

## CARDIOVASCULAR SYSTEM

Cardiovascular fitness is the body's ability to continuously provide oxygen to muscles as work is performed over an extended period of time. This component of fitness includes the circulatory system (heart, blood, and blood vessels) and the respiratory system (lungs and air passages).

Research has shown that body functions improve with use and decline with disuse. In other words, the heart, lungs, and muscles become stronger and more efficient in their utilization of oxygen as they are used more. To understand how to improve your cardiovascular fitness, you must first understand how the circulatory and respiratory systems function and what diseases may result if these areas are neglected.

### Circulatory and Respiratory System

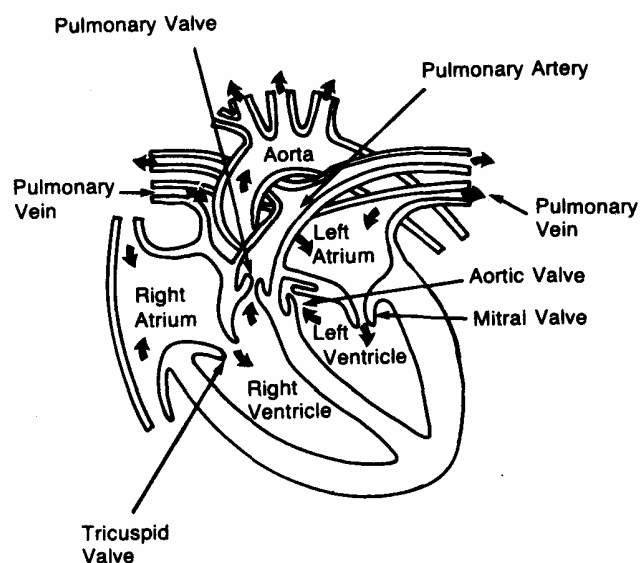
People often take oxygen for granted and never think of it as fuel for the body. The fact is, the more oxygen muscles receive, the more energy they can produce and the better you feel. The circulatory and respiratory systems work together in providing muscles with necessary oxygen. As air is breathed in, the blood picks up oxygen from the lungs and carries it to the heart.

The heart is a remarkable muscle that actually serves as two pumps. The chambers on the left side of the heart force blood containing oxygen throughout the body through elastic blood vessels called arteries. Arteries always carry blood away from the heart.

As arteries branch out in the body, they gradually decrease in size until they form tiny capillaries. This is where food and oxygen are delivered from the blood to cells throughout the body. Notice how the capillaries serve as bridges between arteries and veins. Veins always carry blood toward the heart.

Just as ashes are left after a fire, some waste materials remain when cells use up oxygen. These wastes are picked up by the blood in the capillaries and are transported back to the heart by veins. Blood is forced through the veins by contracting muscles. The blood in veins can only move toward the heart, because one-way valves keep the blood from flowing backward when the muscle relaxes. The right chambers of the heart pump this returning blood to the lungs where wastes are exchanged for more oxygen and the process repeats itself.

Your body holds only about 6 litres of blood. Therefore, the blood must circulate throughout the body to continuously supply all the body cells with oxygen and nutrients and remove wastes. That is why the heart, blood vessels and blood are called the circulatory system.



Cross section of the heart. Note the left ventricle muscle walls are thicker than the right ventricle walls, since this chamber pumps blood throughout the body compared to the right ventricle, which only has to pump it to the nearby lungs.

### Monitoring the Heart

How fast does the heart beat to pump blood? Your heart rate varies with the changing needs of your body. When you are lying down, your heart rate will be less than when you are standing. Running will produce a higher heart rate than when you are doing a less vigorous activity, such as walking. Your size also has an effect upon your heart rate. The average heart rate for adults is 70 beats per minute. In children, the heart beats about 100 times per minute. It is important for you to know how hard your heart muscle is working. One method is to measure your pulse rate.

### Pulse

Your pulse is caused by pressure of the blood on the artery wall and it corresponds to your heart beat. The best locations for measuring your pulse rate are at the wrist and neck, where arteries lie just below the skin. To take your pulse at the wrist, place your index and middle finger against the skin at the base of your thumb on the soft area of the wrist.

Pulse may be taken at the wrist or carotid artery. Take the pulse for ten seconds and multiply by six for a one-minute heart rate count.

To measure your pulse rate at the carotid artery of the neck, move your index and middle fingers from the ear lobe midway toward your Adam's apple. Once you have located the pulse, count it for six (6) seconds and place a zero at the end of that number, or take it for ten (10) seconds and multiply by six (6) to obtain a one-minute pulse rate.

### Resting heart rate

Since the heart is a muscle, it becomes stronger when exercised. By keeping a record of your resting heart rate, you can measure the progress gained in your cardiovascular fitness program. An active person has a lower resting heart rate than someone who is inactive. The heart of an active person pumps more blood with each beat, thus working more efficiently. After a few months of cardiovascular training, a sedentary person will note a decrease in the resting heart rate of ten to twenty-five beats per minute. This illustrates that your heart is becoming stronger and more efficient.

To measure the resting heart rate, take your pulse just after waking in the morning, and before getting out of bed. Your pulse should be taken while you are in a sitting or lying position. A range of 50-100 beats per minute for resting heart rate has been established as normal by the Heart and Stroke Foundation of Canada. However, research shows that adults with resting heart rates over 70 have a greater risk of heart attack than those with resting heart rates below 70.

Resting heart rate should be taken first thing in the morning and in the same position.

### Recovery heart rate

To determine when it is safe to progress in your training program, you should check your pulse after the exercise session to determine your recovery heart rate. The guiding principle is that your heart rate should drop to about 120 beats per minute (BPM) within 5-6 minutes after the workout and be less than 100 beats per minute after 10 minutes.

5-6 minutes after exercise = 120 BPM

10 minutes after exercise = 100 BPM

If after five minutes your pulse does not drop to 120 beats per minute, or after ten minutes to 100 beats per minute, you need to reduce the intensity of your workout. On the other hand, you may elect to increase the intensity of your workout if your recovery heart rate is

Monitor recovery heart rate to determine when to progress in below 120 beats per minute five minutes after exercising and below your training program. 100 beats per minute after ten minutes.

#### Blood pressure

Blood pressure is the measure of blood force against the walls of the arteries. Blood pressure is recorded with two numbers. The higher number recorded is the systolic pressure and is your blood pressure at the moment blood is pumped from the heart by the ventricles. The lower number is the diastolic pressure and represents the blood pressure when the heart is relaxed and filling with blood. The normal range for blood pressure is stated as:

systolic pressure 120 + or — 20

diastolic pressure 80 + or — 10

Aerobic exercises contribute to blood pressure control. Both systolic and diastolic pressures can be reduced as a result of aerobic training. Long-term research studies have shown that the lower the blood pressure within the normal range (100/70), the lower the risk of having a heart attack.

#### Application of Training Principles

The main purpose of any cardiovascular fitness program is to increase the body's ability to utilize oxygen. To increase cardiovascular fitness you must engage in exercises that involve movements of the large muscles of the body. You must be able to maintain these exercises continuously for at least fifteen to thirty minutes. Such exercises are called aerobic, since the working muscles continue to receive as much oxygen as they need. Brisk walking or jogging are activities that would meet the above requirements.

Considerable research has led to the development of the principles of training. By following these principles, you will be able to train efficiently and avoid possible strain and injury.

#### Principle of overload

One way to increase the oxygen supply to the muscles is to develop the muscle that serves as the pump. Since the heart is a muscle, it responds to training as do all other muscles.

To develop the heart muscle you must push it beyond its normal range and make it pump more blood with each beat. This additional overload can be placed on the heart by an increase in the frequency, intensity, or time of the exercise program.

#### FREQUENCY

FREQUENCY —The exercise selected must be performed regularly to reach an adequate level of cardiovascular fitness. Ideally, your training program will become a daily habit; however, benefits can be achieved with fewer workouts.

Aerobic activities must be performed at least three times per week to reach an adequate level of cardiovascular fitness. For example, to decrease the type of cholesterol that clogs blood vessels a person must jog 17.5 kilometres per week.

As a beginner you may elect to swim, jog, or bike three days per week, then increase the overload by doing your selected activity four days, then five days, and finally on a daily basis. Participating in such activities two days per week will not significantly increase cardiovascular fitness. However, such a schedule may maintain the level you have acquired.

#### INTENSITY

INTENSITY —In cardiovascular training you are trying to strengthen the heart and improve the body's ability to utilize oxygen. Even though the heart is a muscle, you cannot observe it getting stronger as you can the biceps. Therefore, you must rely upon the pulse rate, which is an external sign of the heart's condition, since it corresponds exactly to the beat of the heart.

The intensity of a cardiovascular activity may be determined by the response of the pulse rate. How much you increase the heart rate is the critical question. If you do not increase it enough, little or no improvement in cardiovascular fitness will occur. On the other hand, exercising too hard too soon may cause extreme discomfort.

Each person has a maximum heart rate which should not be exceeded. To determine your maximum heart rate, subtract your age from 220. The greatest cardiovascular benefits result when the heart rate increases to 60 to 90 percent of your maximum heart rate. Refer to the chart to find your maximum heart rate.

This 60 to 90 percent range of your maximum heart rate is termed the target heart rate zone and is the desired level of intensity for most people. However, you should start at a lower percentage if you have not been active for some time or are overweight. For example, start at a 40 percent target heart rate and gradually progress to the 60 to 90 percent range. The chart also illustrates the target heart rate zone for various ages using 70 beats per minute as the resting heart rate.

To compute your target heart rate zone, you must first determine your own maximum heart rate. Remember, to obtain this figure subtract your age from 220. Your resting heart rate is then subtracted from your maximum heart rate. This value is multiplied by the lower percent at which you wish to train and is added to the resting heart rate.

$$[(220 - \text{age}) - \text{resting heart rate}] \times 60 \text{ percent} + \text{resting heart rate} = \text{lower level of target heart rate zone}$$

The above formula should be used again to obtain the upper limit of your target heart rate zone. Ninety percent would be substituted in the formula in place of the 60 percent lower limit.

Once the target heart rate zone is known, you will be able to check the intensity of your exercise by stopping briefly from time to time to count your pulse rate.

Many people find it difficult to utilize this information, since they have to count their pulse for ten seconds and then multiply by six for a one minute count (60 seconds). This may be hard to do, if you are swimming in a pool or jogging 3 kilometres from home. A helpful hint is to use a pencil and paper to divide the lower and upper limits of your target heart rate zone by six. This will give you a ten second count that can be easily remembered. For example, if your target heart rate lower limit is 151 and your upper limit is 192, divide both by six. The ten second count would be 25 for the lower limit, and 32 for the upper limit.

While exercising, if your pulse falls below the lower limit of your target heart rate zone, you should increase your intensity (speed up your pace). If your pulse goes above the upper limit of your target heart rate zone, decrease your intensity (slow down your pace).

**TIME** – To achieve all the values of cardiovascular training you must maintain the target heart rate (60 to 90 percent of your maximum heart rate) for a minimum of 15 minutes. A beginner may find it necessary to start a program involving less time and progressively increase the length of time of the exercise session.

To increase the overload you may choose to increase the pace (intensity) or the distance (time) jogged. For example, after weeks of 15- minute exercise sessions, in which you were steadily increasing your pace (intensity) to keep your pulse in the target heart rate zone, you may choose to increase your distance (time) and decrease your pace (intensity). Remember, as time is increased, intensity will decrease.

The chart summarizes a typical aerobic exercise session. As you will note, this individual has a normal heart rate of 76 beats per minute. After a five- to ten-minute warm-up, the individual gradually increases

Progressively add overload.

her heart rate to 140 beats per minute, which is at the lower level of the target heart rate zone. She slightly increases her heart rate and maintains it within the target heart rate zone of 123 to 185 beats per minute. This level of activity is maintained

for 15 to 30 minutes. At the conclusion of the training period, she begins her cool-down session to gradually reduce the heart rate. After the cool-down, she begins the recovery stage, with the heart returning to its pre-activity level.

#### Principle of progression

Since the heart adjusts to the workload you place on it, the overload must be periodically increased in order for improvement to occur. For example, if you begin a regular exercise program that involves jogging 1.5 kilometres in nine minutes, you might find the workout stressful. Your cardiovascular fitness would gradually improve if you continued the nine-minute rate. But, after several weeks of jogging the same distance in the same time, cardiovascular improvement would stop and adaptation would occur. To continue improving your cardiovascular fitness, you would have to increase the stress by jogging 1.5 kilometres in a shorter period of time. This progressive increase in the overload would place additional stress on your cardiovascular system and produce additional improvement.

Remember to observe your target heart rate and recovery heart rate. If while training, your heart rate goes above or below your target heart rate zone, adjustments need to be made. Also, you need to reduce the intensity or duration of your training program if your recovery heart rate is not less than 120 beats per minute five minutes after exercising or less than 100 beats per minute ten minutes after exercising.

#### Principle of specificity

Aerobic exercise promotes cardiovascular fitness better than any other type of activity. Aerobic means with oxygen and involves activities that can be performed for at least fifteen minutes without gasping to catch your breath. Examples of aerobic activities include jogging, dancing, swimming, bicycling, racquetball, and soccer.

Anaerobic (without oxygen) activity is performing at a pace which uses oxygen faster than the body can replenish it. Since this is true, anaerobic exercise can be done only for a short period of time. An example would be the 200 metre dash or the 50 metre freestyle swimming event.