ELEMENTARY SCIENCE SEMINARS
LIFE SCIENCE: The Science Fitness Investigation

OBJECTIVES

- Conduct a physical fitness-related experiment.
- Select a variable relating to the experiment and test the variable's impact on the experiment's problem.
- Apply Newton's third law of motion to a fitness problem.
- Examine and conduct strength training exercises for the arms and the legs.
- Identify and define the basic concepts of experimental design (e.g. independent variables, dependent variables, constants, control group, hypothesis, and repeated trials).
- Design an experiment to investigate a fitness problem.
- Use a simple diagram to communicate the major components of an experiment.
- Construct an appropriate data table for organizing data.
- Use scientific process skills including observing, measuring, recording, and analyzing data.
- Investigate how nutrition and mental fitness affect physical performance.

BEFORE THE PROGRAM

Listed below are materials that each student or each student team should have for participating in the program. If space is limited, you may wish to divide students into teams and ask different team members to perform the different activities and exercises shown during the broadcast.

Permit a working area that is enables students to move about when exercises are performed. The standing and long broad jumps will be the focus of the investigation, and students will complete several exercises as they explore the scientific approach involved in competing in these events.

Materials Per Student or Student Team:
tennis shoes
loose fitting clothes
a large towel
two 16 oz. cans
a large book (e.g., dictionary)

PROGRAM ACTIVITY: PUMP UP YOUR JUMP*

NOTE: During the broadcast, two broad jump lanes will be set up. The directions below are for setting up four lanes. Also, the described activity is for a cumulative distance exercise for an entire class. During the broadcast, the activity will be done on an individual basis.

Materials: 4 measuring tapes or yardsticks, masking tape, broad jump graph

Preparation:

1. Locate an open space. You will need an area at least 45 meters long and 55 meters wide.

2. Using masking tape, mark four starting lines, each 1 meter long. Leave at least 2 meters on each side of each lane for walking and maneuvering. These starting lines will mark standing broad jump lanes. Each starting line will be a lane for a different broad jump style (arms stiff with legs bent, legs stiff with arms bent, etc.). These lanes can be thought of as a giant Y-axis of a bar graph. The axis of the graph will indicate thecumulative distances for the entire class for each of the four broad jump styles. (NOTE: In this event, students stand in one place and jump as far as they can without a running start.)

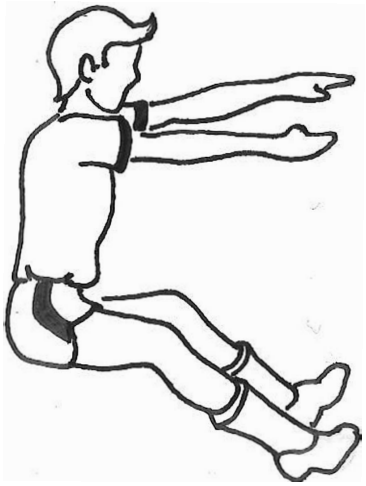
3. Label each broad jump lane as follows:

   JUMP 1: Legs stiff with very little knee bending; arms stiff and straight down at sides

   JUMP 2: Legs stiff; arms able to swing naturally

   JUMP 3: Arms stiff and straight down at the sides; legs able to bend naturally

   JUMP 4: Use both arms and legs during the jump in a natural bending, swinging fashion.



4. Set a measuring tape or yardstick and a roll of masking tape near each lane.

5. If necessary, organize into pairs of students.

PROGRAM ACTIVITY: PUMP UP YOUR JUMP* (cont.)

Procedure:

1. Explain that students will jump four times to experiment with how their arm and leg positions affect their jump. Demonstrate for the class the four jumping techniques they will use. (See description above.)

2. Divide the student pairs evenly among the four broad jump lanes. Explain that each individual pair will take turns jumping. Ask the first student in each lane to jump. His or her partner will measure the distance and then mark it with a small piece of masking tape. (NOTE: Measure from the back of the heel to the starting line of the jump. If a student falls forward or backward, the jump can be repeated.)

3. Now, direct the first jumpers' partners to use the distance markers just placed for the previous jumps as the starting lines for their jumps. As before, the partner who is not jumping will mark the distance. Direct student pairs to continue to take turns jumping, with each student using the previous student's distance marker as the starting line. Student pairs should rotate lanes until everyone has jumped in each of the four lanes. In this way, students will have the opportunity to try each of the broad jump techniques once.

4. When all students have finished jumping in all the lanes, the markers will create a graph showing the cumulative distances of the entire class for each jump. Write down the cumulative distances for each of the four jumps before returning to the classroom.

5. Distribute the broad jump graph and write the cumulative distance for each jump on the chalkboard. Explain that students will fill in the graph by making a bar showing the distance of each jump. (NOTE: You may want to display a completed broad jump graph using an overhead projector and invite volunteers to explain the data shown.)

6. Invite students to evaluate the data. Encourage students to discuss which technique seemed to help people jump further and which technique resulted in the shortest distances. Ask students to note both cumulative and individual distances, eliciting from them quantitative comparisons about the jumps. Lead a discussion about what students have noticed about the importance of arms to jumping. Most students will understand from their jumps that arms help them maintain balance and improve their jumps.

7. Encourage students to brainstorm ways to improve their jumping form, such as swinging their arms faster or higher, rocking back and forth for added momentum, or leaning forward as they jump.

*Activity from National Science & Technology Week 1992-1993 curriculum packet

BROAD JUMP GRAPH

Name _____

Legs stiff with very little knee bending; arms stiff and straight down at sides

Jump 1

Legs stiff; arm; able to swing natmally

Jump 2

Arms stiff and straight down at the sides; legs able to bend naturally

Jump 3

Use both arms and legs performing the jump in a natural bending swinging fashion

Jump 4

Meters/
Measuring Unit

PROGRAM ACTIVITY: DESIGN DETECTIVE

Students will perform the “Pump Up Your Jump” and will use this activity to identify the independent variable, dependent variable, constants, control, and repeated trial components of an investigation.

Vocabulary

Hypothesis:	an educated guess about the relationship between the variables, which can be tested (e.g., If arms are held out in front during the jump, the jumper will jump farther than if the arms are held at the sides.)
Independent Variable (IV)	the variable that is purposefully changed by the experimenter (e.g., position of arms)
Dependent Variable (DV)	the variable that responds (e.g., distance jumped)
Constants (C)	all factors that remain the same and have a fixed value (e.g., shoes and clothes, jumping surface)
Control	the standard for comparing experimental effects
Repeated Trials	the number of experimental repetitions, objects, or organisms tested at each level of the independent variable

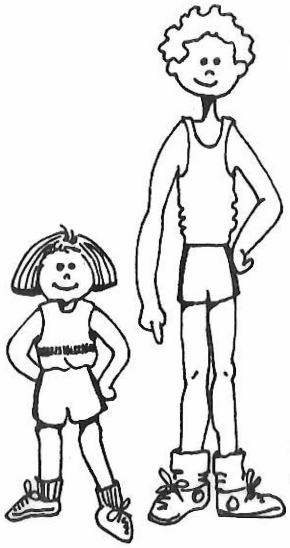
Students will complete the following table by inserting specific student actions, purposeful changes, and responses obtained by watching and/or doing the broad jump activity:

ACTION	PURPOSEFUL CHANGE	RESPONSE TO CHANGE	REMAINED THE SAME
Component			
Control			

FOLLOW-UP ACTIVITY: FAMILY CONNECTION

Encourage students to conduct a broad jump experiment with family members, friends, and neighbors. Invite students to choose a variable they would like to test (for example, foot size, height, length of legs) for its impact on broad jump distance.

Have students identify and diagram the basic concepts of their experimental design as shown in the sample below:



HYPOTHESIS:			
NAME OF JUMPER	INDEPENDENT VARIABLE	DEPENDENT VARIABLE	DERIVED QUANTITY (cm)
	Length of Legs	Jump Distance Trials 1 2 3	Average Distance

FOLLOW-UP ACTIVITY: THINK BEFORE YOU LEAP

Important factors to standing broad and long jump distances are the *velocity* and the *angle* of the jumper's takeoff. In this activity, students will use calculators to compute which angle and velocity combination will give the longest distance. Calculators should contain the sine function key. Students will use the following information to complete the given matrix:

VELOCITY

3mph = 1.34 m/s
7mph = 3.13 m/s
10 mph = 4.47 m/s

mph = miles per hour
m/s = meters per second

ANGLE

10°
45°
60°

FORMULA

$$D = \frac{v_i^2 \sin(2\Theta)}{g}$$

d = distance
g = force of gravity (9.81 m/s)
v_i^2 = velocity
Θ = angle

m/s \ Θ	10°	45°	60°
1.34			
3.13			
4.47			

FOLLOW-UP ACTIVITY: GOING THE DISTANCE

Brainstorm with the students different ways they could improve their horizontal velocity and takeoff angle. Direct students to test ideas and to record test ideas and outcomes on the following chart.

(HYPOTHESIS) ACTION	(IV) PURPOSEFUL CHANGE	(DV) RESPONSE TO CHANGE	(C) REMAINED THE SAME
CONTROL:			

PROGRAM ACTIVITY: MODEL ARM*

Students will create a model arm that will help explain the workings of muscle teams.

Materials: cardboard squares (3 per student), paper clips, long balloons (2 per student), masking tape

For the Bones: Cut three cardboard squares equal to student's arm length; roll the cardboard squares tightly; bind the ends with tape and label one the humerus, one the radius, and one the ulna.

For the Joint: Make a hole through all three bones with something sharp;unbend a paper clip, thread it through the holes, and loop the ends.(See the drawing on the next page.)

For the Muscles: Slightly inflate two long balloons; tie knots in both ends.

Procedures:

1. Tie on the balloon muscles. First the bicep muscle and then the tricep muscle.

2. Move the arm joints. What happens when the biceps contracts?

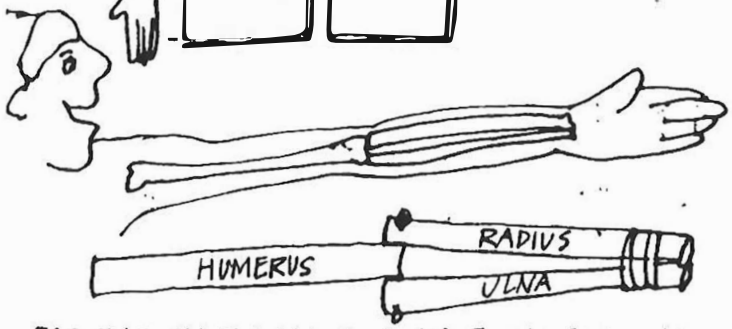
*excerpt from *Blood and Guts*, p. 39. (See Resource Section)

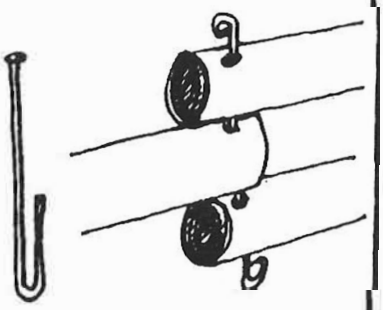
Model Arm You can make a rather nice model arm that will help explain the workings of muscle teams. It will also look splendid on your wall.

FOR THE BONES:

① CUT SOME CARBOARD SQUARES EQUAL TO YOUR ARM MEASUREMENTS (IN LENGTH).

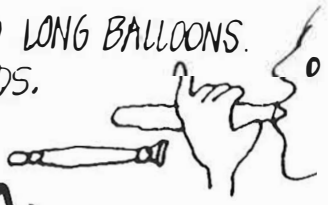
② ROLL THEM TIGHTLY. BIND THE ENDS WITH TAPE. LABEL THEM.



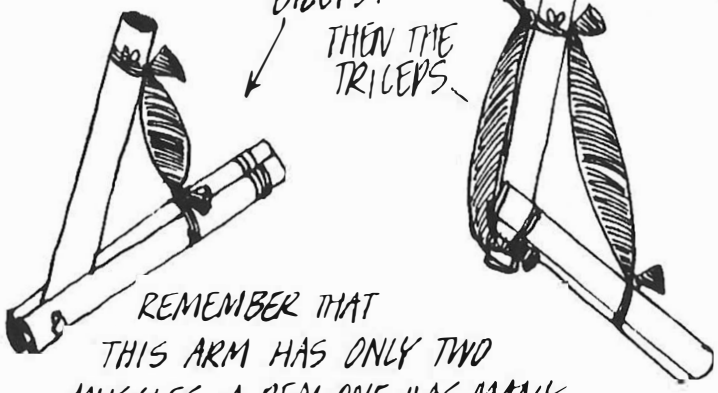


FOR THE JOINT: MAKE A HOLE THROUGH ALL THREE BONES WITH SOMETHING SHARP. UNBEND A PAPER CLIP. THREAD IT THROUGH THE HOLES. LOOP THE ENDS.

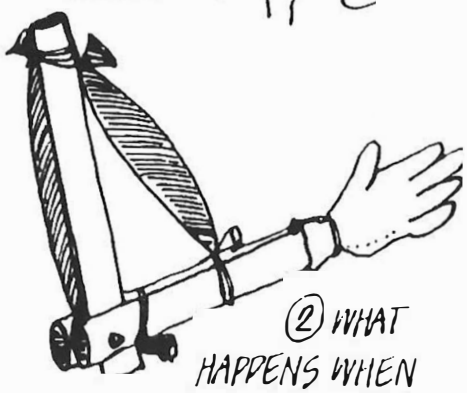
FOR THE MUSCLES: SLIGHTLY INFLATE TWO LONG BALLOONS. TIE KNOTS IN BOTH ENDS.



① TIE ON THE BALLOON MUSCLES. FIRST THE BICEPS. THEN THE TRICEPS.



REMEMBER THAT THIS ARM HAS ONLY TWO MUSCLES. A REAL ONE HAS MANY.



② WHAT HAPPENS WHEN THE BICEPS CONTRACTS? (GETS FATTER?)

FOLLOW-UP ACTIVITY: HAIRPIN DANCE*

You can obseNe the tiny contractions of the muscles in your arm by doing this simple experiment. The amount of motion will surprise you.

Materials: kitchen knife and a hairpin (not a bobby pin) or a bent wire

Procedures:

1. Balance the pin on a knife.
2. Concentrate on holding your arm still. The pin should barely touch the table.
3. Try it with your left and right hands.
4. How do you do after 10 push-ups?
5. How can you explain this motion based on muscle theory?

*excerpt from *Blood and Guts*, p. 43. (See Resource Section.)

FOLLOW-UP ACTIVITY: COMING IN FOR A LANDING

Two important factors contributing to a broad jump distance are the velocity and angle of the jumper's takeoff and the efficiency of the jumper's landing. The following activity will challenge sleuths to think on their feet. Caution students on this activity. Jumps should be from low heights and, if a chair is used, students should spot one another.

Materials: styrofoam cup, water, staircase or chair (low height)

TRIALS	QUESTIONS
Stand on the BOTTOM STEP of a staircase. Leap off and land with your legs stiff.	How did that feel? What did you notice? Your body has absorbed the Earth's force in one jolt. In athletic games, such as basketball or long jumping, this kind of landing can sometimes break bones or twist ankles..
Stand on the BOTTOM STEP of a staircase. Leap from the bottom stair again, but this time make contactfirst with your toes, then the balls of your feet, and finally the heels. As your feet are making contact, bend your knees.	How does it feel? Using your feet and knees this way spreads your impact over a longer period of time, so you make a gradual acquaintance with the ground.
Here is the real challenge, now. Fill the styrofoam cup with water and hold it when you jump off the bottom step. The object is not to spill any water. You will have to practice bending your knees and extending the length of time you remain on your toes, then on the balls of your feet, and finally on the heels.	Does bending your whole body help? Practice until you can do a dry landing. Make sure you wipe up any spills between jumps to avoid slipping.
Repeat the above trial in the broad jump.	Is the landing technique the same or different in a broad jump?

PROGRAM ACTIVITY: MENTAL AEROBICS*

To get an extra edge on an opponent, regardless of whether that opponent is another person, yourself, or your studies, strengthening your mental powers is important. By using suggested exercises we've excerpted from the book *Mental Aerobics: Exercises for a Stronger, Healthier Mind* (see Resource Section), you can work on strengthening your mind just as you do your body. The format of these exercises will seem very familiar: warm-up, strengtheners, and cool-downs. The program sleuths will encourage the viewing sleuths to try out some of the mental aerobics following the show.

Warm-Up Exercise: Race-Walking Your Mind

You already know the advantages of warming up your body; the same principles apply to warming up your mind. This is a good exercise to run through just before sitting down to a project that requires mental sharpness.

Time: 5 minutes
Materials: A pen and some paper; an alarm clock, a stopwatch, or a timer
Body Position: sitting

1. Pick up any form of printed material and select the first noun you see, e.g., the word "frost" on the weather page.

2. Sit down and set the timer to ring in five minutes.

3. At the top of your paper, write the noun you've selected. For the next five minutes, write as many phrases or words as you can that include the noun. Don't stop to think or analyze; just write. (for example: "Jack Frost," "frostbitten," "defrost the freezer") The idea is to beat the clock by writing as quickly as you can, even if the associations seem silly.

4. After five minutes, stop, "shake out" your mind by counting to 20, and continue your day.

Mind Strengtheners: For the Workplace

This is intended to confuse your mind and force it to reprogram how it takes in and records information. What you will do is go through your daily routine but mix up the activities in order to break old patterns. Try to do at least one per day. Add each day's new activities to those you performed the day before. For example:

Monday:	Brush your teeth with the opposite hand.
Tuesday:	Read your least favorite section of the paper first and brush your teeth with the opposite hand.
Wednesday:	Take a different route to school, read your least favorite section of the paper first, and brush your teeth with the opposite hand.

After two to three weeks, you'll be amazed at the new ideas that will pop into your mind.