Chapter 2—*Aerobic Fitness and Work Capacity*

Quinton Instrument Co.

Aerobic means with oxygen. In order to perform hard work for extended periods of time, the body derives energy from the oxidative metabolism of fat and carbohydrate. Aerobic fitness is defined as the maximal capacity to:

Take in, transport, and utilize Oxygen.

It indicates the functional capacity of the respiratory system (take in oxygen), the circulatory system (transport oxygen), and the muscles (utilize oxygen). Aerobic fitness or the maximal oxygen intake (VO_2 max) is usually measured in a laboratory treadmill test, using a computerized metabolic measurement system. It can be estimated with simple field tests (see Chapter 7).

VO_2 max Test

Before taking the test, the subject should fill out a health risk questionnaire (PAR Q, page 4) and sign an informed consent form. The subject is fitted with electrocardiograph electrodes and a breathing valve that directs expired air to a metabolic analyzer. The test is conducted on a treadmill after a warmup at a speed dictated by the subject's level of fitness. The grade of the treadmill is increased systematically until the subject cannot continue or until the subject's oxygen intake levels off. The maximal oxygen intake or VO_2 max is the highest level attained. The score in liters of oxygen per minute indicates the maximal capacity of the subject's respiratory system, or aerobic capacity. When that value is divided by the weight (in kilograms), the score is adjusted for body size. This measure, in milliliters of oxygen per kilogram of body weight (mL/kg • min), is called aerobic power. It is correlated to the ability to perform arduous work.

3 L/min/60 kg (132 lb) = 50 mL/kg • min

Since 1975 a score of 45 (mL/kg • min) or higher has been the minimum for wildland firefighters required to do arduous work. That requirement is based on the known energy requirements of the work (average about 22.5 mL/kg • min) and the knowledge that even highly trained and motivated workers are unable to sustain more than 50% of their capacity during extended work shifts. So a worker's aerobic fitness needs to be at least two times the energy demands of the job (2 x 22.5 = 45 mL/kg • min).

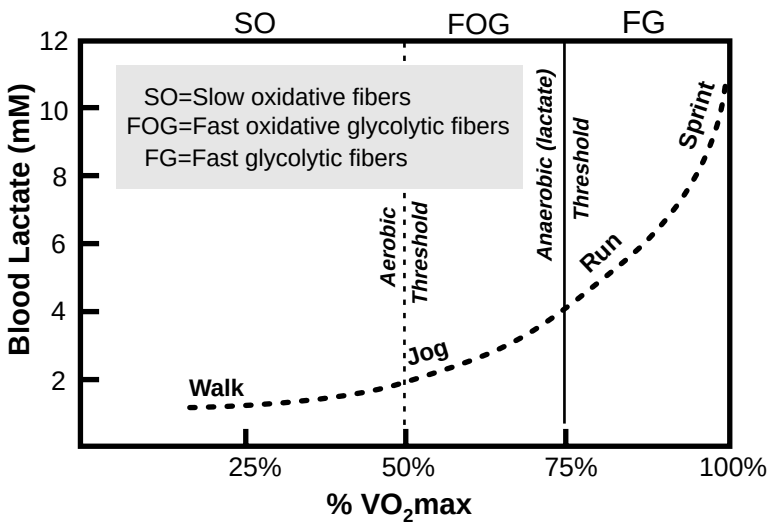

Figure 2.1—**Aerobic/Anaerobic thresholds**. In light exercise such as walking we use slow muscle fibers. As exercise intensity increases, we recruit fast fibers that produce more lactic acid. Continue to increase intensity (% VO_2 max) and even more lactic acid is produced.

When work is too strenuous to be met with aerobic metabolism, workers begin to use the body's limited sources of anaerobic energy. Continued reliance on anaerobic energy sources rapidly leads to fatigue.

Fiber Types

Humans have three main types of muscle fibers: slow-twitch (slow-oxidative) fibers that use oxygen efficiently for long-term work; a fast-contracting type that can work with or without oxygen (fast oxidative glycolytic); and a fast-twitch fiber type that uses muscle glycogen for short intense contractions (fast glycolytic). Slow-oxidative fibers are used for light or moderate effort. As work intensity increases, we use more fast-oxidative glycolytic fibers. When fast-glycolytic fibers are used for high-intensity effort, the muscle's ability to utilize oxygen is exceeded and lactic acid is produced. Excess lactic acid interferes with the muscle's contractile and metabolic capabilities, causing fatigue. Endurance training improves the oxidative ability of slow-oxidative and fast-oxidative glycolytic fibers, reducing the accumulation of lactic acid.

Aerobic and Anaerobic Thresholds

In addition to the VO_2 max, the aerobic and anaerobic thresholds define other important dimensions of aerobic fitness. Both are excellent predictors of performance in work and sport.

Aerobic Threshold

This threshold, which is defined by the initial rise in the lactic acid (a metabolic byproduct) during a progressive test, is associated with the performance of prolonged submaximal work (Figure 2.1). In arduous day-long work such as wildland firefighting and field work, the aerobic threshold predicts work capacity.

Anaerobic Threshold

Also called the lactate threshold, this measure indicates the rapid rise in blood lactic acid when a muscle exceeds its capacity to produce energy aerobically (Figure 2.1). The lactic acid interferes with muscles' contractile force and energy production, leading to reduced work output and fatigue. Measured in a progressive work test, the blood lactate indicates the **upper limit of aerobic metabolism**, and is often defined as a percentage of the VO_2 max. In a strenuous event of 1 hour or less, sedentary individuals can only sustain about 50% of their VO_2

max (50% x 40 mL = 20 mL/kg • min). Active individuals may sustain 70% of their higher VO_2 max (70% x 50 mL = 35 mL/kg • min), and highly trained athletes may exceed 85% of their even higher VO_2 max (85% x 70 = 59.5 mL/kg • min). So the trained athlete can sustain a level of aerobic metabolism three times higher than the sedentary individual. That translates to tremendous differences in performance.

Ventilatory Threshold

Breathing rate and depth increase dramatically at the anaerobic (lactate) threshold. This increase is noticeable and can be used to gauge training intensity. This "breakaway ventilation" is a sign you are at your threshold, and that fatigue is likely if the current pace is maintained or exceeded. Athletes use this information to pace themselves during a race.

To find your threshold, slowly increase pace from a jog, to a run, to a fast run. When your respiration becomes labored and you realize that you cannot maintain the pace indefinitely, you have reached—or crossed—your threshold.

For prolonged arduous effort the aerobic fitness (VO_2 max) and the aerobic threshold define long-term work capacity. (Table 2.1)

Table 2.1—**The aerobic threshold and long-term work capacity**.

	Aerobic threshold *		Fitness		Long-term work capacity
	Percent		mL		mL/kg • min
Unfit	30	x	35	=	10.5
Active	40	x	45	=	18
Trained	50	x	55	=	27.5

* As percentage of VO_2 max.

In wildland firefighting, work requires an average of 22.5 mL of oxygen per kilogram-minute. Sedentary individuals will fall far short of job demands. Active workers will need specific training to raise their aerobic threshold, their fitness—or both—if they hope to maintain work output and have the energy to meet unforeseen emergencies throughout long work shifts.

Aerobic fitness (VO_2 max) defines the maximal **intensity** of effort that can be accomplished, while the aerobic and anaerobic thresholds define **duration** or how long an effort can be sustained. Both measures are important to fully understand aerobic fitness and its contribution to work capacity.

Efficiency

Another factor that has a significant impact on work capacity is one's efficiency or economy of motion. Efficient workers use less energy to accomplish a given task, allowing them to work at a lower percentage of their maximum capacity. This efficiency conserves energy and prolongs performance. Fortunately, efficiency can be taught and learned. With appropriate instruction and practice, workers can learn to use tools and accomplish tasks with a minimum of wasted motion. So efficiency can help compensate somewhat for differences in VO_2 max or the aerobic threshold. The ideal worker has a high VO_2 max and aerobic threshold combined with skill and economy of motion.

But what if you have a desk job and never expect to do strenuous work? What will aerobic fitness do for you? Aside from the many health benefits of activity and fitness, the active life ensures that you will have more energy to do your job, with plenty left over to enjoy family, hobbies, and leisure-time pursuits. Fitness reduces the risk of lower back, repetitive trauma, and other common workplace injuries. It is an essential part of the employee safety and health (wellness) programs.

Specificity of Exercise

Exercise and the effects of a particular kind of training are specific to the muscles and metabolic pathways used in the training. Firefighting and many field tasks require prolonged work with the arms. It is essential to train the muscles that will be used on the job. Untrained arm muscles may fatigue, in spite of a high max VO_2 based on a leg test and leg training. A high max VO_2 ensures the cardiovascular and respiratory capacity for work, but does not ensure specific training of the arm and trunk muscles used to perform prolonged arduous work with hand tools. Athletes recognize the importance of specificity and follow general off-season training with sport-specific training as the season approaches. The same principle applies to firefighters and field workers who should engage in shoveling, wood cutting, raking, and other tasks to prepare for work.

Factors That Influence Fitness

While aerobic fitness is primarily a product of heredity and training, it is also influenced by gender, age, and body fat.

Heredity

The best way to ensure a high level of fitness is to pick your parents carefully. Researchers estimate that aerobic fitness is 25 to 50% inherited, so some sedentary individuals with good genes may have higher fitness scores than others who train.

Training

Training can improve aerobic fitness by 20 to 25%, or more if accompanied by significant weight loss. The major improvements in aerobic fitness (VO_2 max) occur in the first 3 to 4 months, with subtle changes afterward. But after aerobic fitness reaches a plateau, training continues to improve the submaximal work capacity, the aerobic threshold. This measure defines the level of effort that can be sustained for prolonged periods.

Gender

Aerobic fitness levels for untrained young women average 39 to 41 mL/kg • min, while the levels for untrained young men average 45 to 48 mL/kg • min. Regular activity increases the score for both sexes (raising scores to the mid 40's for women and 50's for men). Training leads to further increases (raising scores to the 50's for women and 60's for men). Elite female endurance athletes score in the high 60's and 70's, while men score in the 70's and 80's. At any distance, women's running records fall only 10% behind those recorded by men. Some part of the differences in performance may be due to differences in muscle mass, oxygen transport (hemoglobin), or body fat.

Age

Cross-sectional and longitudinal studies show that fitness declines approximately 10% per decade (1% per year) in our sedentary society. However, that rapid loss of fitness can be cut in half with regular activity (5% per decade), and halved again with fitness training (2 to 3% per decade). Between the ages of 25 and 65, a fitness score of 50 mL/kg • min could decline to 30 mL/kg • min with inactivity, to 40 with regular activity, or to 45 with regular training (Figure 2.2). The choice is yours.

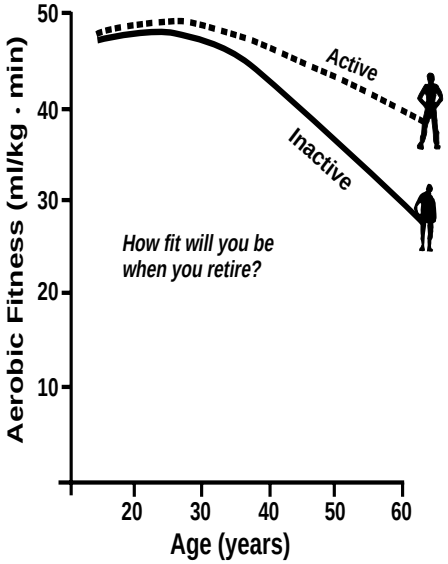

Figure 2.2—**Age and Aerobic fitness**.

Body Fat

Since aerobic fitness is reported per unit (kilogram) of body weight, changes in weight or fat will influence the score. If someone weighing 100 kilograms (220 pounds) with 25% body fat loses 10 kilograms (22 pounds) of fat, fitness will improve…

from: 4 L / 100 kg = 40 mL/kg • min

to: 4 L / 90 kg = 44.4 mL/kg • min.

Then with a 20% improvement from training, the fitness score could climb to 53.3 (44.4 x 20% = 8.88 + 44.4 = 53.3 mL/kg • min). The combination of weight (fat) loss and training can improve fitness by more than 33%.

The average young female has 25% fat while the average male has 12.5 to 15%. Part of this difference is due to sex-specific fat, so I do not recommend weight loss without a thorough analysis of body composition and nutrition. Body fat values below 5% for males and 12% for females are not consistent with good health and long-term maintenance of performance.

Aerobic Fitness Prescriptions

The benefits of fitness are achieved gradually, through regular aerobic exercise. Like any treatment or medicine, the exercise must be prescribed carefully if its benefits are to be realized, and its potentially harmful side effects are to be avoided. The first step involves a health screening, followed by an estimate of your current level of fitness. Later I will provide guidelines for fitness training. The rest is up to you.

Health Screening

Should you have a medical examination before beginning a fitness program? Here is the opinion of world-renowned physician and exercise scientist P.O. Astrand, M.D.:

> *…Anyone who is in doubt about the condition of his health should consult his physician. But as a general rule, moderate activity is less harmful to the health than inactivity. You could also put it*

this way: A medical examination is more urgent for those who plan to remain inactive than for those who intend to get into good physical shape!

The American College of Sports Medicine recommends a medical examination for those over 40 years of age, or when fitness training or pending work assignments constitute a major increase in exercise habits. A simple health screening questionnaire will help you decide if you need to see your physician (see the PAR-Q health screening questionnaire on page 42).

Aerobic Fitness Index

The next step is to estimate your level of aerobic fitness. This can be done with a maximal test on a treadmill or bicycle ergometer, with a submaximal test (Step Test or bicycle), or field test (1.5-mile run). The simplest and safest way, however, is to estimate your fitness with the Aerobic Fitness Index (Table 2.2). Based on the relationship of regular physical activity to fitness, this paper and pencil test provides enough information to estimate fitness. The index is based on your regular level of physical activity.

The Fitness Prescription

The dose of aerobic exercise for safe, steady improvements in aerobic fitness is expressed in terms of exercise:

Intensity – ***Your training heart rate***
Duration – ***Minutes (or calories) of exercise***
Frequency – ***How often you need to train.***

Let's briefly consider each factor and combine them in a fitness prescription.

Table 2.2—**Aerobic fitness index**. Calculate your fitness index by multiplying the score in each category: Fitness Index = Intensity x Duration x Frequency.

Category	Score	Activity
Intensity	5	Sustained heavy breathing and perspiration
	4	Moderately heavy breathing and perspiration
	3	Intermittent heavy breathing, as in recreational sports
	2	Moderate, as in brisk walking or volleyball
	1	Light, as in fishing, gardening, or easy walking
Duration	4	Longer than 40 minutes
	3	30 to 40 minutes
	2	20 to 30 minutes
	1	Less than 20 minutes
Frequency	5	Daily or almost daily
	4	Three to five times a week
	3	One to two times a week
	2	Less than once a week
	1	Once a month

Evaluation and Fitness Estimate

Score	Evaluation	**Fitness estimate** (mL/kg • min)
100	Very active and fit	High (higher than 50)
80	Active and fit	(45-50)
60 to 80	Active and healthy	Medium (40-45)
40 to 60	Consider changes	(35-40)
20 to 40	Improvement needed	Low (lower than 35)
Lower than 20	Sedentary	(lower than 35)

Intensity

The exercise heart rate or your perception of effort can be used to gauge exercise intensity. The heart rate is a good indicator of intensity because it is directly related to oxygen consumed and calories burned. As exercise becomes more intense, requiring more oxygen, heart rate increases. Research has shown that fitness improves when you exercise at a given percentage of your maximal heart rate. Subsequent studies have developed heart rate training zones for different levels of fitness. The zone ranges from the aerobic threshold on the low end to the anaerobic threshold on the high end. The aerobic threshold defines the oxidative ability of the slow oxidative muscle fibers used for prolonged work, while the anaerobic (lactate) threshold indicates the oxidative ability of fast fibers. To see if you are in the training zone, stop to take your pulse after several minutes of sustained exercise (use a 10-second count at your wrist or throat and multiply by six to get beats per minute). You don't need to train near your maximal level to improve aerobic fitness. In fact, exercising within your training zone should feel relatively comfortable. Inexpensive heart rate monitors are available to simplify measuring the exercise heart rate and training zones.

Fitness training studies have shown that exercise intensity is the most important factor in improving aerobic fitness as measured by the VO_2 max test. But long-term work capacity, the ability to sustain a given level of effort, requires attention to another training factor, duration.

Perceived Exertion

Recently, we have learned that the rating of perceived exertion (RPE) is also a reliable gauge of exercise intensity.

How does the exercise feel?	Rating
	6
Very, very light	7
	8
Very light	9
	10
Fairly light	11
	12
Somewhat hard	13
	14
Hard	15
	16
Very hard	17
	18
Very, very hard	19
	20

Note: *Rating x 10 is approximately equal to the heart rate (e.g., "somewhat hard" = 13 x 10 or 130).*

Find the level that corresponds with your training zone and work at that level. Check your pulse now and then to confirm your perception of effort. In time you'll know how it feels to be in the training zone. Another good way to limit exercise intensity is the talk test. You should be able to carry on a conversation while you train. Pulse counts and heart rate monitors are not essential for fitness training. What is essential is that you select an exercise that will use a large muscle group, and that you exercise intensely enough to change the muscles' capacity to use oxygen.

The Training Heart Rate

The training heart rate is a useful measure of exercise intensity when it is determined during sustained large muscle activity, such as jogging, cycling, or swimming. One of training's most important effects is improving the muscles' ability to use oxygen. The effect is specific; it only occurs in the muscles used in training. And improvements only occur when the effort is sustained long enough to improve the muscles' capacity to use oxygen.

Over the years the use of the training heart rate has become somewhat confused. Originally, the training heart rate was presented as a way to estimate training intensity. The concept somehow evolved to became the focus or goal of training…simply raise the heart rate and training will occur. That isn't correct. It is not sufficient to raise the heart rate with a variety of short-term exercises, as is done in circuit weight training. Circuit training is fine for muscular fitness, but if you want to improve aerobic fitness, use a sustained large muscle aerobic activity such as jogging, cycling, or swimming.

Duration

Exercise duration and intensity go hand in hand: an increase in one requires a decrease in the other. Exercise duration can be prescribed in terms of time (minutes of exercise), distance (miles or kilometers of exercise), or calories (calories per exercise session). I prefer calories: the calorie is the basic measure of energy expenditure during exercise, and it is the basic measure of energy intake when eating or drinking. By using calories you learn how much exercise is required to balance extra caloric intake (one light beer or a handful of peanuts contains 100 calories, the energy burned by a 1-mile jog). I will provide information to help you convert distance and time of various activities into calories (Table 2.3).

Table 2.3—**Caloric expenditure**. Multiply the calories per minute for a given exercise by the number of minutes to determine calories burned. For instance, 20 minutes of jogging burns 200 calories (20 minutes times 10 calories per minute).

	Calories per minute*	***Minutes to burn 200 calories***
Calisthenics	5.0	40
Walking (3.5 mph)	5.6	36
Cycling (10 mph)	8.5	24
Swimming (crawl)	9.0	22
Skipping rope (120 skips/min)	10.0	20
Jogging (5 mph)	10.0	20
Running (7.5 mph)	15.0	14

**Exact calories burned depends on efficiency and body size. Thus, 20 minutes of jogging burns 200 calories (20 x 10 calories); 20 minutes of walking, about 112.*

Twenty minutes of jogging burns 200 calories. It takes 36 minutes of walking to accomplish the same goal. If you are overweight and wish to lose excess fat, exercise at a lower intensity (walk, don't run), but do so for a longer time. If you want to lose weight faster, exercise more often.

While studies have shown that health benefits can be achieved when exercise is done in short segments (30 minutes of exercise in three, 10-minute blocks), the same is not true for fitness. For fitness, best results occur in longer sessions. The prescription requires sessions of longer duration as training progresses. Fat metabolism increases with exercise duration, and fitness improves the most in sessions that last more than 30 minutes. Finally, the ability to perform arduous long-term work or endurance activities depends on an aerobic foundation developed with long-duration training.

Frequency

Three training sessions per week are sufficient for those beginning a program and for individuals in the low fitness category. Training days should be alternated with rest days to allow time for recovery. As training progresses you will need to increase the frequency of training. Improvements in fitness are proportional to the frequency of training. Endurance athletes train 6 days a week. A couple of those days may include training sessions twice a day or more. As training frequency is increased, fitness experts recommend alternating hard days with easy days to allow time for recovery. Table 2.4 summarizes the aerobic fitness prescription.

Table 2.4—**Aerobic fitness prescription**.

Fitness ml/kg • min	***Intensity*** Percent max HR*****	***Duration*** Calories	***Frequency*** Times/ week
Low (lower than 35)	60-75	100-200	3-4******
Medium (35-45)	70-85	200-400	5-6
High (higher than 45)	75-90	400+	6+

***Max HR (maximum heart rate) = 220 – age.*
****Every other day.*

Let's say you're 30 years old and your fitness level is in the medium category. Your maximal heart rate is estimated at 190 (220 – 30). You should begin training at the low end of the intensity range (70% x 190 = 133) and stay within the training zone of 133 to 162 beats per minute (85% x 190 = 162). After several minutes of continuous exercise check your heart rate (count your pulse or wear a heart monitor) to see if you are in the training zone. You

The Maximal Heart Rate

The maximal heart rate is influenced by age, physical activity, and individual factors. The rate declines with age, but regular activity and training slow the decline. The formula (220 – age) is an estimate that reflects the rate of decline in the population; your actual maximal heart rate may be somewhat higher or lower than predicted (205–(age/2) for active and fit individuals). The variability (standard deviation) for maximal heart rate is ± 12 heartbeats per minute, which means that 68% of all cases fall within ± 12 beats of the mean for an age (for 30 years of age, 220 – 30 = 190 ± 12 bpm or 178 – 202). Ninety-five percent of cases fall within ± 2 standard deviations, or 166 - 214, and 99% fall within ± 3 SD's or 154 – 226 bpm. So you see there is a chance for considerable error when you presume a maximal heart rate based on age (the standard deviation rises to 15 for those over 60 years of age). If you want to know your actual maximal heart rate you can get an electrocardiograph-monitored treadmill test, or you can put on a pulse monitor, go out for a long uphill run and gradually increase effort until you reach your max (not recommended for untrained or older individuals).

can exceed the zone for short intervals, such as the last portion of a jog or bicycle ride. If the prescription seems too low or too high, don't hesitate to make gradual adjustments. The prescription is only a starting point, and since it is based on an estimate of your maximal heart rate, it may not be entirely accurate.

Eventually you'll forget about heart rates and gauge intensity by how the exercise feels, your perception of effort. The beauty of this approach is that it adjusts for changes in temperature and altitude, and personal factors such as mood, fatigue, or illness. High heat or humidity cause the heart rate and perception of effort to rise. If the exercise feels too difficult, it probably is. Back off and you will enjoy it more.

Your Fitness Program

Now that you know how hard, how long, and how often to exercise, it is time to select your training activity and get started. Your choice of training exercise is important. It must be something you enjoy so you will do it regularly, and it should contribute to your training goals. If your goal is to improve general fitness, you can get results in a variety of activities such as jogging, cycling, or swimming. But if your goal is to improve in a specific sport or in job performance, the training should relate specifically to the sport or the job.

Muscle is the target of training.

Training serves to coax a slow but continuous stream of adaptations from the working muscles. Improvements take place when the work imposes an overload on the muscles, when the training exceeds regular demands. The effects of training are specific to the demands imposed by training. Moreover, the effects are limited to those muscles used in the training. Since training to improve work capacity could eventually consume many hours, we recommend that you use activities closely related to your work, increasing the intensity and decreasing the duration of training sessions. As the work season approaches, the training should become more specific to the job, utilizing the muscles and movement patterns required on the job.

Popular sports, such as tennis, racquetball, or basketball, are fine for maintaining a modest level of fitness. But they are not suited to training. Even professional athletes engage in fitness training to achieve and maintain the capacity for high performance. Games are not a substitute for aerobic training. Because games involve brief periods of extreme exertion, they increase the risk of injury.

Don't play sports to get in shape; get in shape to play sports!

Specificity of Training

Years ago, we thought that the main effects of fitness training were on the cardiovascular system. But we have learned that significant changes in the ability to utilize oxygen take place in the muscles used in training. Studies have proven the obvious: running does little to improve swimming performance, and swimming does little to increase running performance. Leg training does little for the arms. To aid performance, the training must simulate the activity. The best training for a bicycle trip includes a lot of cycling. If the trip involves climbing mountain passes, a fair amount of time should be spent training on hills. If you are training for a summer of wildland firefighting, you will need to emphasize the ability to hike with a pack, and develop the endurance to work long hours with hand tools. Some transfer of training (cross training) does take place when muscles and movement patterns are similar. Cycling builds leg strength for hiking with a pack. But the main benefit of cross training is to provide rest and reduce the risk of overuse injuries to overworked muscles, bones, and joints.

Stay Active Year-Round

The ideal approach is to remain active year-round, varying your activities to fit the seasons. Include several activities in your program to avoid boredom and overuse injuries. Use one season to prepare for the next. For example, use the fall to get in shape for downhill and cross-country skiing, and the spring to prepare for summer field work. In this way fitness remains high, minimizing the time required to prepare for the next season.

The Training Session

The elements of the training session are:

- *Warmup*
- *Aerobic exercise*
- *Cooldown.*

The warmup includes flexibility exercises (stretching), and a gradual increase in body temperature,

circulation, and respiration. Some people stretch and then exercise, others prefer to warmup with some light exercise and then stretch. Remember to stretch the lower back, hamstrings, and calf muscles to minimize soreness and the risk of injury.

Figure 2.3 illustrates the aerobic training session for a 32-year-old woman with a fitness score of 45 mL/kg • min. The prescription calls for an intensity of 141 to 169 heartbeats per minute, a duration of 200 to 400 calories, and a frequency of 5 days a week. With jogging as the aerobic exercise (10 cal/min), 200 calories will be burned in 20 minutes. She can vary daily sessions by jogging in different locales, alternating hard days (high end of her training zone) with easy days (low end of her training zone), or by alternating jogging with another aerobic activity. In time the exercise will be accomplished with less effort. Then it will be time to increase pace, distance, and frequency to continue improving. Increasing distance (duration) will provide the endurance needed for long-duration activities.

Gradually cooling down after the session is important to avoid soreness, cramps, or more serious cardiovascular complications. Complete rest immediately after exercise allows blood to pool in the veins and slows the removal of metabolic waste products. Walking or easy jogging continues the pumping action of the muscles, promoting circulation and speeding recovery. A few minutes of stretching may also reduce subsequent soreness. Always cool down after a workout.

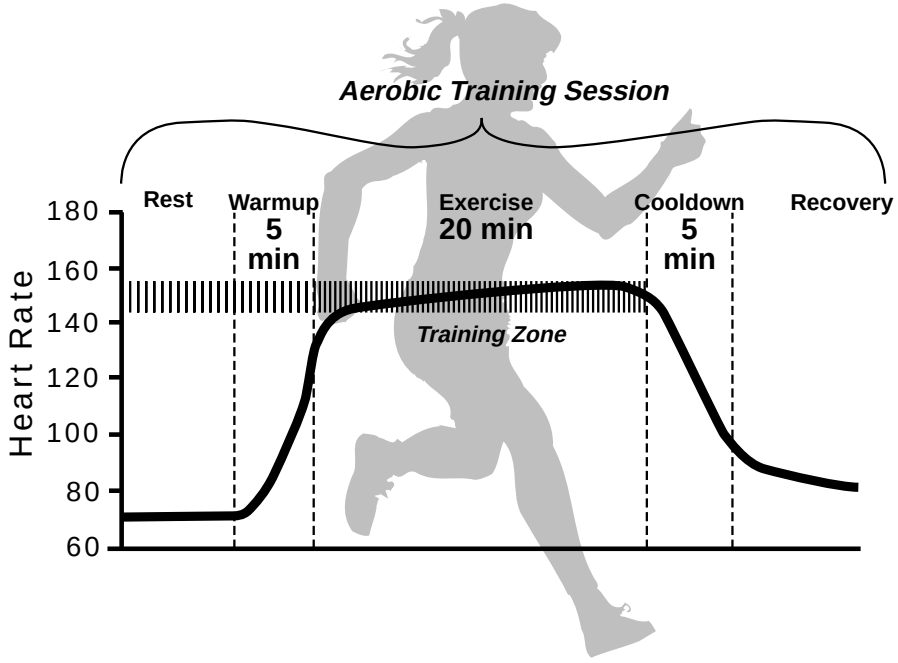

Figure 2.3—**Aerobic training session**: "Warmup, aerobic exercise, cooldown—those are the elements of your training session."

Progress

You can expect to see a 20 to 25% improvement in fitness within 3 months, even more improvement if you lose much weight. Improvement depends on level of fitness and age. Inactive individuals will see greater improvement, as will younger folks. But even senior citizens can expect to improve fitness with training. You will also see significant improvements in performance, both in work and sport, and you will have more energy for daily tasks.

Maintenance

Once you achieve the desired level of fitness you can maintain that level with two to three training sessions per week. While the VO_2 max plateaus after about 3 months of training, long-term work performance continues to improve. So you may want to continue your program or add some variety (cross training). By employing several types of exercise you maintain an active lifestyle while resting overworked bones and muscles. Although swim training won't make you a better runner, it does train different muscles and burn calories. Closely related training will improve performance; for example, swimming adds arm endurance for paddling or cross-country skiing.

The key to health benefits is regular, moderate physical activity throughout the year. The key to high-level performance is a year-round training program and an active lifestyle that changes with the seasons and adjusts to the demands of work or sport (see chapter 8 for aerobic fitness programs and other training aids).

Summary

Appropriate training improves the important components of aerobic fitness. Table 2.5 summarizes the components and includes effective training methods.

Table 2.5—**Aerobic fitness training**.

Component	Important for	Training method	Improves
Aerobic threshold	Prolonged effort (many hours)	Overdistance (long-slow distance)	Fat utilization in slow-twitch muscle fibers
Anaerobic threshold	Sustained high-intensity effort (15 min - 3 hr)	Underdistance (intervals) race pace	Oxidation of carbohydrate and fat in fast-twitch muscle fibers
VO_2 max	Maximal intensity effort (5-15 min)	Intervals, races	Oxidative capacity and cardiovascular system

See Chapter 8 for aerobic training programs.