Experiment
27A

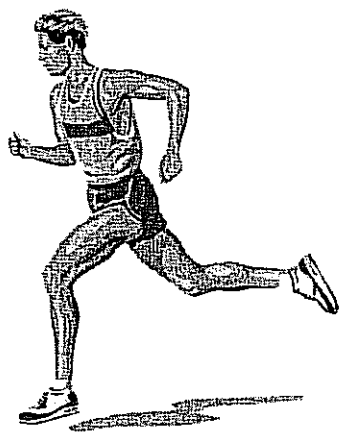
Heart Rate and Physical Fitness

The circulatory system is responsible for the internal transport of many vital substances in humans, including oxygen, carbon dioxide, and nutrients. The components of the circulatory system include the heart, blood vessels, and blood. Heartbeats result from electrical stimulation of the heart cells by the *pacemaker,* located in the heart's inner wall of the right atrium. Although the electrical activity of the pacemaker originates from within the heart, the rhythmic sequence of impulses produced by the pacemaker is influenced by nerves outside the heart. Many things might affect heart rate, including the physical fitness of the individual, the presence of drugs such as caffeine or nicotine in the blood, and the age of the person.

As a rule, the maximum heart rate of all individuals of the same age and sex is about the same. However, the time it takes individuals to reach that maximum level while exercising varies greatly. Since physically fit people can deliver a greater volume of blood in a single cardiac cycle than unfit individuals, they can usually sustain a greater work level before reaching the maximum heart rate. Physically fit people not only have less of an increase in their heart rate during exercise, but their heart rate recovers to the resting rate more rapidly than unfit people.

In this experiment, you will evaluate your physical fitness. An arbitrary rating system will be used to "score" fitness during a variety of situations. Tests will be made while in a resting position, in a prone position, as well as during and after physical exercise.

Important: Do not attempt this experiment if physical exertion will aggravate a health problem. Inform your instructor of any possible health problems that might be affected if you participate in this exercise.



OBJECTIVES

In this experiment, you will

- Determine the effect of body position on heart rates.
- Determine the effect of exercise on heart rates.
- Determine your fitness level.
- Correlate the fitness level of individuals with factors such as smoking, the amount of daily exercise, and other factors identified by students.

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Vernier Exercise Heart Rate Monitor
stepping stool, 45 cm (18 inches) high
saline solution in dropper bottle

PROCEDURE

Each person in a lab group will take turns being the subject and the tester. When it is your turn to be the subject, your partner will be responsible for recording the data on your lab sheet.

1. Elastic straps, for securing the transmitter belt, come in two different sizes. Select the size of elastic strap that best fits the subject being tested. It is important that the strap provide a snug fit of the transmitter belt.
2. Wet each of the electrodes (the two grooved rectangular areas on the underside of the transmitter belt) with 3 drops of saline solution.
3. Secure the transmitter belt against the skin directly over the base of the rib cage. The POLAR logo on the front of the belt should be in line with the chest center as shown in Figure 1. Adjust the elastic strap to ensure a tight fit.
4. Connect the receiver module of the Exercise Heart Rate Monitor to the Vernier computer interface.

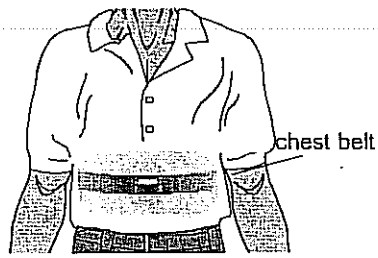


Figure 1

5. Have the subject hold the receiver in his right hand. Remember, the receiver must be within 80 cm of the transmitter belt while data is being collected.

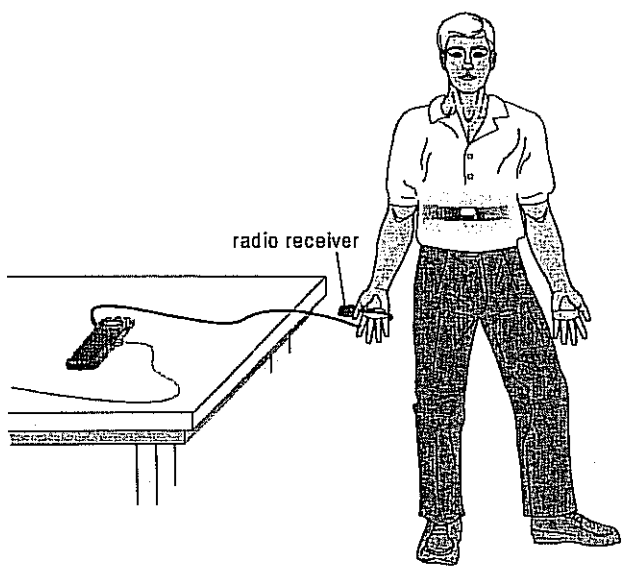


Figure 2

6. Prepare the computer for data collection by opening the file "27 Heart Rate & Fitness" from the *Biology with Computers* folder of Logger*Pro*.
7. Click [Collect] to begin monitoring heart rate.

8. Determine that the sensor is functioning correctly. The readings should be consistent and within the normal range of the individual, usually between 55 and 80 beats per minute. Click [Stop] when you have determined that the equipment is operating properly.

Standing heart rate

9. Click [Collect] to begin monitoring heart rate. Stand upright for 2 minutes.
10. Record the resulting heart rate in Table 6.
11. Use the resulting heart rate to assign fitness points based on Table 1 and record the value in Table 6.

Table 1: Standing Heart Rate			
Beats/min	Points	Beats/min	Points
60–70	12	101–110	8
71–80	11	111–120	7
81–90	10	121–130	6
91–100	9	131–140	4

Reclining heart rate

12. Recline on a clean surface or table for 2 minutes.
13. Record the resulting heart rate in Table 6.
14. Assign fitness points based on Table 2 and record the value in Table 6.

Table 2: Reclining Heart Rate			
Beats/min	Points	Beats/min	Points
50–60	12	81–90	8
61–70	11	91–100	6
71–80	10	101–110	4

Heart rate change from reclining to standing

15. Stand up next to the lab table.
16. Immediately record the peak heart rate in Table 6.
17. Subtract the reclining rate value in Step 13 from the peak heart rate after standing to find the heart rate increase after standing.
18. Locate the row corresponding to the reclining heart rate from Step 13 in Table 3.
19. Use the calculated heart rate increase after standing (from Step 17) to locate the proper column for fitness points in Table 3. Record the fitness points in Table 6

Table 3					
Reclining rate	Heart rate increase after standing				
beats/min	0–10	11–17	18–24	25–33	34+
50–60	12	11	10	8	6
61–70	12	10	8	6	4
71–80	11	9	6	4	2
81–90	10	8	4	2	0
91–100	8	6	2	0	0
101–110	6	4	0	0	0

20. Rest for 2 minutes. Click [Stop] to end data collection. When the rest period is over, click [Collect] to begin data collection.

Step test

21. Before performing the step test, record the subject's heart rate (Pre-exercise) in Table 6.
22. Perform a step test using the following procedure:
    a. Place the right foot on the top step of the stool.
    b. Place the left foot completely on the top step of the stool next to the right foot.
    c. Place the right foot back on the floor.
    d. Place the left foot completely on the floor next to the right foot.
    e. This stepping cycle should take 3 seconds to complete.
23. When five steps have been completed, record the heart rate in Table 6. Quickly move to Step 24.

Recovery rate

24. With a stopwatch or clock, begin timing to determine the subject's recovery time. During the recovery period, the subject should remain standing and relatively still. Monitor the heart rate readings and stop timing when the readings return to the pre-exercise heart rate value recorded in Step 21. Record the recovery time in Table 6.
25. Click [Stop] to end data collection.
26. Locate the subject's recovery time in Table 4 and record the corresponding fitness point value in Table 6. If the subject's heart rate did not return to within 10 beats/min from their pre-exercise heart rate, record a value of 6 points.

Table 4	
Time (sec)	Points
0–30	14
31–60	12
61–90	10
91–120	8

Step test for endurance

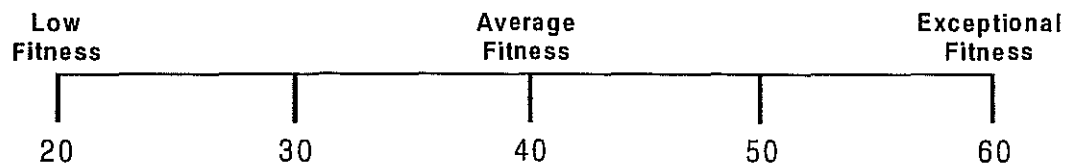
27. Subtract the subject's pre-exercise heart rate (from Step 21) from his or her heart rate after 5 steps of exercise. Record this heart rate increase in the endurance row of Table 6.

28. Locate the row corresponding to the pre-exercise heart rate in Table 5 and use the heart rate increase value to determine the proper fitness points. In Table 6, record the fitness points.

Table 5

Pre-exercise heart rate	Heart rate increase after exercise				
	0–10	11–20	21–30	31–40	41+
60–70	12	12	10	8	6
71–80	12	10	8	6	4
81–90	12	10	7	4	2
91–100	10	8	6	2	0
101–110	8	6	4	1	0
111–120	8	4	2	1	0
121–130	6	2	1	0	0
131+	5	1	0	0	0

29. Total all the fitness points recorded in Table 6. Determine the subject's personal fitness level using the scale below.



DATA

Table 6

Condition	Rate or time	Points
Standing heart rate	beats/min	
Reclining heart rate	beats/min	
Reclining to standing	beats/min	
Pre-exercise heart rate	beats/min	
After 5 steps	beats/min	
Recovery time	seconds	
Endurance	beats/min	
		Total points:

QUESTIONS

1. How did your heart rate change after moving from a standing position to a reclining position? Is this what you expected? How do you account for this?

2. How did your heart rate change after moving from a reclining position back to a standing position? Is this what you expected? How do you account for this?

3. Predict what your heart rate might be if you had exercised for twice the length of time that you actually did. Explain.

4. How does your maximum heart rate compare to other students in your group. Is this what you expected? How do you account for this?

5. Why would athletes need to work longer and harder before their heart rates were at the maximum value?

6. How do you evaluate your physical fitness? Do you agree with the rating obtained from this experiment? Explain.

7. Current research indicates that most heart attacks occur as people get out of bed after sleep. Account for this observation.

EXTENSION

1. Using a sphygmomanometer, learn how to measure blood pressure. Compare a person's blood pressure when reclining, to that of the same person immediately after standing from a reclined position. Relate the change in blood pressure to the heart rate values measured when going from reclining to standing.
2. Design an anonymous survey to be taken by each member of your class. In the survey, ask questions that you think might influence the test results. Examples might include:
   - Did you have more than six hours of sleep last night? Gender? Age?
   - Do you smoke? If so, how many packs per week do you smoke?
   - What was your total number of fitness points?
3. Try to determine whether any of the variables from your survey show a statistical link to fitness. You may want to use a statistical T-Tests to determine whether a relationship between the variable and physical fitness is due to chance.