Research and Seminars in Science Honors - Waksman Course Overview

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Cover

EAST BRUNSWICK PUBLIC SCHOOLS

East Brunswick New Jersey

Superintendent of Schools

Dr. Victor P. Valeski

Science

Research and Seminars in Science Honors

Course Number: 1142

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Course Overview

Research Sci-Honors

This is an honors-level advanced research program that is formulated to reflect the skills, behaviors, techniques, and proficiencies necessary for conducting authentic science research. Students will learn how to analyze and interpret experimental data generated in class and by other researchers. The ultimate goal is for students to visualize how science is conducted by participating in the Waksman Research Institute. Students will receive honors credit. Laboratory experiences are embed in the curriculum and will take

place during the regularly scheduled class periods. The Waksman Student Scholars Program is supported by the National Science Foundation under Grant No. 0737574.

The Summer Institutes
A teacher and one or two students from 44 high schools commute to the Waksman Institute at Rutgers University in Piscataway, NJ daily for a three-week session in July. Two week summer Institutes will also be held at the JohnsHopkinsUniversity, Baltimore, MD and the Lawrence Livermore National Laboratories in Livermore, CA. At each summer Institute students and teachers learn about a research project in molecular biology. Both the background material and the laboratory skills necessary to carry out the project are presented.

The Academic Year
Teachers and students return to their classrooms in September and begin working on the research project. Additional students will be recruited. Some schools offer a research course for high school credit; others offer the research as an after-school activity. The students return to the sites of the summer institutes for meetings during the academic year. At the end of the year, in May or June, a forum is held where students present the results of their studies at a poster session.

Modifications

Each teacher, each student, each classroom is unique and adaptations are specific to each situation. Differentiating instruction and providing multiple ways to assess allows more flexibility for students to meet the standards and requirements of the class. Below are samples of the types of adaptations/modifications that may occur for students based on need including ELLs, students with a 504 Plan, Special Education, Basic Skills and Gifted and Talented students.

Adaptations/Modifications:

Input	Output	Time
Adapt the way instruction is delivered to the learner. ***For example:*** • Use different visual aids,	Adapt how the learner can respond to instruction. ***For example:*** • Allow a verbal vs. written	Adapt the time allotted and allowed for learning, task completion or testing. ***For example:***

• Plan more concrete examples, • Provide hands-on activities, • Place students in cooperative groups.	response, • Use a communication book for students, • Allow students to show knowledge with hands-on materials.	• Individualize a timeline for completing a task, • Pace learning differently (increase or decrease) for some learners.
Difficulty Adapt the skill level, problem type, or the rules on how the learner may approach the work. ***For example:*** • Simplify task directions. • Use of calculator.	**Level of Support** Increase the amount of personal assistance with specific learner. ***For example:*** • Assign peer buddies, teaching assistants, peer tutors or cross-age tutors.	**Size** Adapt the number of items that the learner is expected to learn or complete. ***For example:*** • Reduce the number of vocabulary words a learner must learn at any one time.
Degree of Participation Adapt the extent to which a learner is actively involved in the task. ***For example:*** • Allow for small group/individual presentations vs. presentations to the whole class.	**Alternate Goals** Adapt the goals or outcome expectations while using the same materials. ***For example:*** • Students in the same class are expected to either write a paragraph, write a bulleted response, or meet with the teacher to provide a verbal response.	**Substitute Curriculum** Provide differentiated instruction and materials to meet a learner's individual goals. ***For example:*** • Individualize a timeline for completing a task, pace learning differently (increase or decrease) for some learners, • Use of Learning Ally.

Materials and Resources

This is a laboratory based course that uses seminal primary research articles in the field of biology as the text.

Content Specific Standards

SCI.9-12.HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
SCI.9-12.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
SCI.9-12.HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
SCI.9-12.HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of

	expressed traits in a population.
SCI.9-12.HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
SCI.9-12.HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
SCI.9-12.HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Interdisciplinary Standards

LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
LA.RST.9-10.6	Determine the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
LA.RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
LA.RST.9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
LA.WHST.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.
LA.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
LA.WHST.9-10.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
LA.WHST.9-10.6	Use technology, including the Internet, to produce, share, and update writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
LA.WHST.9-10.7	Conduct short as well as more sustained research projects to answer a question (including

	a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.WHST.9-10.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
LA.WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.

21st Century Life and Career Ready Practice Standards

CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP3.1	Career-ready individuals understand the relationship between personal health, workplace performance and personal well-being; they act on that understanding to regularly practice healthy diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work

	as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP9.1	Career-ready individuals consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others' action, attitudes and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morals and organizational culture.
CRP.K-12.CRP10.1	Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.
CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.
CRP.K-12.CRP12.1	Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

Technology Standards

TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of

	technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.C	Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
TECH.8.1.12.D	Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
TECH.8.1.12.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.12.F	Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.12.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.12.B	Technology and Society: Knowledge and understanding of human, cultural and society values are fundamental when designing technology systems and products in the global society.
TECH.8.2.12.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.12.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.12.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

Pacing Guide

Sequential Unit Description	Marking Period Guide	Other Pacing Guide References (Lab Work)	Proficiency Assessments (Lab Proficiencies)
roduction and overview of project (video) lymers and DNA Structure ctors: Plasmids, Libraries, and Plasmid DNA preps R, Mapping the size of an insert striction enzymes,Mapping the size of an insert JA Sequencing, gging onto DSAP, Sequence quality, cropping the	1-4 continuously	1. Introduction to the WSSP laboratory - Overview of the laboratory experiments 2. Pipeting and weighing 3. Sterile technique and setting up ON cultures Entering information into Google Docs Clone Report Sheet (video)	Successfully Pipeting and weighing Use of Sterile technique and setting ON cultures Entering informati into Google Docs Clone Report She (video) Successful PCR Reaction with Bacte Cultures Successfully Running an Agarose G the PCR Samples Pouring an agarose gel vide Successfully Loading an agarose gel Creating a Mock-up of a gel image i

iting the waveform .ASTN (DNA vs DNA search LASTX (Translated DNA vs Protein search) termining ORFs, BLASTP (Protein vs Protein ı) iterature Search Iultiple Sequence alignment CLUSTALW onserved domain (CDD) and structural analysis Cn3D sis of REV sequences: determine overlap, contigs panning the gap between FOR and REV sequences and Protein Modeling (see Jmol tutorials in RT) Iolecular Biology Experiments: What to do next enomic Analysis and Barcoding reparing a poster		4. Setting Up a PCR Reaction with Bacterial Cultures 5. Running an Agarose Gel on the PCR Samples Pouring an agarose gel video. 6. Loading an agarose gel video. 7. Examples of gel loading video. 8. Mocking up a gel image in Powerpoint 9. PCR Gel template (PCRG-Template.ppt) 10. Uploading a gel image to Google Docs Report sheet 11. Plasmid DNA Minipreps 12. Restriction Digests of Plasmid DNA See videos in Lab 4 for how to set up, run, mock up, and upload an agarose gel 13. Running an agarose gel for the restriction digests	Powerpoint Creating a PCR Gel template (PCRC Template.ppt) Successfully Uploading a gel image Google Docs Report sheet video. Completing Plasmid DNA Miniprep Succesffully Setting up the Restricti Digests of Plasmid DNA See videos in Lab 4 for hov set up, run, mock up, and upload an agarose gel Successfully Running an agarose ge the restriction digests

COURSE RESOURCES

Waksman Student Scholars websites:

http://wssp.rutgers.edu/
http://wssp.rutgers.edu/StudentScholars/WSSP13/FrameSet.html
http://wssp.rutgers.edu/StudentScholars/WSSP13/FrameSet.html
https://benzer.rutgers.edu/DSAP/Projects/DSAP2013/login.php
http://avery.rutgers.edu/WSSP/Tutorials/indexNew.html
http://morgan.rutgers.edu/TutorialIndex.html
http://morgan.rutgers.edu/RNAStructure/RNA.php
http://morgan.rutgers.edu/ProteinStructure/Protein.php
http://avery.rutgers.edu/WSSP/InternetResources/index.html
http://wssp.rutgers.edu/WSSP12-13/index.php

GRADING PROCEDURES Description of the grading procedures in accordance with East Brunswick Board of Education Policy

Grading procedures must be described in sufficient detail so that a pupil will understand, the minimal to advanced proficiency, expected of him/her as the outcome of each unit, for the marking period and for the course as a whole. Benchmark level assessments associated with the course also need to be identified. While assessments of proficiency levels must be valid and reliable they do not need be the same for all students. Other criteria to be considered in grading must be identified and the degree to which such criteria will be considered in a grade. Each pupil must receive a copy of the grading procedures, proficiencies and criteria for each unit and/or marking period.

In terms of proficiency the East Brunswick grades will be as follows:

P Student meets course objectives by participation and productivity in assigned research project

F Student does not meet course objectives by participation and productivity in assigned research project

Marking period grades for Research Sci-Honors will be determined using the following weighting:

50% Laboratory Participation ? Semester 1

50% Laboratory Participation ? Semester 2

The Big Ideas (Major Concepts) that we seek to convey to the students are the following:

- Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.
- Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.
- Scientific knowledge builds on itself over time.
- The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.
- Living organisms are composed of cellular units that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.
- Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

The Essential Questions that we expect students to be able to answer are:

- How do we build and refine models that describe and explain the natural and designed world?
- What constitutes useful scientific evidence?
- How is scientific knowledge constructed?
- How does scientific knowledge benefit ? deepen and broaden ? from scientists sharing and debating ideas and information with peers?
- How does structure relate to function in living systems from the organismal to the cellular level?
- How is genetic information passed through generations?
- How does natural selection encourage inter and intraspecific diversity over time?

The Enduring Understandings that we expect students to take away from this course are as follows:

- Measurement and observation tools are used to categorize, represent and interpret the natural world.
- Evidence is used for building, refining, and/or critiquing scientific explanations.
- Scientific knowledge builds upon itself over time.
- The growth of scientific knowledge involves critique and communication ? social practices that are governed by a core set of values and norms.
- Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function.
- The survival of organisms is affected by interactions with each other and their environment, and can be altered by human manipulation.
- There are predictable patterns of inheritance, and the variation that exists within a species is related to its mode of reproduction (sexual or asexual).

- The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring.

LIST OF NJCCCS/CPI'S TO BE ADDRESSED IN THE COURSE

5. Science
   - 5.1.12.A. Understand Scientific Explanations (M)
   - 5.1.12.B. Generate Scientific Evidence through Active Investigations (M)
   - 5.1.12.C. Reflect on Scientific Knowledge (M)
   - 5.1.12.D. Participate Productively in Science (M)
   - 5.3.12.A. Organization and Development (M)
   - 5.3.12.B. Changes in Matter (M)
   - 5.3.12.D. Heredity and Reproduction (M)

PART II

Research Sci-Honors Curriculum			
Instructional Objectives	N.J.C.C.C.S.	Instructional Activities/ Methods/ Assignments	Materials / Resources
1. Introduction and overview of project Polymers and DNA Structure 2. Vectors: Plasmids, Libraries, and Plasmid DNA preps PCR, Mapping the size of an insert 3. Restriction enzymes,Mapping the size of an insert DNA Sequencing, 4. Logging onto DSAP, Sequence quality, cropping the ends Editing the waveform 5. BLASTN (DNA vs DNA search) 6. BLASTX (Translated DNA vs Protein search) 7. Determining ORFs, BLASTP (Protein vs Protein search) 8. Literature Search 9. Multiple Sequence alignment CLUSTALW 10. Conserved domain (CDD) and structural	5.1.12.A (M) 5.1.12.B (M) 5.1.12.C (M) 5.1.12.D (M) 5.3.12.A (M) 5.3.12.C (M) 5.3.12.D (M)	1. Introduction to the WSSP laboratory - Overview of the laboratory experiments (video) 2. Pipeting and weighing (video) 3. Sterile technique and setting up ON cultures (video) Entering information into Google Docs Clone Report Sheet (video) 4. Setting Up a PCR Reaction with Bacterial Cultures 5. Running an Agarose Gel on the PCR Samples Pouring an agarose gel video. 6. Loading an agarose gel video. 7. Examples of gel loading video. 8. Mocking up a gel image in Powerpoint 9. PCR Gel template (PCRG-Template.ppt) 10. Uploading a gel image to Google Docs	Molecular genetics equipment supplied by Rutgers Unive well as common molecular biology and genetics equipme found in an Advanced Placement Biology Laboratory fac http://wssp.rutgers.edu/ http://wssp.rutgers.edu/StudentScholars/WSSP13/FrameS http://wssp.rutgers.edu/StudentScholars/WSSP13/FrameS https://benzer.rutgers.edu/DSAP/Projects/DSAP2013/log http://avery.rutgers.edu/WSSP/Tutorials/indexNew.html http://morgan.rutgers.edu/TutorialIndex.html http://morgan.rutgers.edu/RNAStructure/RNA.php http://morgan.rutgers.edu/ProteinStructure/Protein.php http://avery.rutgers.edu/WSSP/InternetResources/index.h http://wssp.rutgers.edu/WSSP12-13/index.php

analysis with Cn3D 11. Analysis of REV sequences: determine overlap, contigs 12. Spanning the gap between FOR and REV sequences 13. JMol and Protein Modeling (see Jmol tutorials in SMART) 14. Molecular Biology Experiments: What to do next 15. Genomic Analysis and Barcoding 16. Preparing a poster		Report sheet video. 11. Plasmid DNA Minipreps (video) 12. Setting up the Restriction Digests of Plasmid DNA See videos in Lab 4 for how to set up, run, mock up, and upload an agarose gel 13. Running an agarose gel for the restriction digests	

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Formative and Summative Assessment

Teachers ultilize a variety of methods for assesment including:

	Unit Tests and Quizzes	**Labs, Projects & Classwork**	**Lab Assessments**	**Homework**
Category Criteria	Individual assessments based on specific or general content knowledge.	Any group work primarily completed in class to be checked and/or graded for completion.	Individual assessments based on group lab work. Lab data and other notes may sometimes be used.	Any work assigned to be completed outside of the classroom.

All students take a common Midterm and Final Exam.

Grading and Evaluation Guidelines

GRADING PROCEDURES:

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Other Details

SCED

03212 Research Sci-H
This is an honors-level advanced research program that is formulated to reflect the skills, behaviors, techniques, and proficiencies necessary for conducting authentic science research. Students will learn how to analyze and interpret experimental data generated in class and by other researchers. The ultimate goal is for students to visualize how science is conducted by participating in the RutgersUniversity / Waksman Student Scholars Program. Students will receive honors credit. Laboratory experiences are embed in the curriculum and will take place during the regularly scheduled class periods.

(Prerequisites: Biology)