3.2 Respiratory Fitness

Cardiorespiratory fitness is often considered the most important element of physical fitness because increased cardiorespiratory fitness is linked to decreased heart disease risk.

Why does the body need more oxygen during exercise?

ATP Energy

ATP is the energy for cross-bridge formation, sarcomere sliding, and even muscle relaxation. Muscle fibers need a continual supply of ATP, but the amount of ATP stored in muscles is rapidly depleted during exercise and needs to be continually replenished through three methods.

1) ATP/CP

As intensive exercise begins, a small amount of ATP stored in muscles is rapidly depleted. cP _____ _____ is a molecule found inside the muscle cells that is used to make ATP directly.

2) _____ Glycolysis/Lactic Acid System

This ATP production system breaks down _____ (from _____) without the use of oxygen and produces _____ as a by-product. ATP production during this system is limited and only produces about 5% of what the aerobic system is capable of producing. The anaerobic glycolysis system is most efficient for intense exercise.

3) _____ System

During low to moderate intensity exercise, most of the ATP is supplied by the aerobic system. This system _____ _____ and can use carbohydrates, fats and proteins (if necessary) to supply the raw materials for ATP production. The aerobic system is capable of producing high levels of ATP.

Oxygen Transport and Utilization
Once air flows into the alveoli of the lungs, the oxygen is transported in the blood through the circulation system.

This occurs in two ways:
1) Oxygen can bind to an iron-protein compound inside red blood cells to form _____. This can be affected by:

- ➔ .
- ➔ .
- ➔ .

If oxygen is bound to hemoglobin then it is not being used for producing energy in cells.

2) In fluid or the blood (plasma): The fluid portion of blood is plasma. A very small amount of oxygen can travel freely in the blood in this manner.

Ventilation Rate
Just like pulse rate, exercise can increase the _____ of breathing and the _____ of each breath. Increasing cardiorespiratory fitness through aerobic activities can increase the _____ of ventilation.

_____ **=** The amount of air taken in during normal inspiration or expiration. This is around 6oo ml for males and 500 ml for females, but can reach as high as 1.0 L (1000 ml) for larger individuals.

_____ **=** Maximum inspiration volume.
Normal value for males is 6 L and for females is 4-5 L (depends on body size). This volume can increase with aerobic training (e.g. 7-8 L for elite athletes)

Maximal Oxygen Consumption (VO2Max) =

Aerobic training increases your VO2Max

At rest, oxygen consumption of the trained and untrained is similar, around 3.5 mL of oxygen per kg of body weight per minute (mL/kg/min). During maximum exercise, the advantage of aerobic training is clearly highlighted: untrained 35 mL/kg/min, and trained 6o mL/kg/min. Values as high as 75-85 mL/kg/min have been recorded for elite athletes.

"Second Wind"

During exercise, individuals often experience a feeling described only as a _____ _____. There are many reasons (many just educated guesses) for the second wind:

- ➔ .
- ➔ .
- ➔ .
- ➔ .

Recovery Rate

Following aerobic exercise, heart rate rapidly declines to near resting levels in 3-5 minutes. The fitter the individual (aerobically), the faster the heart rate returns to the resting level. Respiration rate follows a similar pattern, increasing at the start of exercise, leveling off during steady state and returning to normal following exercise.

Respiratory Cautions

1) _____ = respiration beyond what is necessary to meet the needs of the body. Stress, the thought of exercise, and many other factors other than exercise can be the cause of hyperventilation. Hyperventilation _____ is never a good idea.

2) _____ = shortness of breath often experienced during exercise by beginners exercising too hard.

3) _____
Improper exercise and breathing technique during heavy lifting can unwittingly result in this dangerous situation.

The Valsalva Effect is the result of many factors:

- ➔ Forceful contraction of the abdominal muscles and diaphragm
- ➔ Forceful contraction of the muscles of the chest cavity
- ➔ Closed epiglottis (covers the windpipe or trachea)

As a result of the Valsalva Effect, the large veins in the abdominal and chest cavity are compressed and _____ If the condition persists, cardiac output can be decreased and blood pressure can be elevated.

In an exercising environment, _____ of the exercise can help prevent the Valsalva Effect.

3.2 Respiratory Fitness (teacher)

Cardiorespiratory fitness is often considered the most important element of physical fitness because increased cardio fitness is linked to decreased heart disease risk.

Why does the body need more oxygen during exercise?

ATP Energy (Adenosine triphosphate)
ATP is the energy for cross-bridge formation, sarcomere sliding, and even muscle relaxation. Muscle fibers need a continual supply of ATP, but the amount of ATP stored in muscles is rapidly depleted during exercise and needs to be continually replenished through three methods.

1) ATP/CP
As intensive exercise begins, a small amount of ATP stored in muscles is rapidly depleted. cP (creatine phosphate) is a molecule found inside the muscle cells that is used to make ATP directly.

2) Anaerobic Glycolysis/Lactic Acid System
This ATP production system breaks down glucose (from carbohydrates) without the use of oxygen and produces lactic acid as a by-product. ATP production during this system is limited and only produces about 5% of what the aerobic system is capable of producing. The anaerobic glycolysis system is most efficient for intense exercise.

3) Aerobic System
During low to moderate intensity exercise, most of the ATP is supplied by the aerobic system. This system requires oxygen and can use carbohydrates, fats and proteins (if necessary) to supply the raw materials for ATP production. The aerobic system is capable of producing high levels of ATP.

Oxygen Transport and Utilization
Once air flows into the alveoli of the lungs, the oxygen is transported in the blood through the circulation system.

This occurs in two ways:
1) Oxygen can bind to an iron-protein compound inside red blood cells to form **oxyhemoglobin**. Exercise, high altitude, and a change in body temperature can affect how much oxygen is bound to hemoglobin. If oxygen is bound to hemoglobin then it is not being used for producing energy in cells.

2) In fluid or the blood (plasma): The fluid portion of blood is plasma. A very small amount of oxygen can travel freely in the blood in this manner.

Ventilation Rate
Just like pulse rate, exercise can increase the rate of breathing and the volume of each breath. Increasing cardiorespiratory fitness through aerobic activities can increase the efficiency of ventilation.

Tidal Volume = The amount of air taken in during normal inspiration or expiration. This is around 6oo ml for males and 500 ml for females, but can reach as high as 1.0 L (1000 ml) for larger individuals.

Total Lung Capacity (TLC) = Maximum inspiration volume.
Normal value for males is 6 L and for females is 4-5 L (depends on body size). This volume can increase with aerobic training (e.g. 7-8 L for elite athletes)

Maximal Oxygen Consumption (VO2Max) =
The maximal amount of oxygen that is delivered to, and is used (consumed) by muscles.
Aerobic training increases maximum oxygen delivery and consumption, and increases the amount of energy that can be produced aerobically.

At rest, oxygen consumption of the trained and untrained is similar, around 3.5 mL of oxygen per kg of body weight per minute (mL/kg/min). During maximum exercise, the advantage of aerobic training is clearly highlighted: untrained 35 mL/kg/min, and trained 6o mL/kg/min. Values as high as 75-85 mL/kg/min have been recorded for elite athletes.

"Second Wind"
During exercise, individuals often experience a feeling described only as a 'shot of energy'. There are many reasons (many just educated guesses) for the second wind:

- ➔ The respiratory system, including breathing muscles, has adjusted to the workload and is in a comfortable steady state.
- ➔ Any lactic acid that accumulated in the blood at the start of exercise has been removed and aerobic energy systems are working at peak efficiency.
- ➔ Chemicals (endorphins) produced by the brain act as natural painkillers during exercise.
- ➔ Psychological factors including stress reduction and enjoyment of the exercise.

Recovery Heart Rate, Blood Pressure and Breathing Rate
Following aerobic exercise, heart rate rapidly declines to near resting levels in 3-5 minutes. The fitter the individual (aerobically), the faster the heart rate returns to the resting level. For healthy and hypertensive individuals, there is a slight drop in systolic blood pressure that lasts for up to 12 hours following exercise. Respiration rate follows a similar pattern, increasing at the start of exercise, leveling off during steady state and returning to normal following exercise.

Respiratory Cautions

1) Hyperventilation: Hyperventilation is respiration beyond what is necessary to meet the needs of the body. Stress, the thought of exercise, and many other factors other than exercise can be the cause of hyperventilation. Hyperventilation on purpose is never a good idea.

2) Dyspnea: Dyspnea is shortness of breath often experienced during exercise by beginners exercising too hard.

3) The Valsalva Effect

Improper exercise and breathing technique during heavy lifting can unwittingly result in this dangerous situation.

The Valsalva Effect is the result of many factors:

- ➔ Forceful contraction of the abdominal muscles and diaphragm
- ➔ Forceful contraction of the muscles of the chest cavity
- ➔ Closed epiglottis (covers the windpipe or trachea)

As a result of the Valsalva Effect, the large veins in the abdominal and chest cavity are compressed and **blood returns to the heart is reduced**. If the condition persists, cardiac output can be decreased and blood pressure can be elevated.

In an exercising environment, **breathing out on the exertion portion** of the exercise can help prevent the Valsalva Effect.