A Gene Called ACE — Blood Pressure

Secrets of the Sequence Video Series on the Life Sciences • Grades 9 — 12

Teaching materials developed by **VCU** Life Sciences

Virginia Commonwealth University

Classroom Tested Lesson

Video Description

"Secrets of the Sequence," Show 111, Episode 3
"A Gene Called ACE – Blood Pressure" – approximately 9 minutes viewing time

Ever wonder why some people just seem naturally better at sports than others? Why some people burn off fat in the gym and others don't? Some research suggests that there's one amazing gene that could predict our physical state and our vulnerability to disease. A remarkable study in the UK is suggesting that the ACE gene could unlock all these secrets and more.

Ward Television:
Producer: Liz Boggis
Featuring: Dr. Hugh Montgomery, Center for Cardiovascular Genetics at University College, Dr. John Payne, Center for Cardiovascular Genetics at University College, London
Lesson Author; Reviewers: Beth Richert; Catherine Dahl, Dick Rezba, and Kieron Torres
Trial Testing Teachers: Reuwai Hanewald

National and State Science Standards of Learning

National Science Education Standards Connection

Content Standard A: Science as Inquiry
As a result of activities in grades 9-12, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science
As a result of their activities in grades 9-12, all students should develop understanding of

- Matter, energy, and organization in living systems

Content Standard F: Science in Personal and Social Perspectives.
As a result of their activities in grades 9-12, all students should develop understanding of

- Personal and community health

Selected State Science Standards Connections

Use http://www.eduhound.com (click on "Standards by State") or a search engine to access additional state science standards.

Delaware
Grades 9-12

Science as Inquiry

By the end of the twelfth grade students should know that:

1. The identification and formulation of appropriate questions guide the design and breadth of a scientific investigation. Based on the type of question(s) proposed, investigations explore new phenomena, solve science and technology related problems, compare different theories, resolve conflicts concerning societal issues, determine reasons for discrepancies in previous experimental results, or test the practicality of a consumer product. .
2. Scientific investigations in many cases follow no fixed set of steps. However, there are certain features of a valid scientific investigation that are essential and result in evidence that can be used to construct explanations.

Matter and Energy Transformations

1. Cells carry out a variety of chemical transformations which allow conversion of energy from one form to another, the breakdown of molecules into smaller units, and the building of larger molecules from smaller ones. Most of these transformations are made possible by protein catalysts called enzymes.

Oklahoma

Grade 9 Biology

Science Process Skills

By the end of instruction in biology I students should know that

1. Experimenting is a method of discovering information. It requires making observations and measurements to test ideas. The student will accomplish these objectives to meet this process standard.
    - Evaluate the design of a biology laboratory investigation.
    - Identify the independent variables, dependent variables, and control in an experiment.
    - Use mathematics to show relationships within a given set of observations (e.g., population studies, biomass, probability, etc.).
    - Identify a hypothesis for a given problem in biology investigations.

Overview

This video can be very useful in helping students understand the nature of scientific inquiry. The design of a well-controlled study to determine the effects of exercise on individuals with differing levels of ACE (Angiotensin Converting Enzyme) is highlighted and explained. The ACE gene can predict an individual's vulnerability to certain diseases associated with the heart as well as that individual's response to physical exercise.

High blood pressure is so prevalent in the population that it has prompted research on a number of ACE inhibitor drugs that have proven to be highly successful in treating this disease. Images of both a healthy and a diseased heart are shown in the video with clear explanations of how increased heart muscle diminishes the size of the heart chambers. This forces the heart to work harder to pump the same volume of blood, therefore putting increased strain on the organ.

Testing: A sample related multiple choice item from State Standardized Exams

Experimental Design

A biology class is studying the effect of competition between two species of insects, Species A and Species B. For their experiment, they have placed individuals of Species A and Species B in three different aquariums. Species A and B eat the same type of food. The experimental design is summarized in the table below.

Aquarium	Species A (Number of Individuals	Species B (Number of Individuals)	Amount of food added each day grams
1	10	10	2
2	5	15	2
3	15	5	2

Which of these would be the best way to set up the fourth aquarium to test the effect of competition on Species A?

- Place in it 10 individuals of Species A and 10 individuals of Species B, and provide them with 1 gram of food per day. *
- Place in it 5 individuals of Species A and 5 individuals of Species B, and provide them with 2 grams of food per day.
- Place in it 20 individuals of Species A and provide them with 2 grams of food per day.
- Place in it 20 individuals of Species B and provide them with 1 gram of food per day.

Source: 2003 practice test for Oklahoma's End of Instruction Biology Exam.

Video Preparation

Preview the video and make note of the locations you will need later to pause the video for discussion.

Before Viewing

1. Introduce students to ACE or the Angiotensin Converting Enzyme. Humans have two ACE genes – one from each parent, which creates three possible combinations for an offspring - II, DD or ID. The relationship between the ACE gene and blood pressure has been known for sometime. An individual with the 'II' combination tends to have lower amounts of ACE that relates to lower blood pressure, while an individual with the DD combination tends to have higher amounts of ACE that relates to higher blood pressure. To treat high blood pressure a number of successful drugs have been developed called ACE inhibitors that lower the blood pressure and significantly reduce mortality rates.

2. Ask the students to list some of the health problems caused by high blood pressure. *(Heart attacks, peripheral vascular disease, kidney failure, and strokes)*

During Viewing

1. START the video.

2. PAUSE the video (3.50 minutes into the video) after Dr. Payne says, "…this wall – the left ventricle- is definitely thicker and is making the cavity which is full of fluid (blood) actually look smaller." Review the structure of the heart with its chambers and flow of blood.

   Note: There are actually two different MRI's of the heart shown in this section of the video. The first shows a "normal" heart with normal thickness of the heart muscle, while the second is a diseased heart showing a thickened muscle around the left ventricle. Have the students compare the two MRI's so they see that the diseased left ventricle has a smaller cavity. This smaller cavity reduces the blood flow and causes the heart to work harder than a healthier heart to pump the same volume of blood out to the rest of the body. Replay the tape from 3.00 to 3.50 so the students can clearly differentiate the two MRI's.

3. RESUME the video and play to the end.

After Viewing

This video describes a good example of scientific inquiry where a well-controlled study has been designed to determine the effects of exercise on individuals with differing levels of ACE. Discuss the following components of this study.

1. Establish a base line.
   All army recruits were tested for endurance, strength, and speed; MRI's were taken of their hearts to determine muscle levels)

2. Create the comparison groups
   All army recruits had DNA swabs taken from their mouths to determine which had the ACE gene expressed as DD, and which had II.

3. Keep factors constant. Ask the students a) to list the variables that were kept the same in this study and b) to explain why they think army recruits were used as the subjects.
   a) *constants: subjects' age, diet, level of physical activity, and sleep patterns.*
   b) *army recruits were used in this study to keep these variables as constant as possible because they were all roughly the same age and lived a nearly identical, highly regulated lifestyle throughout a 12 week period of extensive exercise.*

4. Make final measurements and compare to base line
   All army recruits were retested for endurance, strength, and speed, and had a second MRI to determine changes in heart muscle.

5. Conclusions from the data
   The recruits in the 'II' group showed no substantial change in heart muscle in their MRI's but had pronounced increases in all levels of endurance, speed, and strength evidencing increased metabolism. The recruits in the DD group showed a marked increase in muscle development including muscle around the heart but no improvement in endurance despite the extensive training.

6. Possible interpretations and pitfalls
   The results might suggest that those individuals who know they have the DD variant as their ACE gene might choose to forgo any physical exercise to prevent their heart muscle enlarging. However, this would be unwise at a time when other research suggests that aerobic exercise is beneficial. The ACE gene is not the only gene that explains an individual's response to exercise. Incomplete answers in science sometimes lead to conflicting information and advice to the general public. More study is often the solution.

Teacher Notes for the Student Activity:
Pulse Rate Lab—Designing a Controlled Experiment

Part A:

1. Caution: Check with students and/or the school nurse to determine if any of your students are restricted from doing vigorous exercise before engaging in these laboratory activities. Students who cannot engage in vigorous exercise can still participate by taking pulse rates and recording data from other class members.
2. Have students read through their Student Handout: Part A – Procedures, and discuss any questions they may have.
3. Demonstrate the proper procedure for taking a pulse after students have completed reading through the procedures.
4. Review procedures for writing a *testable* hypothesis.
5. Review dependent and independent variables and graphing skills before students begin. A sample graph may be provided on the board.
6. Have students complete Part A of the procedures as written.
7. Assign students to lab groups.

Part B: Laboratory Extension

1. Students should review the testing procedures outlined in the video and discussed at the conclusion of the video. A discussion of the importance of keeping factors constant should ensue before students make hypotheses or begin designing their experiments. Students should be encouraged to form their own testable hypothesis. Some examples of factors that could be tested are:
    - The effect of body position on pulse rate
    - The effect of gender on pulse rate
    - The effect of walking on pulse rate
    - The effect of muscle fatigue on pulse rate
    - The effect of regular daily exercise on pulse rate
    - The effect of BMI on pulse rate
    - The effect of hip to waist ratio on pulse rate
    - The effect of mean daily hours of sleep on pulse rate

    Note: A trial test teacher suggests discussing these examples with the class and choosing one factor to study as a class project.

2. Make sure that each group checks their hypothesis with the teacher to see if it is testable. Discuss hypothesis errors with the lab group pointing out reasons why their hypothesis is or is not a testable one. Use examples from the video to reinforce these concepts.
3. Before students begin developing procedures, review the importance of controlling variables once again. Review the concepts covered in the video segment. Discuss the limitations that might be faced as students use their classmates as test subjects. Some questions to ask:
    - Does everyone in class have the same fitness/activity level?
    - Does everyone in class have the same diet?
    - Does everyone in class have the same sleeping patterns?
    - Is everyone in class approximately the same age?
    - How would the accuracy of our results be affected if we had more test subjects?
4. Do a class survey of these questions and record the results on the board:
    - Have students go to the board by lab group.
    - Students record their names under the appropriate activity, diet, and sleep categories.

    Note: Explain that this data can be used for controlling variables when they begin experimentation. Therefore, it is very important that students be honest about their assessments of themselves.

Example:

Daily Activity Level

(Leave space under each category for students to record their names.)

High—exercise 5 or more times a week for at least 30minutes

Example:

Jessica	Stewart	James
Aaron	Tashanda	John Paul
Ty	Susan	

Moderate—exercise 3 to 5 times a week for at least 30 minutes

Trevor	Lorena	Maria
Sasha	Lindsey	Coralia
Salvador	Blanton	Micky

Low—exercise less than twice a week

Jamie	Justin	Dusty
Matt	Ashley	Rosario
Veronica	Nick	Michah

Diet

Display a USDA Food Pyramid or print one from one the websites listed below:

http://www.nutricounter.com/articles/pyramid.htm
http://www.printablechecklists.com/checklist84.shtml

Excellent—Mostly eats the recommended servings for all food groups, avoids junk foods, carbonated/sugary beverages, etc.
Good—Attempts to eat the recommended servings and avoids junk food. Avoids skipping meals and high fat foods, but occasionally indulges in junk food and sometimes does not eat recommended food servings.
Poor— Sometimes eats well, but consumes junk food daily, or skips meals frequently. Misses several suggested servings of one or more of the food groups.
Bad—Almost always eats junk food and skips meals. Typically, does not get the recommended servings of most food groups.

Sleep

Excellent: Sleeps the recommended 8-10 hours a day nearly every day of the week
Good: Sleeps the recommended 8-10 hours a day 3-5 days a week
Poor: Sleeps the recommended 8-10 hours a day 0-2 days a week

5. After each group has a testable hypothesis, remind them to use the data on the board to choose their test subjects. For example, if they are testing the effects of sleep on pulse rate, they would want to select test subjects that had similar diets and similar activity levels, but different sleep patterns.
6. As students begin designing their experiments, walk around the room asking lab groups to explain what they are planning. Discuss changes they may need to make as you find errors or omissions in their experimental designs.

Student Handout: Pulse Rate Lab—Designing a Controlled Experiment

Name_____

Part A — Introductory Problem

Hypothesis or Prediction

1. State a hypothesis about the effects of exercise on the resting pulse rate.

_____

_____

2. State a hypothesis about the recovery time (the amount of time required to return to normal resting pulse).

_____

_____

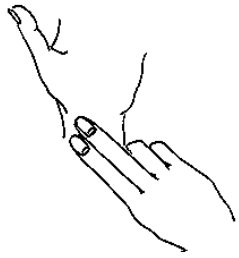
Materials

- Clock or watch with a second hand
- Graph paper
- Pencil

Procedure

Section One:

1. Find your pulse by placing your right index finger on the thumb side of your left wrist. Press lightly. You should feel a pulsing flow of blood. This pulsing is called the radial pulse. The radial artery is above the radius (the forearm bone on the thumb side). If you have difficulty locating your pulse on your wrist, try the carotid pulse. The carotid pulse is found by placing your index finger and middle fingers of your right hand on the side of your throat. Push these fingers up to feel the pulse.



Correct positioning of fingers

2. Practice finding your pulse a few times.
3. Sit quietly for one minute. Do not cross your legs or feet. Count your pulse for 15 seconds. Calculate your pulse rate for one minute by multiplying by 4 (15 seconds X 4 = 60 seconds). Repeat two more times. Record your observations in Table 1.
4. Determine your mean pulse rate per minute. Record your pulse rate in Table 1.
5. Calculate your group's mean resting pulse. Record data in Table 2.

Section Two:

1. Engage in some mild exercise for one minute: Walk around the room, do side bends, body twists or other light exercise as determined by the class. After exercise is completed, take your pulse and record your results in Table 3. Repeat the exercise and pulse procedure two more times to determine

your mean pulse rate after mild exercise.

Section Three:

1. Now engage in vigorous exercise for one minute. In order to make this a controlled experiment, decide as a class on the specific form of exercise. For example: push-ups, jumping jacks, sit-ups, jog in place, or some other vigorous exercise approved by your teacher. After exercise is completed, take your pulse. Record your results in Table 3. Repeat exercise and pulse procedure two more times to determine your mean pulse rate after vigorous exercise.
2. Repeat the vigorous exercise section of this activity to determine an average pulse rate after vigorous exercise. Immediately after exercise, sit quietly and take your pulse for 15 seconds. Continue taking the pulse again every minute for 15 seconds until it returns to the resting pulse rate or until time equals six minutes after exercise. Record all data on Table 4.
3. Complete a line graph to show what happened to your pulse rate after exercise. Put pulse rate per minute on the y-axis, and time in minutes after exercise on the x-axis.

Table 1: Individual Resting Pulse Rate

Trial	Pulse Rate/ 15 seconds	Pulse rate/ minute
1		
2		
3		
Mean Pulse Rate		

Table 2: Group's Mean Resting Pulse Rate

Group Member	Mean Resting Pulse rate/minute

Table 3: Individual Pulse Rate during Exercise

Trial	Mild Exercise rate/ minute	Vigorous Exercise rate/minute
1		
2		
3		
Mean		

Table 4: Individual Pulse Rate: Time to Return to Normal Pulse

Time (minutes) after Exercise	Pulse rate/minute
0	
1	
2	
3	
4	
5	

Questions/Analysis

1. Did your results support or reject your initial hypothesis? Explain.

2. What was the independent variable in your experiment?

3. What was the dependent variable in your experiment?

4. Identify other factors that could influence the pulse rate during exercise.

5. Why did you take a resting pulse rate?

6. What factors might determine a person's time to return to normal?

Part B: Laboratory Extension

Student designed experiment

Now that you have completed the preliminary part of this activity, design an experiment that can be carried out in the classroom for testing one variable other than exercise that might affect the *resting pulse rate*. Design an experiment to test this variable. Use the following as a guide:

- Design a controlled experiment based on your hypothesis.
- Make a numbered list of steps, similar to a recipe that anyone could follow to perform the experiment.
- Design tables for convenient recording of data. Decide how you will report your data and analysis in the oral presentation to the class. You may use one of the options used in Part A.

Hypothesis

From the information you now have about this topic, develop a hypothesis that could be tested in a controlled experiment that will gather quantitative data.

Explain the reasoning behind your hypothesis.

The results should include designed tables and graphs.

Plan of Investigation

Consider the following questions in designing your data tables and graphs:

- What will you measure?
- What materials will you need?
- How will you proceed with the investigation?
- How will you show your results in tables and graphs?

What is the question you are investigating?

What variables are important?

What will be your independent variable?

What will be your dependant variable?

What procedures will you use to test your hypothesis?

What materials will you need for this investigation?

Have you included a list of constants and repeated trials?

What will you measure?

How will you graphically organize your data?

Conduct your experiment

Graph your data.

Analyze and Conclude

Explain how your data supports or does not support your hypothesis.

What conclusions can you make from your data? Be sure to use your data to support any statements you make.

Were all variables other than the independent and dependent variables held constant? Explain how your results might have been affected by your ability to control these other potential variables.

Additional Resources

Because Web sites frequently change, some of these resources may no longer be available. Use a search engine and related key words to generate new Web sites.

Information on ACE Genes
http://www.suite101.com/article.cfm/5045/41810
http://www.pponline.co.uk/encyc/0831.htm
http://www.heartcenteronline.com/myheartdr/home/research-detail.cfm?reutersid=1258

Food Pyramid Guides:
http://schoolmeals.nal.usda.gov/
http://www.pueblo.gsa.gov/cic_text/food/food-pyramid/main.htm
http://www.nal.usda.gov/fnic/Fpyr/pyramid.html

Heart Health Information:
http://www.health-heart.org/
http://www.health.uab.edu/hospital/show.asp?durki=26746
http://www.einstein.edu/e3front.dll?durki=11573

Taking Your Pulse, Information and other Labs on the Web:
http://www.fm.cnyric.org/mott_road/Taking_pulse.html
http://www.madsci.org/experiments/archive/857361537.Bi.html
http://www.mhhe.com/hper/health/personalhealth/labs/cardiovascular/lab3-1.html

Calculating BMI and Hip to Waist Ratios
http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm
http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm
http://www.nhnutrition.com/Fitnesstools/waisthipratio.htm

Genomic Revolution
http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml
The Web site to the government-funded Human Genome Project with links about genomics, the history of the project, and more.

Secrets of the Sequence Videos and Lessons
This video and 49 others with their accompanying lessons are available *at no charge* from www.vcu.edu/lifesci/sosq