Perris Union High School District
Course of Study

A. COURSE INFORMATION

Course Title:
BioSustainability
✓ New
☐ Revised

If revised previous course name if changed

Transcript Course Code/Number:
(To be assigned by Educational Services)

Subject Area:
☐ Social Science
☐ English
☐ Mathematics
✓ Laboratory Science
☐ World Languages
☐ Visual or Performing Arts
☐ College Prep Elective
☐ Other

Is this classified as a Career Technical Education course?
☐ Yes
✓ No

Grade Level
☐ MS
☐ HS
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9
☐ 10
✓ 11
✓ 12

Required for Graduation:
☐ Yes
✓ No

Meets UC/CSU Requirements?
✓ Yes
☐ No

Was this course *previously approved by UC* for PUHSD?
☐ Yes
✓ No
(Will be verified by Ed Services)

Credential Required to teach this course:
Single Subject: Biological Sciences

To be completed by Human Resources only.

DocuSigned by:
[signature] 12/10/2020
DOFF5000E4E4480
Signature **Date**

Meets "Honors" Requirements?
☐ Yes
✓ No

Meets "AP" Requirements?
☐ Yes
✓ No

Unit Value/Length of Course:
☐ 0.5 (half year or semester equivalent)
✓ 1.0 (one year equivalent)
☐ 2.0 (two year equivalent)
☐ Other:

Submitted by: Maria Schmidt
Site: PVHS
Date: 10/28/2020

Approvals	Name/Signature	Date
Director of Curriculum & Instruction	[signature]	11/30/2020
Asst. Superintendent of Educational Services	[signature]	12/08/2020
Governing Board		

Prerequisite(s) (REQUIRED):

Biology

Corequisite(s) (REQUIRED):

N/A

Brief Course Description (REQUIRED):

This Biology-based elective science course will utilize an interdisciplinary approach to examine topics in Biology, Chemistry, Physics and Earth Science, using a student designed, built and maintained aquaponics system. The aquaponics system will provide a model to study the intricate connections which exist in nature amongst living organisms, to learn applied science in an interdisciplinary setting and will emphasize critical thinking skills, problem solving, collaborative learning and community service while creating bridges to our local community. The solar powered aquaponics system can supply a Culinary Arts Academy with organically grown produce and fish, as well as make daily/weekly contributions to our local Temecula Valley Food Banks.

B. COURSE CONTENT

Course Purpose (REQUIRED):
What is the purpose of this course? Please provide a brief description of the goals and expected outcomes. Note: More specificity than a simple recitation of the State Standards is needed.

Students will be expected to monitor and maintain the integrity of the aquaponics system as well as design experimental growth beds to test methods for improving yield. By the end of the course, students should have assimilated sufficient knowledge to complete their exit project, which will see them successfully design a pilot aquaponic system. This STEM course will require that students master content in all four major areas of study in science, while connecting the dots between content and understanding how each of the four sciences are at work in the system.

Course Outline (REQUIRED):
Detailed description of topics covered. All historical knowledge is expected to be empirically based, give examples. Show examples of how the text is incorporated into the topics covered.

Unit 1. Biodiversity, population demands and an intro to aquaponics (5 weeks)

- Biodiversity and sustainable development
- Population growth models
- History of aquaponics
- Aquaponics vs hydroponics vs traditional plot farming

- modern agriculture/fisheries demands vs production

Unit 2. Chemistry (5 weeks)
- Nitrification
- water chemistry (pH, dissolved O2, Phosphates, Nitrates/ammonia)
- organic vs traditional techniques for system remediation.

Unit 3. Physics/Earth Science (4 weeks)
- Solar design (flow/batteries/production)
- Pumps, system demands, calculations of maximal loads
- Flow of liquids
- volume/pressure relationships
- Grow media geology

Unit 4. Biological Systems (8 weeks)
- Photosynthesis and Cellular Respiration
- Fermentation, energy demands
- system homeostasis
- Germination and plant growth models
- Fish development- fertilization, gastrulation, differentiation, stem cells
- nutrient cycling
- Bacterial culture

Unit 5. Aquaponic system design (6 weeks)
- Fishery design, maintenance and harvest.
- Growbed media pros/cons (media filled, NFT and Deep Water Culture, cinder, expanded
- clay, coconut husk)
- bacterial culture types and techniques for nitrification
- Filtration media and the biochemistry involved

Unit 6. Botany (4 weeks)
- Plant nutritional needs
- Plant productivity, morphogenesis and growth patterns
- Vegetative and Flowering cycles
- Plant health and remediation

Unit 7. Animal Physiology (4 weeks)
- Animal nutritional needs
- Key body systems
- Reproductive cycles, embryogenesis and growth patterns
- Health and remediation

Writing Assignments (REQUIRED):
Give examples of the writing assignments and the use of critical analysis within the writing assignments.

- Students will be investigating through research how to build and design the many aspects that will go into building and maintaining an aquaponics system within a greenhouse.
- Students will need to write proposals and present to the class/teacher/admin for their design to get approved.
- Students will also be taught how to write grants to secure funds for supplies. Students will also be taught how to write emails and letters to contact community members and businesses to secure funds and donations to move their project forward. These writing assignments will assist students in developing skills needed for college for those students that may go into research later in their post secondary education.
- Students will also have journal prompts which will lead to a discussion in class.

INSTRUCTIONAL MATERIALS (REQUIRED)	
Textbook #1	
Title: All resources will be online. No textbook needed for this course.	Edition:
Author:	ISBN:
Publisher:	Publication Date:
Usage: ❑ Primary Text ❑ Read in entirety or near	
Textbook #2	
Title: N/A	Edition:
Author:	ISBN:
Publisher:	Publication Date:
Usage: ❑ Primary Text ❑ Read in entirety or near	
Supplemental Instructional Materials *Please include online, and open source resources if any.*	
The students will be using vast resources online to research. Temecula Valley High School's BioSustainability class has also offered to have workshops with our students to teach them and show them the projects they have and are working on. TVHS has also offered to come to our site for a Saturday "work day" to work with our students. Here are a list of the online resources: https://files.eric.ed.gov/fulltext/ED067218.pdf (water and soil science) https://flexbooks.ck12.org/cbook/ck-12-middle-school-earth-science-flexbook-2.0/ (earth science concepts) https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/ (biology concepts) https://flexbooks.ck12.org/cbook/ck-12-chemistry-flexbook-2.0/ (chemistry concepts) https://untamedscience.com/biology/ecology/ecology-articles/the-science-of-compost/ (composting science) https://www.cias.wisc.edu/wp-content/uploads/2008/07/artofcompost.pdf (composting science) https://lakewaytilapia.com/How_To_Raise_Tilapia.php (tilapia fish farming) http://agrilife.org/fisheries2/files/2013/10/Aquaponics-Vegetable-and-Fish-Co-Production-2013.pdf (fish farming/aquaponics) https://aces.nmsu.edu/pubs/_circulars/CR680.pdf (aquaponics)	
Estimated costs for classroom materials and supplies (REQUIRED). *Please describe in detail.* If more space is needed than what is provided, please attach backup as applicable.	
Cost for class set of textbooks: $0	Description of Additional Costs: Water and soil test kits will be needed to teach the

Additional costs:$500-$1000	students how to conduct water and soil testing. The remainder of the costs will be acquired through grants.
Total cost per class set of instructional materials:	$1000

Key Assignments (REQUIRED):

Please provide a detailed description of the Key Assignments including tests, and quizzes, which should incorporate not only short answers but essay questions also. How do assignments incorporate topics? Include all major assessments that students will be required to complete

Assessments:

- We will have tests, weekly quizzes, lab reports, journal questions, and responses to current events in science..
- Labs and activities will be the emphasis as we move through the course content.

Participation and Maintenance.

- The majority of the participation grade will be based on completion of journal questions and participation in classroom or group discussions. Another large portion of the Aquaponics grade is based on participation on maintenance days. Each week, we will be working in the lab to clean and maintain our system. It is extremely important that students take this seriously and also follow all the safety procedures.
- There will be a weekly quiz that goes over course content and a larger test at the end of each unit. Dates for quizzes and tests will be announced in advance.

Projects/Presentations

- Various projects will be assigned throughout the course. A rubric and project outline will be provided in advance so students have adequate time to complete the work.

Instructional Methods and/or Strategies (REQUIRED):

Please list specific instructional methods that will be use.

1. Teacher Clarity; Setting objectives, learning goals, expectations, content)
2. Cooperative Learning
3. Cues, Questions & Advance Organizers
4. Summarizing & Note Taking
5. Identifying Similarities and Differences
6. Generating & Testing Hypotheses
7. Direct Instruction
8. Scaffolding Instruction
9. Provide opportunities for student practice
10. Individualized Instruction
11. Inquiry-Based Teaching
12. Concept Mapping
13. Reciprocal Teaching
14. Higher-level questioning
15. Response Notebooking/Journaling

Assessment Methods and/or Tools (REQUIRED):
Please list different methods of assessments that will be used.
Direct Assessment in the following formats: • Written work • Portfolios of student work • Interactive Science Notebooks • Visual/Audio recordings of student presentations • Capstone Projects • Field/Service projects • Performance on in-class tests Indirect Assessments in the following formats: • Surveys • Entrance/Exit out the door tickets • Students explaining concepts/projects to community members

COURSE PACING GUIDE AND OBJECTIVES (REQUIRED)				
Day(s)	**Objective**	**Standard(s)**	**Chapter(s)**	**Reference**
	1.0 Students will summarize world population growth projections and projected food demands. Students will understand the global impacts of human development on biodiversity and will demonstrate content proficiency by: • 1.1. Analyzing biodiversity data and identifying biodiversity losses as linked directly to increases in human population • 1.2. Describing sustainable development and identifying possible adjustments to current construction, development and agriculture methodology. • 1.3. Describing the main tenants and productivity levels of plot agriculture, hydroponic culture and aquaponic culture • 1.4. Analyzing current biosustainability/biodiversity legislation and propose possible strategies to amend/improve. • 1.5. Discussing the use of aquaponic culture in ancient and modern civilizations	NGSS Standards Covered: HS-ESS3-1 HS-ESS3-2. HS-ESS3-3. HS-ESS3-4. HS-ESS3-6. HS-LS2-1. HS-LS2-2. HS-LS2-3. HS-LS2-4. HS-LS2-5. HS-LS2-6. HS-LS2-7. HS-ETS1-1	Various Online Resources	Various Online Resources;
	2.0 Students will be able to apply understanding	HS-PS1-1.	Various Online	Various Online

	of Chemistry to aquaponic culture and effectively measure and amend water levels of key chemicals to maximize fish and plant growth. Students will demonstrate content proficiency by: • 2.1. Describing the basic characteristics of matter. • 2.2. Changing whole numbers or (decimal fractions) into scientific notation, and vice versa. • 2.3. Performing calculations involving numbers in scientific notation with a calculator. • 2.4. In regard to the GIVEN quantity in a quantitative problem, convert into moles using dimensional analysis the following quantities: mass, volume, • 2.5. Given an equation, form a conversion factor (molar ratio) showing the relationship of moles of "given" substance to moles of "desired" substance. • 2.6. In regard to the desired quantity in a quantitative problem, convert moles into the following quantities: mass, volume, • 2.7. Calculating adjustments to water pH, dissolved O2, Nitrates/ammonia and phosphate levels based on total water volume • 2.8. Defining acids and bases in terms of: (1) H+ and OH- ions (Arrhenius theory), (2)proton-donor, proton-acceptor (Bronsted-Lowery theory). • 2.9. Interpreting observations (data) of the effects of acidic and basic solutions on the color of litmus test paper. • 2.10. Calculating the hydrogen ion [H+] or hydroxide ion [OH-] concentration in molarity (M) from a given concentration of a solution or from a given pH, or vice versa. • 2.11. Defining a buffer in terms of (a) the chemical components of the solution, and (b) how the solution behaves upon addition of either acid or base.	HS-PS1-2. HS-PS1-3. HS-PS1-6. HS-ESS2-5.	Resources	Resources:
	Students will describe the principles of solar energy generation and be able to describe the flow of energy through the system's solar circuit. Students will also be able to explain the relationship between pressure	HS-ETS1-1. HS-ETS1-2. HS-ETS1-3. HS-PS3-3. HS-ESS3-1.	Various Online Resources	Various Online Resources

	and flow in a liquid. Students will demonstrate content proficiency by: • 3.1. Listing the advantages and disadvantages of PV systems compared to alternative electricity generation sources • 3.2. Describing the features and benefits of PV systems that operate independently of the electric utility grid and benefits of PV systems that are interconnected to and operate in parallel with the electric utility grid. • 3.3. Discussing the importance of conservation and energy efficiency as they relate to PV system applications. • 3.4. Explaining the meaning of basic electrical parameters including electrical charge, current, voltage, power and resistance, and relate these parameters to their hydraulic analogies (volume, flow, pressure, hydraulic power and friction). • 3.5. Identifying factors that reduce or enhance the amount of solar energy collected by a PV array. • 3.6. Qualifying the effects of changing orientation (azimuth and tilt angle) on the amount of solar energy received on an array surface at any given location • 3.7. Explaining how a solar cell converts sunlight into electrical power. • 3.8. Given the surface area, incident solar irradiance and electrical power output for a PV cell, module or array, calculate the efficiency and determine the power output per unit area • 3.9. Given the power usage and time of use for various electrical loads, determine the peak power demand and energy consumption over a given period of time • 3.10. Given the fluid volume of a system, flow requirements and size of piping, students will be able to calculate pump size requirements • 3.11. Given a stand-alone application with a defined electrical load and available solar energy resource, along with PV module specifications, size and configure the PV array, battery subsystem, and other equipment as required, to meet the electrical load during the critical design period.	HS-ESS3-3. HS-ESS3-4. HS-ESS3-6. HS-LS4-6. HS-LS2-7.		

	• 3.12. Describing the pros/cons of different growth bed media based on geological/chemical reactions that might affect water composition			
	Students will understand the biological interactions amongst living organisms as well as the foundational processes that sustain life on Earth. Students will demonstrate content proficiency by: • 4.1. Explaining the interdependence of relationships in nature and describe the three main types of symbiotic relationships • 4.2. Explaining the main processes and net gains of cellular respiration and photosynthesis • 4.3. Describing the interdependent nature of carbon cycling and detail what role cellular respiration and photosynthesis play in this process • 4.4. Explaining fermentation and the byproducts of fermentation • 4.5. Producing a diagram demonstrating differences between mitosis and binary fission • 4.6. Defining homeostasis and explain the homeostatic balance that exists in the aquaponic culture • 4.7. Explaining the importance of bacterial culture in living systems in terms of nutrient recycling, conversion and energy production • 4.8. Differentiating between plant and animal morphogenesis • 4.9. Describing the role bacteria play in ammonia/nitrate conversion • 4.10. Describing the processes of mitosis and meiosis and explain fundamental differences in regards to ploidy • 4.11. Drawing a diagram which details the process of gastrulation and embryonic development • 4.12. Defining germination and explain seed requirements for germination • 4.13. Demonstrating the ability culture bacteria and prepare growth media • 4.14. Analyzing bacterial growth patterns from the aquaponic system and	HS-LS1-2. HS-LS1-3. HS-LS1-4. HS-LS1-5. HS-LS1-6. HS-LS1-7. HS-LS2-1. HS-LS2-2. HS-LS2-3. HS-LS2-4. HS-LS2-5. HS-LS2-6. HS-LS2-7. HS-LS4-5. HS-LS4-6. HS-ESS2-5. HS-ESS2-6. HS-ESS3-1. HS-ESS3-2. HS-ESS3-3. HS-ESS3-4. HS-ETS1-1. HS-ETS1-2. HS-ETS1-3. HS-ETS1-4.	Various Online Resources	Various Online Resources

	differentiate between Nitrosomonas and Nitrobacter using qualitative methods			
	Students will understand layout of a basic aquaponic system as well as the pros/cons of different growth media and bacterial culture systems. Students will demonstrate content proficiency by: • 5.1. Producing a flow diagram showing the flow of water and nutrients through the aquaponic system • 5.2. Explaining the purpose of 'sump' tanks in an aquaponic system • 5.3. Identifying components of the biotic and abiotic aquaponic environment • 5.4. Measuring levels of ammonia, nitrite, and nitrate • 5.5. Measuring, graph and interpret plant growth data • 5.6. Constructing graphs of nutrient levels and plant growth rates • 5.7. Describing the role of bacteria in ammonia conversion • 5.8. Explaining the difference between the two bacterial cultures and what they do to produce nitrates • 5.9. Describing the pros/cons of the different grow bed media	HS-LS1-2. HS-LS1-3. HS-LS1-5.. HS-LS2-3. HS-LS2-4. HS-LS2-5. HS-LS2-6. HS-LS2-7. HS-LS2-8. HS-LS4-5. HS-LS4-6. HS-ESS2-5. HS-ESS2-6. HS-ESS3-1.. HS-ESS3-2. HS-ESS3-3. HS-ESS3-4. HS-ETS1-1. HS-ETS1-2. HS-ETS1-3. HS-ETS1-4.	Various Online Resources	Various Online Resources
	Students will understand the nutritional and light requirements for plant vegetative and flowering growth and will be able to explain plant growth and typical health related issues with plants. Students will demonstrate content proficiency by: • 6.1. Describing the basic principles of plant cells and tissues; plant organs; plant physiology; plant reproduction and diversity; and plant ecology • 6.2. Examining plants using observational tools, scientific techniques, and empirical analysis • 6.3. Explaining how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped	HS-LS1-2. HS-LS1-3. HS-LS1-4. HS-LS1-5. HS-LS1-6. HS-LS1-7. HS-LS2-1. HS-LS2-2. HS-LS2-3. HS-LS2-4. HS-LS2-5. HS-LS2-6. HS-LS2-7. HS-LS4-5. HS-LS4-6. HS-ESS2-5. HS-ESS2-6. HS-ESS3-1.	Various Online Resources	Various Online Resources

	plant morphology, physiology, and life history • 6.4. Investigating and understanding basic plant propagation methods • 6.5. Draw a diagram which explains alternation of generations • 6.6. Describe major differences in vegetative and flowering growth • 6.7. Describing standard mineral deficiencies in plants and visual signals of mineral deficiency • 6.8. Describing basic remediation plans to rectify plant mineral deficiencies.	HS-ESS3-2. HS-ESS3-3. HS-ESS3-4. HS-ETS1-1. HS-ETS1-2. HS-ETS1-3. HS-ETS1-4.		
	Students will understand the nutritional and environmental requirements of animal development, specifically those of fish and will be able to explain fish growth and growth rates.Students will demonstrate content proficiency by: • 7.1. Describing the basic principles of animal cells and tissues, animal organs, animal physiology, reproduction and diversity. • 7.2. Explaining how animal excretory systems remove nitrogenous waste from the blood and detail how fish process and excrete nitrogenous waste. • 7.3. Explaining growth rates of R and K selected animal populations. • 7.4. Measuring growth rates of developing fish and tracking fish through major developmental stages • 7.5. Explaining the differences between mitosis and meiosis. • 7.6. Describing basic principles of animal reproduction and development • 7.7. Organizing a flow chart of basic fish health maladies and typical forms of organic remediation	HS-LS1-2. HS-LS1-3. HS-LS1-4. HS-LS1-5. HS-LS1-6. HS-LS1-7. HS-LS2-1.. HS-LS2-2. HS-LS2-3. HS-LS2-4. HS-LS2-5. HS-LS2-6. HS-LS2-7. HS-LS4-6. HS-ESS2-5. HS-ESS2-6. HS-ESS3-2. HS-ESS3-4. HS-ETS1-1. HS-ETS1-2. HS-ETS1-3.	Various Online Resources	Various Online Resources

C. HONORS COURSES ONLY

Indicate how much this honors course is different from the standard course.

N/A

D. BACKGROUND INFORMATION

Context for course (optional)

This STEM course will require that students master content in all four major areas of study in science, while connecting the dots between content and understanding how each of the four sciences are at work in the system. A sampling of these content specific concepts that will be covered in BioSustainability:

- Biology- bacterial medium conversion of ammonia to nitrates, germination, plant growth models, photosynthesis, cellular respiration, fermentation, antibiotics, population growth models, carrying capacity, mitosis, meiosis, gastrulation, morphogenesis, plant and animal physiology and reproduction, plant anatomy,
- Chemistry- water pH, nitrates, water testing, volume calculation, buffers, catalysts, nutrient cycling
- Physics- solar system design, batteries, loads, pump demands, flow calculations
- Earth Science- geology, nutrient content of grow media examined, effects of mineral/ rock content on water chemistry

History of Course Development (optional)

This course was originally designed by Tobin Brannon at Temecula Valley High School. Fall of 2019, Kyle Garrity, took the Environmental Science Club (known as Paloma Planet) to TVHS to view the greenhouse and students in action. Both Dr. Garrity and the students came back very excited over the possibilities and introduced the course to me. I then visited and observed TVHS. I was completely amazed that this had all been done by students. Researched, designed, built and maintained all by the students. Mr. Brannon wrote a grant to CTE and secured $25,000 two years in a row. Mr. Brannon has been gracious enough to share his grant proposal, course description, and syllabus with me. Mr. Brannon has also shared his proposal with another school up North and they too received the same funding from CTE. Mr. Brannon has already submitted the course to the UC/CSU portal and it has been approved as a "G" lab science. My intentions are to apply for the same grant, but to also teach the students how to secure funding through grant submissions and donations from the community. Eventually the goal is to offer some of the produce to a Culinary Arts program and donate to the local food banks.