

Pascack Valley Regional High School District

**Pascack Hills High School, Montvale, New Jersey
Pascack Valley High School, Hillsdale, New Jersey**

Course Name: Research in Molecular Genetics I, II & III

Born On: August, 2017
Board Approval: 9/25/17

COURSE DESCRIPTION: Research in Molecular Genetics

Research in Molecular Genetics is a one year to three year elective honors science course. The center piece of this course involves a year long authentic research project with an unknown outcome. Any results achieved by students should have value and relevance to the scientific community. As students perform their research, they will gain an understanding for research methodology, molecular genetics, DNA science, microbiology, proper laboratory techniques, bioinformatics, bioethical issues, evolution and methods of scientific communication in context to a real life application.

This course is designed to emphasize problem solving and inquiry activities that are long term, interdisciplinary, collaborative, student centered, and integrated with real world issues and practices. In addition, *Research in Molecular Genetics* provides student opportunities to use technology effectively as a tool for learning, data collection, data analysis, organization, and presentation of projects.

Students will also have the opportunity to earn college credits from Rutgers University and collaborate with scientists from Rutgers as well as teachers and students from other New Jersey schools. Finally, those students with a strong interest in scientific research may choose to continue taking the course for up to three years to allow them time to fully develop their own independent research project.

COURSE NAME: Research in Molecular Genetics

OBJECTIVES	ACTIVITIES & EXPERIENCES	EVALUATION	LEARNING STANDARDS
<p>UNIT I-RESEARCH METHODS</p> <p>(3 weeks and extended into course projects)</p> <p>Basic principals of experimental design and data analysis</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Develop and apply basic concepts of experimental design 2. Generate experimental ideas 3. Design experimental procedure 4. Construct tables and graphs 5. Create scientific reports 	<ol style="list-style-type: none"> 1. Designer planes (Students and Research, Kendall/Hunt) 2. Hot solutions (Students and Research, Kendall/Hunt) 3. Design detective (Students and Research, Kendall/Hunt) 4. Four question strategy (Students and Research, Kendall/Hunt) 5. Peanut butter strategy (Students and Research, Kendall/Hunt) 6. Time and absorption (Students and Research, Kendall/Hunt) 7. Brand and absorption (Students and Research, Kendall/Hunt) 8. Research projects 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters & papers 4. Presence and presentations at NJ Reg. Science Competition, PHHS science & GE Healthcare symposium 6. Tests & Quiz 7. Completion of hands-on learning activities 8. Quality of research project 	<p>HS-ETS1-2.</p> <p>HS-ETS1-1.</p> <p>HS-ETS1-3.</p> <p>HS-ETS1-4.</p>

OBJECTIVES	ACTIVITIES & EXPERIENCES	EVALUATION	LEARNING STANDARDS
<p>Advanced principals of experimental design</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Utilize library and internet resources 2. Analyze experimental data 3. Formulate descriptive statistics 4. Display dispersions/variations in data 5. Determine statistical significance 	<ol style="list-style-type: none"> 1. Paper worms (Students and Research, Kendall/Hunt) 2. Watery statistics worms (Students and Research, Kendall/Hunt) 3. Magnetic time (Students and Research, Kendall/Hunt) 4. Containing the curdles time (Students and Research, Kendall/Hunt) 5. Research projects 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters & papers 4. Presence and presentations at NJ Reg. Science Competition, PHHS science & GE Healthcare symposium 6. Tests & Quiz 7. Completion of hands-on learning activities 8. Quality of research project 	

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<p>Preparing a formal paper</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Explain the importance of the literature review 2. Compose a literature review 3. Identify the elements of a scientific research paper 4. Construct appropriate paragraphs of results and conclusions for their research project 5. Create a scientific research paper for an independent research science project 	<ol style="list-style-type: none"> 1. Dissecting a scientific paper 2. Practice sets 3. Power point presentation 4. Writing a paper 5. Research projects 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters & papers 4. Presence and presentations at NJ Reg. Science Competition, PHHS science & GE Healthcare symposium 6. Tests & Quiz 7. Completion of hands-on learning activities 8. Quality of research project 	

OBJECTIVES	ACTIVITIES & EXPERIENCES	EVALUATION	LEARNING STANDARDS
<p>Presenting scientific research</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Prepare a scientific poster consistent with Waksman Institute standards 2. Identify important features of a quality poster 3. Present and defend their project publicly 	<ol style="list-style-type: none"> 1. Analyzing scientific posters 2. Preparing a poster 3. Poster presentation 4. Research projects 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters & papers 4. Presence and presentations at NJ Reg. Science Competition, PHHS science & GE Healthcare symposium 6. Tests & Quiz 7. Completion of hands-on learning activities 8. Quality of research project 	

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<p>UNIT II-BIOINFORMATICS</p> <p>(2 weeks and extended into Waksman project)</p> <p>DNA analysis</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> Analyze DNA waveforms for quality Create an edited DNA waveform Construct a contig from overlapping sequences Compare their DNA sequences to known DNA sequences in the databases Determine if their DNA sequence contains an open reading frame 	<ol style="list-style-type: none"> Utilize Chromas to edit their DNA sequence Align two sequences using blast program Utilize Blast N program to find DNA matches Utilize NEBcutter program to map restriction sites Fill in Sequence submission form Research project BSCS bioinformatics module 	<ol style="list-style-type: none"> Lab notebook and journal Power point presentations Scientific posters & papers Completion of sequence submission Tests Quality of independent research project 	<p>HS-LS3-3.</p> <p>HS-LS3-1.</p> <p>HS-LS3-2.</p> <p>HS-ETS1-2.</p> <p>HS-ETS1-1.</p> <p>HS-ETS1-3.</p> <p>HS-ETS1-4.</p>

OBJECTIVES	ACTIVITIES & EXPERIENCES	EVALUATION	LEARNING STANDARDS
<p>Protein analysis</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Determine the protein encoded by their DNA 2. Investigate the function of their protein 3. Deduce protein structure 4. Document their findings on a sequence submission form 	<ol style="list-style-type: none"> 1. Utilize Blast P program to find protein matches 2. Utilize Blast X program to find open reading frames 3. Utilize Rasmol for visualization of protein structure 4. Utilize Protein data bank to find protein structure 5. Utilize Pubmed search for literature review 6. Utilize Medline search for literature review 7. Utilize Entrez search engine for literature review 8. Fill in Sequence submission form 9. Research project 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters & papers 4. Completion of sequence submission 5. Tests 6. Quality of independent research project 	

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<p>UNIT III-USE OF TECHNOLOGY AS A TOOL FOR RESEARCH</p> <p>(1 week and extended into course projects)</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Utilize internet sites and search engines for literature review 2. Employ 3-D molecular model programs to analyze biochemical structures 3. Interact with databases and interpret data and formulate conclusions from information derived from databases 	<ol style="list-style-type: none"> 1. Utilize Chromas software program for DNA editing 2. Utilize Align two sequence blast program to compare two DNA or protein sequences 3 Utilize Blast N program to find DNA matches 4. Utilize NEBcutter program for restriction mapping 5. Fill in Sequence submission form 6. Research project 8. Utilize Blast P program to find protein matches 9. Utilize Blast X program to find open reading frames 10. Utilize Rasmo1 to visualize protein structure 11. Utilize Protein data bank to find protein structures 	<ol style="list-style-type: none"> 1. Power point presentations 2. Scientific posters 3. Scientific papers 4. Completion of Waksman online challenges 5. Genes, genomes, and human genetics online textbook-completion of chapter tests 6. Completion of sequence submission form 7. Completion of online problem 	<p>HS-ETS1-2.</p> <p>HS-ETS1-1.</p> <p>HS-ETS1-3.</p> <p>HS-ETS1-4.</p>

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<p>4. Utilize multimedia tools to enhance presentations</p> <p>5. Apply citation programs to their work</p> <p>6. Communicate with scientists via e-mail and websites.</p> <p>7. Navigate the sequence submission form</p> <p>8. Utilize online textbooks</p>	<p>12. Utilize Pubmed search for topic research</p> <p>13. Utilize Medline search for topic research</p> <p>14. Utilize Entrez search engine for topic research</p> <p>15. Utilize Online textbook for background information</p> <p>16. Utilize Questia for literature review</p> <p>17. Utilize Cnd3 program to visualize proteins</p> <p>18. Perform Waksman online challenges</p>	sets	

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<p>UNIT IV-BASIC PRINCIPLES OF MOLECULAR GENETICS</p> <p>(3 weeks)</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Analyze the structure of DNA 2. Determine how the structure of DNA enables it to reproduce itself accurately 3. Sequence the steps involved in protein synthesis 4. Summarize the steps used to 	<ol style="list-style-type: none"> 1. Constructing a paper helix (Recombinant DNA and Biotechnology, ASM Press) 2. The replicator (Recombinant DNA and Biotechnology, ASM Press) 3. Acting out transcription & translation (A Demo a Day) 4. DNA scissors (Recombinant DNA and Biotechnology, ASM Press) 5. Gel electrophoresis virtual lab http://gslc.genetics.utah.edu/units/biotech/gel/ 6. DNA goes to the races (Recombinant DNA and Biotechnology, ASM Press) 7. Paper plasmids (Recombinant DNA and Biotechnology, ASM Press) 8. Fishing for DNA 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Completion of Waksman online challenges 3. Genes, genomes, and human genetics online textbook-completion of chapter tests 4. Presence and presentations at NJ Regional Science Competition, PHHS science symposium, & GE Healthcare symposium 5. Completion of 	<p>HLSLS1-1.</p> <p>HS-LS3-3.</p> <p>HS-LS3-1.</p> <p>HS-LS3-2.</p> <p>HS-ETS1-2.</p> <p>HS-ETS1-1.</p>

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<p>engineer clones</p> <p>5. Outline the process of transcription</p> <p>6. Relate the role of codons to the sequence of amino acids</p> <p>7. Explain translation</p> <p>8. Evaluate how restriction enzymes and vectors are essential to genetic engineering</p> <p>9. Relate the roles of gel electrophoresis and probes in identifying specific genes</p> <p>10. Sequence the stages of gene regulation in eukaryotes</p> <p>11. Summarize transcriptional gene regulation and justify its importance</p> <p>12. Relate gene regulation to phenotypes</p>	<p>(Recombinant DNA and Biotechnology, ASM Press)</p> <p>9. Paper PCR (Recombinant DNA and Biotechnology, ASM Press)</p> <p>10. DNA sequencing terminator (Recombinant DNA and Biotechnology, ASM Press)</p> <p>11. A mix up at the hospital (Recombinant DNA and Biotechnology, ASM Press)</p> <p>12. Case of the bloody knife (Recombinant DNA and Biotechnology, ASM Press)</p> <p>13. Gene gateway web quest & workbook http://www.ornl.gov/sci/techresources/Human_Genome/posters/chromosome/</p> <p>14. Research projects</p>	<p>sequence submission form</p> <p>6. Completion of online problem</p> <p>7. Tests</p> <p>8. Completion of hands-on learning activities</p>	

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<p>13. Summarize how gene manipulation affects genetics</p> <p>14. Compare and contrast cDNA libraries with genomic libraries</p> <p>15. Explain DNA sequencing</p> <p>UNIT V-WAKSMAN RESEARCH PROJECT</p> <p>(2 months)</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Apply sterile technique to their research 2. Select and apply appropriate molecular biology lab procedures 	<ol style="list-style-type: none"> 1. Micropipeting 2. Setting up overnight cultures 3. Plasmid DNA minipreps 4. Restriction digests 5. PCR 6. Preparing an agarose gel 7. Running an agarose gel 8. Analyzing gels 9. DNA sequencing 10. Bioinformatic analysis 11. Creating power points, papers, and posters 12. Presenting power points, papers, and posters 13. Review of literature 14. Online textbook 15. Completing sequence submission forms 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters 4. Scientific papers 5. Presence and presentations at NJ Regional Science Competition, PHHS science symposium, & GE Healthcare symposium 6. Completion of sequence submission form 	<p>HLS1-1.</p> <p>HS-LS3-3.</p> <p>HS-LS3-1.</p> <p>HS-LS3-2.</p> <p>HS-ETS1-2.</p> <p>HS-ETS1-1.</p> <p>HS-ETS1-3.</p> <p>HS-ETS1-4.</p>

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<ul style="list-style-type: none">3. Employ the concept of a model organism to their research4. Analyze and formulate conclusions based on their findings5. Communicate their research to others6. Interpret restriction maps, gels, and data from databases.7. Explain and relate basic molecular genetic principles to their research8. Integrate knowledge of research methods, bioinformatics, computer technology, and molecular genetics into their research project.9. Deduce how the effort to do genomic analysis will benefit mankind and enhance basic		<ul style="list-style-type: none">7. Tests8. Quality of independent research project	

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<p>biological knowledge</p> <p>UNIT VI-INDEPENDENT RESEARCH PROJECT</p> <p>(4 months)</p> <p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Design their own independent and novel experiment 2. Generate experimental ideas 3. Analyze collected and 	<ol style="list-style-type: none"> 1. Independent research and review of literature 2. Creating power points, papers, and posters 3. Presenting power points, papers, and posters 	<ol style="list-style-type: none"> 1. Lab notebook and journal 2. Power point presentations 3. Scientific posters 4. Scientific papers 5. Presence and presentations at New Jersey Regional Science Competition & PHHS science symposium 6. Quality of independent research project 	<p>HS-ETS1-2.</p> <p>HS-ETS1-1.</p> <p>HS-ETS1-3.</p> <p>HS-ETS1-4.</p>

OBJECTIVES	ACTIVITIES & EXPERIENCES	EVALUATION	LEARNING STANDARDS
researched data 4. Create a scientific paper and power point presentation 5. Construct a scientific research poster 6. Communicate their research to others			