risk Management

Instructor: Steve Holmgren, MSU Chemistry Department (vita on file)

Textbook requirement: Materials provided by instructor.
Course Information:
Class: MTWR 1:00 pm - 4:00 pm
Location: CHBCH 3

Course Description:
This seminar provides information on safe school laboratory practices including protocols for chemical purchase, storage and disposal, as well as the use of personal safety equipment. Fire control procedures will be addressed including a hands-on fire extinguishing experience. Personal risk and liability will be discussed. Biological lab safety issues will also be considered.

July 12-16, 2015

GEO 522 Dinosaur Paleontology II
Instructor: Dan Lawver, Doctoral Candidate, Department of Earth Sciences, MSU-Bozeman (vita on file)
Textbook requirement: Materials provided by instructor.
Course Information:
Class: SMTWR Depart Sunday 8:00 am for Field Camp at Egg Mountain, Choteau
Location: Meet van at MSU Strand Union Building, South Entrance
Course Description:
The goal and purpose of this course is to provide an in-depth course for grade 7-12 teachers in geology and paleontology that builds on previous experience and field techniques acquired from GEOL 521 Dinosaur Paleontology of the Hell Creek Formation. In addition to providing basic information on geology and paleontology, this field course includes information on how paleontologists use rocks, fossils and extant animals and modern environments to formulate interpretations about the past. By the end of this course, students will be able to identify sedimentary rocks in which fossils are found, use sedimentary structures for interpretation of depositional environments, and have a better understanding of Montana's geologic past.

July 13-17, 2015

BIOE 522 Birds of Prey of the Greater Yellowstone Ecosystem
Instructor: Dave Willey, MSU Ecology Department (vita on file)
Textbook requirement:
Title: National Geographic Field Guide to the Birds of North America, Sixth Edition
Author: Dunn and Alderfer
Publisher: National Geographic; 6 Rev Upd edition (November 1, 2011)
ISBN: 9781-4-26-20828-7
Class: M 8:00 am to 12 Noon; Lunch break; Afternoon 1:00 to 5:00 pm Location: Lewis Hall, Room 407
T 8:00 am to 12 Noon, Afternoon Field Trip 1:30-5pm (Ringling)
W 8:00 am to 12 Noon, Leave for overnight trip 1:30pm (Jack Creek)
Field Trips: T 1:30-5pm, Leave W 1:30pm, return Friday 3pm
Course Description:
This course is designed to explore the ecology and habitats of raptor species that live in the Greater Yellowstone Ecosystem (GYE). Birds of prey include all species of raptors. Raptors are birds with unique specializations for killing prey, e.g., raptorial claw-like feet and massive bills designed to rip, tear, and crush their prey. The course will explore strategies raptors use to find things to eat and safe places to nest. We will pay special attention to the influence of human activities on raptors and their habitats.This course will have the following components for studying birds of prey in the GYE:
1) Who are the Birds of Prey in the GYE? Field identification of raptors, species ecology and life histories, and species-specific habitat needs.
2) Examination of key principles of raptor population ecology (studying survival and reproduction).
3) Reinforce methods of discovery: raptor responses to human encroachment into wilderness.
4) Review inquiry-based learning: the scientific method and things raptors eat (the concept of “resource availability”).

The course builds foundations in morning lectures, discussion, quizzes and lab exercises. Afternoon field trips include techniques of raptor identification and studying raptor ecology. Field trips will integrate methods to study trends in raptor population status and habitat quality.
Physical Fitness Requirement: Field trips require walking up to 2 miles on moderate slopes on established trails and an overnight stay in Jack Creek.

EELE 591 Solar Cell Basics for Science Teachers
Instructor: Todd Kaiser, MSU Electrical Engineering Department (vita on file)
Textbook requirement: Materials provided by instructor.
Course Information:
Class: MTWRF 8:00 am - 5:00 pm
Location: Cobleigh Hall, Room 632
Course Description:
Solar Cell Basics is a course for science educators, to train them to teach principles of solar cells. The course is designed to help science teachers, grades 6 to 12, understand the operating principles and the fabrication processes of modern solar cells that convert light energy to electrical energy. The course has a laboratory component in which solar cells will be fabricated in the Montana Microfabrication Facility (MMF). Each student will process 4 inch silicon wafers using the various steps necessary to make solar cells.

The course prerequisites are a minimum of 2 years successful science teaching experience, enrolled in MSSE degree, or by instructor approval. Participants must hold a bachelor's degree in science, science education or a related area. Participants should have an understanding of basic chemistry and physics principles.

PHSX 403 Physics by Inquiry III (1st week of 2 weeks)
Instructor: Greg Francis, MSU Physics Department (vita on file)
Textbook Requirement:
Author: McDermott and Shaffer
Title: Physics by Inquiry, Volume 1 & 2
Publisher: Willey
ISBN: #9780471548706
Textbook available through the MSU Bookstore.
Course Information:
Class: MTWRF 9:00 am to 5:00 pm
Location: AJM Johnson Hall, Room 121

Course Description:
Physics 403 is a continuation of the Physics 401 experience, but it may also be taken concurrently with Physics 401. The course will begin with a careful investigation of geometrical optics, leading to an understanding of pinhole cameras, lenses, and prisms. This will be followed by an exploration of magnetic interactions and magnetic materials.

The curriculum used will be the Physics by Inquiry modules developed by the Physics Education Group at University of Washington. This curriculum is based on two decades of research on student misconceptions. Each activity is designed to elicit those misconceptions known to block learning, and to allow the student to confront and resolve the difficulties. Physics 401 is either a prerequisite or a co-requisite for Physics 404.

July 20-24, 2015

BIOE 591 Alpine Ecology
Instructor: Dr. John Winnie (vita on file)
Textbook requirement: Course materials provided by instructor online in D2L by June 15, 2015
Course Information:
Field Class: MTWRF 6:00 am - 8:00 pm
Location: Monday 6 am meet van at MSU Strand Union Building, South Entrance
Course Description:
Our primary goals in this course will be to understand how altitude affects the structure, function and evolution of plants, animals and the communities to which they belong, and to create ways to bring this understanding into the grade 6-12 classroom. Through a mix of online, class and field work, students will move rapidly from basic concepts, to hands-on field work and data collection, to the synthesis and presentation of those data. During class time, students will work on ways to integrate the material we gather in the field into multimedia presentations that can be used in teaching modules. In the field, students will collect data that can in turn be analyzed and interpreted

later by their own students. Students will present and share data and teaching module components with each other on the last day of class, Friday.

For us to progress smoothly during the class week based out of MSU, 2 to 3 weeks of background reading and study are necessary. Pre-class week materials, including homework assignments, will be posted on the course's *Desire to Learn* (D2L) website beginning June 15th.

Field class will be based out of the Jack Creek Preserve. During the day, students will work cooperatively to gather data, photos and (optional) video clips in the field, then in the evenings will work together to link visual materials back to the data. The goal here is to create a virtual field trip for primary and secondary level students, illustrating every aspect of a simple descriptive natural history study, from initial observations, to hypothesis generation, to data gathering, to data summary and finally to drawing overall conclusions. In addition, there will be nightly lectures on concepts and topics relevant to alpine ecology, including island biogeography theory and climate change.
Field Trips: We will spend all or part of 5 days in the field (M-F) regardless of weather. During these trips, students will study field craft, data gathering techniques, and take digital photographs and (optionally) video clips to be used in teaching models to illustrate the process of doing science, and basic ecological concepts.
Grading: Grades will be based on a combination of pre-class homework (1/3); mid-class progress and discussion (1/3); final wrap-up discussions and presentation of teaching module components (1/3).
Readings and Online Material: Reading assignments, exercises and supplemental materials will be posted on the class D2L website beginning June 15th, and provided during class week at MSU.
Online portion of the class: June 15 to July 15: Online portion of the class. Visit the course website on Desire2Learn (D2L) for specific assignments and deadline dates.
Field portion of the class: We will be based out of Jack Creek Preserve. Days will be devoted to field work and discussions in the field. Evenings will consist of lectures and break-out group work.
Physical Fitness Requirements: Field days will be long (up to 10 hours) and sometimes strenuous. Students must be prepared to spend the better part of 5 days hiking and doing field work in rugged terrain at high elevations (7000 to 9000'+). Those coming from low elevation areas are encouraged to arrive 7 to 10 days early and spend that time at or above 5000' to acclimatize before class begins. (Most of Yellowstone Park is above 6000'.)

LRES 591 Lake Ecology
Instructors: Stephanie McGinnis, MSU Land Resources and Environmental Sciences Department
Textbook requirement: Materials provided by instructor.
Course Information:
Class Lecture: ABB 238. M 9:00 am- 5:30pm, T 8:30 – 10:30am , F 1:00 – 5:00pm
Class Lab: Gaines 18. R 2:30-5pm, F 9am - noon
Field Trip: Meet vans at ABB building. Depart T 10:15 am, Return R 2:00pm
Course Description:
1. Learn about the biotic and abiotic factors that influence lake dynamics; we will specifically address lakes within Yellowstone National Park.
2. Understand and perform field sampling and taxonomic and genetic identification techniques in the laboratory.
3. Synthesize and apply learned skills and knowledge in the classroom grades 5-12.

MSU educators, National Park Service resource managers, and other agency professionals will be joining the class to provide a multi-disciplinary perspective. The course will take place in Yellowstone National Park and on the MSU campus. Participants will camp in Yellowstone National Park July 21 and 22. Camping equipment can be rented inexpensively thorough REI in Bozeman. Participants should expect 1 or 2 short treks (4 miles or less) and be prepared to be outdoors in any type of weather. Breakfast and lunch will be provided; dinner in Yellowstone is the responsibility of each participant.

PHSX 403 Physics by Inquiry III Continuation (2nd week)

July 25-31, 2015

ERTH 591 Geology of Glacier National Park
Instructor: Dr. Richard Diecchio, Professor of Geology, George Mason University (vita on file)
Textbook requirement: Materials provided by instructor
Course Information:

Class: Welcome BBQ Saturday 25th 6pm, SuMTWRF. Location: Meet van at MSU Strand Union Building, South Entrance

Field trip: Depart Sunday morning for Glacier National Park, return Friday mid-day.

Course Description:

This field course will focus on the geomorphology and history of glaciers, stratigraphy and the history preserved in the strata, structural geology and tectonic history, and other geo-topics as revealed by the wonderful outdoor laboratory in the vicinity of Glacier National Park. Daily hiking, tent camping and outdoor cooking will be the expectation.

Physical fitness requirements: In order to study the field geology of Glacier National Park, this course will involve very strenuous outdoor physical activity. Students are expected to hike several miles at high elevations in rough, rocky, mountainous terrain in order to accomplish course goals, namely hands-on field experience with geologic observations and interpretations. To assure that all students will have the full benefit of the program, please contact the MSSE Office before signing up for this class if you have concerns about the required physical fitness level and your ability to meet the expectations of this course. If you require an accommodation because of a disability, please contact the MSSE Office.

July 27-31, 2015

PHSX 591 Teaching Electricity and Magnetism Using Research-Based Curriculum

Instructor: Greg Francis, MSU Physics Department (vita on file)

Optional Textbook:

Author: McDermott and Shaffer

Title: Tutorials in Physics and Homework

Publisher: Prentice Hall, 2002

ISBN: #9780130970695

Textbook available through the MSU Bookstore.

Course Information:

Class: MTWRF 9:00 am to 5:00 pm; Location: AJM Johnson Hall, Room 121

Course Description:

Many science teachers feel more comfortable teaching mechanics than the more abstract concepts of electricity and magnetism. This is unfortunate, as the application of these principles can be so much more exciting that the block-down-the-inclined-plane types of problems treated in mechanics. Students can be taught how to wire their own home or build electric motors. This five-day course uses essentially the same mode as in "Teaching Mechanics Using Research-Based Curriculum", except that the topics covered will come from the second semester of the typical introductory physics sequence. Participants will learn how to teach an integrated course built around Tutorials in Introductory Physics (McDermott, et al.). This research-based curriculum challenges students to confront their misconceptions and build gut-level models of the key concepts of electricity and magnetism. The course will showcase both the student-centered tutorial instruction and the supporting active-engagement PowerPoint lectures. We will also review the physics education research literature that provides the foundation for these curricular materials. Participants will receive 70 PowerPoint lectures, each with its own description and learning outcomes, designed to engage the students in active learning and provide the necessary links to the Tutorial experience. A complete description of supporting demonstrations will also be provided. Finally, participants will receive a large bank of research-based homework and exam questions designed specifically to elicit the common misconceptions addressed in the Tutorials. Dr. Francis is the director of the Conceptual Astronomy and Physics Education Research (CAPER) Team in the Department of Physics at Montana State University, where he teaches algebra-based physics in classes of up to 210 students per section. Over the last several years, he has developed a relatively low-budget, high-impact program of physics instruction that is producing gains on the Force Concept Inventory (a widely used test of conceptual understanding in basic mechanics) that are as good or better than lab-based programs that, by their design, require resources that are simply not available to many physics instructors. In addition, a study demonstrating a high long-term retention rate ("Do They Stay Fixed?" The Physics Teacher, 36(8), p. 488 (1998).) suggests that the program is doing much more than training them to give the right answers—it is changing their world view.

Summer 2015 Online Courses

June 15 - July 31, 2015 (Individual course lengths may vary. Exact dates are included in the course descriptions.)

BIOE 513 Terrestrial Ecology of Plains and Prairies
Instructor: Joseph Bradshaw, MSU IPSE Department (vita on file)
Textbook requirement: Materials provided by instructor.
Course Description:
Grassy areas – plains, prairies and meadows – rarely get the attention that lakes do, for example, or forests. But are grassy areas really that boring? What is the difference between the grass in your lawn and the bunchgrass in the field? Why are grasslands of any size important? How does land use change community composition?
In this course, we will take a closer look at one or two grass communities near your home or school and address these questions and others. You will complete six activities in this course:
1) Examine grass plants and learn some of their biology.
2) Locate and describe an important grassland in your area, a park, for example, explaining why it is special.
3) Locate and describe one or two study areas for your class project that ideally could be used for your own classroom activities.
4) Identify 8-10 major plants in your study areas and construct a dichotomous key to the plants that could be used by your students.
5) Quantitatively compare two features between or within your study areas, collecting data and analyzing them statistically (a sample statistics problem will be provided).
6) Write a short paper on your project, following scientific paper format. A "Question of the Week" will spark discussion among class members.
This course will get you outside, investigating areas that you find interesting and relevant to you and your students. It may be combined with BIOL 519, Biology of Riparian Zones and Wetlands, for observing similarities and differences between drier and wetter communities.

BIOE 519 Biology of Riparian Zones and Wetlands
Instructor: Joseph Bradshaw, MSU IPSE Department (vita on file)
Textbook requirement: Materials provided by instructor.
Course Description:
Building a home along the bank of a river (riparian zone) or draining a wet area (wetland) for "useful" purposes are commonplace activities throughout the country. But how do these activities change the functions of naturally occurring riparian zones and wetlands?
In this course, we will explore the structure and functions of these areas transitional between dry and aquatic communities, and their importance in the natural world. You will complete six activities in this course:
1) Read some on-line material about riparian zones and wetlands, and discuss the material.
2) Locate and describe an important riparian zone or wetland, a park for instance, in your area, explaining why it is special.
3) Locate and describe one or two study areas for your class project that ideally could be used for your own classroom activities.
4) Identify 8-10 major plants in your study areas and construct a dichotomous key to the plants that could be used by your students (or friends).
5) Quantitatively compare three features between or within your study areas, collecting data and analyzing them statistically (a sample statistics problem will be provided).
6) Write a short paper on your project, following scientific paper format. We will have a "Question of the Week" for sparking discussion among class members.
Science standards, federal and state, usually require field activities and ecological understanding. This course will get you outside, investigating areas that you find interesting and relevant to you and your students. This course can be combined with BIOL 513, Terrestrial Ecology of Plains and Prairies, for heightening awareness of the similarities and differences between grasslands and wetter areas.

BIOL 591 Anatomy & Physiology
Instructor: Cherie McKeever, MSU Great Falls, Science Department (vita on file)
Textbook requirement: Students may use any current college-level Anatomy & Physiology book they have.
Course Description:
This course is designed for high school and post-secondary teachers of human anatomy and physiology and presumes the student already has a solid foundation in A&P. This course provides an introduction to the use of case studies as an effective way to integrate problem based learning into the human anatomy and physiology classroom. It is a methodology course designed for instructors who are already comfortable with fundamental physiological concepts. Students will review various physiological principles of the human body and then explore clinical applications of these principles via case studies. During the semester, students will participate in discussions regarding various physiological concepts, the use of case studies to improve student comprehension and build critical thinking skills, as well as critiques and modifications of presented case studies to help individuals build a collection of classroom-ready case studies. By semester's end, each student will also develop an original case study for use in their high school or post-secondary A&P classroom.

CHMY 591 Chemistry of the Environment: Water, Air, Earth
Instructors: Bill McLaughlin, Steve Holmgren, MSU Chemistry Dept (vita on file), Amy Washtak, IPSE Dept
Textbook requirement:

Author: G.W. vanLoon and S.J. Duffy
Title: Environmental Chemistry: A Global Perspective
Publisher: Oxford University Press
ISBN: #978-0-199-22886-7
Textbook available through MSU Bookstore
AND
Optional textbook for teachers who teach grades 6-9:
Author: G.W. vanLoon and S.J. Duffy
Title: Environmental Chemistry
Publisher: Walch Publishing
ISBN: #0-825-150-045-0 or 978-0-285-15045-6
Textbook available through MSU Bookstore

Course Description:
This course is designed to familiarize students with basic general science and chemistry concepts of the environment, including water, air and Earth - as well as to provide opportunities to enrich these chemistry concepts through applications and examples. Since this course will be building upon basic chemistry concepts, it is assumed that teachers taking this course have taken general chemistry at the undergraduate level, or the equivalent.

The course will integrate chemistry concepts of water, air and Earth with environmental context. Instructors will use naratives, supplemental reference book examples, internet examples, as well as material complied on the student's part. The textbook will be used as a basis for the course but students will be required to utilize materials from various resources, including but not limited to: the Internet, local professionals and their own classroom materials. Students will complete two original curriculum teaching projects derived from course content, which are designed to complement existing classroom content.
Students will be assessed through the following ways:
• Weekly on-line discussions of a topic posed which is derived from the weekly narrative
• Concise weekly homework questions derived from chemistry concepts explored in narratives and supplemental textbook
• The development of two complete and original curriculum projects derived from course content and one original essay response pertaining to chemistry content.

CHMY 591 Exploring Biochemistry I
Instructor: Angie Sower, MSU Chemistry & Biochemistry Department (vita on file)
Textbook requirement:

Author: Moran
Title: Principles of Biochemistry
Publisher: Prentice Hall
ISBN: # 9780321707338
Textbook available through MSU Bookstore

Course Description:
The course will consider the reactions of the principle biochemical molecules (carbohydrates, lipids, proteins, and nucleic acids) with additional emphasis on biomedical topics. The primary goal of this course is to promote critical thinking about important, current health issues and to examine the role of laboratory modules in teaching these concepts. General biochemistry principles will be presented to understand the diseases under review. Written material will be provided on advanced topics.

CHMY 591 Exploring Chemistry
Instructor: Candace Goodman PhD, MSU Chemistry Department (vita on file)
Textbook requirement:

Author: McMurray & Horton
Title: Chemistry in Context
Publisher: American Chemical Society, MCG Publisher
ISBN: # 9780073375663
Textbook available through MSU Bookstore

Course Description:
This course provides an in depth discussion of critical concepts in chemistry. Chemical principles will be presented in the context of real-world issues including energy production (biofuels), chemistry of water, and polymers. Additional emphasis will be placed on the role of experimental sciences in teaching reading, writing, and logical thinking across multiple student backgrounds. Appropriate student laboratory designs will be addressed.

CHMY 591 Environmental Measurement: Sensors & Electronics (Waiting for Final Approval)

ERTH 591 Fundamentals of Oceanography
Instructor: Dr. Sean Griffin, Marine Science
Course Description:
Fundamentals of Oceanography offers an introduction to the physical, biological, chemical and geological processes of the ocean and its ecosystems. Teachers will learn about the complex interactions between these properties, their influence on terrestrial ecosystems and the impacts humans have on these processes. Exciting laboratory exercises can be adapted to be offered at any grade level.

ERTH 591 Understanding Climate Change
Instructor: Dr. Jordy Hendrikx, Earth Science Department, MSU-Bozeman
Course Description:
The science of climate change is a complex subject that balances the physical record and scientific fact with politics, policy, and ethics. This course explores the science of climate change. Students will learn how the climate system works, what factors cause climate to change across different time scales and how those factors interact. We will also explore how climate has changed in the past and how scientists use models, observations and theory to make predictions about future climate. Finally we will examine the possible consequences of climate change for our planet. The course explores evidence for changes in land and ocean temperature, changes in the cryosphere, sea level and acidity change due to global warming. Students will learn how climate change today is different from past climate cycles and how satellites and other technologies are revealing the global signals of a changing climate. Finally, the course looks at the connection between human activity and the current warming trend and considers some of the potential social, economic and environmental consequences of climate change.

In light of the changes we have already observed, and the projected future changes it is imperative that we equip our teacher and educators with the tools to better prepare and motivate the next generation of scientists in this field. In this course we will build an understanding of climate change and how it will impact our future.

The course goals for teachers in grades 9-12 are to:
Increase content knowledge about climate change,
Increase pedagogical skills related to teaching climate change topics, Create a "tool-kit" of teaching activities relating to climate change, and engender changes in teacher-participants' classrooms that lead to an increased quantity and quality of climate change, weather and climate related instruction.

These goals are accomplished through a highly structured series of on-line lectures, web based activities using a range of on-line resources, and participant discussions on developing classroom activities. This course is specially designed for practicing science teachers at the upper middle to high school level.

EDCI 537 Contemporary Issues in Science Education
Instructor: John Graves, MSU IPSE Department (vita on file)
Textbook requirement: Materials provided by instructor.
Course Description:
This course is designed to provide an overview of pertinent contemporary science education issues and how to incorporate these ideas into an instructional setting.
This course will help students learn the conceptual underpinnings of best practice approaches to science education and professional development as they relate specifically to teaching and learning science at multiple levels, including traditional classrooms and informal science education settings. Topics covered include science education reform efforts, technology in instruction, science education standards, assessment, teachers as leaders, controversial issues in the science classroom and more. Weekly assignments include online readings, discussion among colleagues and reflection on the content.
John has over 35 years of experience with middle school and university instruction. He has a passion for helping teachers remain current with best practices in science education.

MSSE 591 Capstone Data Analysis
Instructor: Terrill Paterson, MSU IPSE & Math Department (vita on file)
Textbook requirement:

Author: Christmann
Title: Beyond the Numbers: Making Sense of Statistics
Publisher: National Science Teachers Association
ISBN: # 9781935155256
Textbook available through MSU Bookstore

Course Description:
This course is designed to provide graduate students in science education with a background in basic descriptive and inferential statistics. By the end of the course, students will be able to choose the most appropriate method to both describe their data and display that data in a clear and concise manner. Students will be able to perform hypothesis tests using a variety of parametric and non-parametric methods with an understanding of the assumptions and limitations of each method as applied to the analysis of capstone data. Students will be able to perform one-way analysis of variance tests in addition to chi-square tests for categorical data. Through the examination of the appropriate use of each of these statistical tools, students will be able to better design their capstone projects so as to maximize the likelihood of addressing their research topics.

MSSE 501 Inquiry through Science and Engineering Practices
Instructor: John Graves, MSU IPSE Department (vita on file)
Textbook requirement (Choose one of the following):

High School Teachers
Author: Llewellyn
Title: Teaching High School Science through Inquiry and Argumentation
Publisher: Corwin Press
ISBN: 978-1-4522-4445-7
OR
Elementary and Middle School Teachers
Author: Llewellyn
Title: Inquire Within: Implementing Inquiry-based Science Standards in Grade 3-8
Publisher: Corwin Press
ISBN: 978-1-4522-9928-0
Textbooks Available at the MSU Bookstore

Course Description:
This course takes a practitioner's look at the art of inquiry instruction appropriate to all learning settings, including, but not limited to classrooms, museums, planetariums, etc. Using many of the current pedagogical approaches of instruction including constructivism, misconceptions, the 5 E learning model, reflective practice, conceptual change

theory and others, students in this course will critically examine their current instructional practice and together craft new approaches to teaching inquiry in the science classroom through the lens of the Science & Engineering Practices as outlined in A Framework for K-12 Science Education. Course assignments include readings, reflections on Science & Engineering Practices, discussions and the completion of an individualized inquiry project. Students in the course can expect a highly active, fully engaging, professionally stimulating class session each week.
John has over 35 years of experience with middle school and university instruction. He has a passion for inquiry instruction and models thought-provoking, challenging examples of research-based best practices of inquiry instruction through the Science & Engineering Practices. The emphasis of the course will be on helping teachers gain the skills necessary to improve inquiry teaching in their teaching settings.

MSSE 591 Framework for Science Education
Instructor: John Graves, MSU IPSE Department (vita on file)
Textbook requirement:

Author: Quinn, Schweingruber, & Keller
Title: A Framework for K-12 Science Education
Publisher: National Research Council
ISBN: # 9780309217422
Free pdf download available online

Course Description:
The Framework for Science Education course provides teachers with any overview of A Framework for K-12 Science Education. The course will familiarize teachers with the eight science and engineering practices and seven Crosscutting Concepts from the Framework. The course utilizes activities that engage teachers in the Practices and Crosscutting Concepts with the goal of developing understanding of each Practice. The outcome of the course will be deeper conceptual understanding of how to implement the Framework in the context of science and engineering instruction K-12.

John has over 35 years of experience with middle school and university instruction. He has a passion for helping teachers remain current with best practices in science education, including the Framework and NGSS.

MSSE 591 Web Tools for Science Teachers
Instructor: Eric Brunsell, MSU IPSE Department (vita on file)
Textbook requirement: Instructor will list online articles that student must purchase for course. Articles are free for NSTA members.
Course Description:
In this course, teachers of science will explore ways to use technology to enhance student learning. The purpose of the course is twofold. First, the course will assist educators in effectively using the web to enhance their professional learning. Second, the course will assist educators in using web tools, many of which students are already comfortable with using in social settings, to enhance student learning and ownership. The specific goals of this course include the following:
1. Articulate a rationale for using Internet-based technology during instruction.
2. Explore pedagogical innovations including flipped classroom approaches, gamification and other ways to use technology to create a student- centered environment.
3. Develop an initial personal learning network.
4. Explore a variety of web-based technology tools and example projects, including blogs, wikis, Google Docs, Google Earth, podcasting, screen capture, and photo sharing services, for professional growth and enhancing instruction.
5. Create a plan for implementing technology into the classroom.

LRES 591 Streamside Science: Hands-On Approach
Instructor: Amber Kirkpatrick, Department of Land Resources and Environmental Sciences, MSU-Bozeman
Course Description:
The primary goal of this course is to increase the water resource knowledge of students through hands-on, field-based curriculum. To accomplish this, students will be asked to adopt a local stream and perform lab assignments "in the field" to better understand hands-on water quality monitoring techniques. The course will improve the teaching skills of secondary science teachers utilizing distant delivery technologies. By completing this course, secondary science teachers will have a better understanding and hands-on working knowledge of the characterization and quantification of water quality as it relates to secondary school science curriculum and

environmental issues on a global scale. Curriculum standards will be linked to each lesson plan so that teachers can easily incorporate the content into their core curriculum.

MATH 518 Statistics for Teachers
Instructor: TBA, Department of Mathematics, MSU-Bozeman
Course Description:
This course will focus on the stochastic concepts that arise in mathematics and science education, including the probabilistic underpinnings of statistics, measures of central tendency, variability, correlation, distributions, sampling, simulation, and experimental design. This course will also focus on the issues of teaching statistics concepts at the pre-college level, including methods and materials.

MB 541 Microbial Genetics
Instructor: Elinor Pulcini, MSU Center for Biofilm Engineering (vita on file)
Textbook requirement: Materials provided by instructor.
Course Description:
This course is designed to provide an understanding of the fundamentals of genetic processes in bacteria (prokaryotes). Why bacteria instead of higher organisms or eukaryotes?

1) The study of bacterial genetics has provided much of the understanding of fundamental genetic processes for all organisms, especially through the use of *in vivo* and *in vitro* genetic tools.

2) Prokaryotic genetics is somewhat simpler than eukaryotic genetics due to the organization of the cell, its genome and transfer of genetic information. However, the basic concepts such as transcription, translation, mutation, and recombination are similar if not identical in all organisms.

3) The short generation time of bacteria lends themselves to genetic studies. Bacterial genetics labs are becoming easier to use, are relatively inexpensive and provide an ideal platform for genetic studies in the secondary school setting. It is critical that science teacher, then understand the fundamental processes of genetics particularly as they apply to microorganisms.

MB 540 Environmental Microbiology
Instructor: Dr. Jim Burritt and Nancy Burritt, Department of Microbiology, MSU-Bozeman
Course Description:
The course will provide students with fundamental knowledge of environmental microbiology. Through reading assignments and discussions on freshwater, marine, food and soil microbiology, students will gain an appreciation of how microorganisms maintain the biosphere in a balanced state. Students will also learn how this fundamental knowledge of microbial ecology has been exploited by man to remediate soils contaminated with toxic wastes and waters polluted with residential, industrial and agricultural waste.

PHSX 491 Conceptual Physics
Instructor: Dr. Robert Wilson, MSU Extended University
Course Description:
This course describes the workings of the world around us. The everyday: how a ball moves when it is thrown, the forces you feel on a roller-coaster, what happens when you turn on a light switch; and the esoteric: time and space from the perspective of Einstein's relativity, the basic structure of atoms and nuclei. The course is mostly at the conceptual level, with some simple algebraic problem solving. A unique feature of the class is a series of at-home experiments using simple materials to illustrate some basic ideas of physics.

PHSX 511 Astronomy for Teachers
Instructor: Dr. Ron Hellings, MSU Extended University
Course Description:
As a fundamental science, astronomy is the study of the motions in the sky, the formation of planets, the evolution of stars, and the origin of galaxies. This course, specially designed for practicing science teachers at the middle and high school levels, serves as a survey of topics in astronomy. The topics are closely aligned with the concepts emphasized in the NRC National Science Education Standards and the instructional strategy uses electronic collaborative group discussions in concert with hands-on laboratories and activities that use NASA data easily accessed via the Internet.

PHSX 513 Quantum Mechanics Online
Instructor: Dr. Mingzhen Tian, MSU Extended University
Course Description:
Can quantum mechanics be made SIMPLE? What lies behind wave functions, wave equations, and atomic structure? How is the sub-microscopic world really put together?

In his popular little book, QED, The Strange Theory of Light and Matter, Richard Feynman reduces the rules of quantum mechanics to a simple command for the electron and the photon: Explore all paths. In 1948 Feynman proved that this command leads to all the same results as the usual wave mechanics.

Our course studies the command "Explore all paths" and its consequences. Using hands-on software, you interact with animated illustrations from Feynman's book. On-line, you discuss with other participants the deep paradoxes of quantum mechanics. But deep does not mean mathematical: NO EQUATIONS until one-third of the way through the course. Then the quantum wave function emerges as a natural consequence of the command "Explore all paths." It accounts for the smoothness of a friend's skin and the gold of sunset.

As I breeze through Feynman, it occurs to me that the reading is easy because of the software simulations we have run...It is very nice to have these computer programs to "experiment" with...This all makes so much more sense now, and I owe a large part of that to the software.

PHSX 591: Physics of Renewable Energy for Teachers
Instructor: Dr. Nick Childs
Course Description
This course is intended to provide secondary physics teachers with a connection between topics in renewable energy sources to Next Generation Science Standards in physics. The goal of the course is to improve their pedagogical knowledge related to teaching the physics associated with renewable energy sources. Students will focus on developing classroom materials related to the subject.

During this online course, participants will complete a series of online units centered on bringing the physics of renewable energy sources into a high school physics classroom. Students will develop an understanding of the underlying physics associated with renewable energy sources. As this course is intended for classroom teachers, instruction will place an emphasis on creating classroom materials appropriate for secondary science classrooms and consistent with the Next Generation Science Standards. Energy sources covered include power derived from nuclear fusion/fission, wind, solar, geothermal, hydro, hydrogen, biomass and water waves. World energy consumption and energy storage will also be covered.

Objectives - Students who successfully complete this course will be able to do the following:
1. Describe the current and projected world energy usage.
2. Describe the necessity of renewable energy sources.
3. Explain how energy is obtained from various renewable energy sources covered in the course.
4. Demonstrate mastery of underlying physics concepts utilized in renewable energy sources covered in the course.
5. Identify Next Generation Science Standards associated with topics in renewable energy.
6. Show the ability to incorporate the underlying physics of renewable energy sources into the teaching of introductory level physics.

All Documents from Plant Identification Terminology: An Illustrated Glossary. cue cards for plant families 2013-10-30.