2.2.8 Explain cardiovascular drift

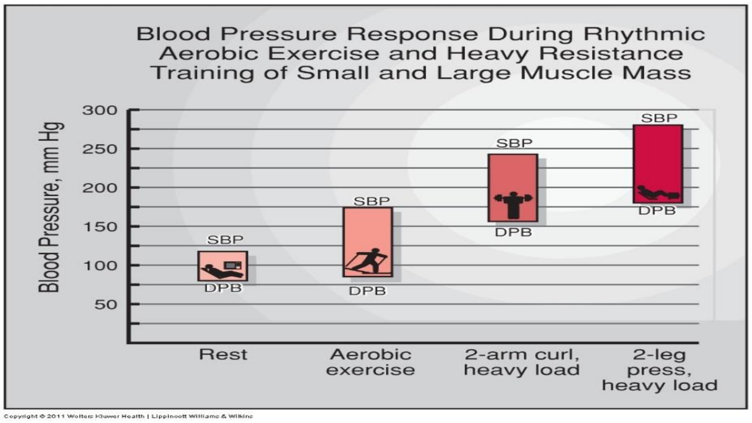
- If you begin a 90 minute steady state ride on your bicycle trainer at a controlled intensity, your heart rate may be 145 after 10 minutes. However, as you ride and check your heart rate every 10 minutes, you will notice a slight upward "drift".
- By 90 minutes, your heart rate may be 160.
- Why is this happening if intensity is held constant?
  - There are two explanations.
    1) As you exercise, you sweat. A portion of this lost fluid volume comes from the plasma volume. This decrease in plasma volume will diminish venous return and stroke volume. Heart rate again increases to compensate and maintain constant cardiac output. Maintaining high fluid consumption before and during the ride will help to minimize this cardiovascular drift, by replacing fluid volume.
    2) Your heart rate is controlled in large part by the "Relative" intensity of work by the muscles.
       a. So in a long hard ride, some of your motor units fatigue due to glycogen (sugar) depletion. Your brain compensates by recruiting more motor units to perform the same absolute workload.
       b. There is a parallel increase in heart rate. Consequently, a ride that began at heart rate 150, can end up with you exhausted and at a heart rate of 175, 2 hours later, even if speed never changed!

2.2.9 Define the terms systolic and diastolic blood pressure

- **Systolic blood pressure**
  - Highest arterial pressure measured after left ventricular contraction
- **Diastolic blood pressure**
  - Lowest arterial pressure measured during left ventricular relaxation
    - **Normal rest values = 120 mm Hg/80 mm Hg**
    - **Extreme Hypertensive values = 300 mm Hg /120 mm Hg**

2.2.10 Analyze systolic and diastolic blood pressure data at rest and during exercise

- **Rhythmic Exercise:** Increases systolic pressure in the first few minutes and then levels off; diastolic pressure remains relatively unchanged (Running, swimming, etc)
- **Resistance (static) Exercise:** Can increase blood pressure dramatically – Muscular force/contraction compresses peripheral arteries increasing the resistance to blood flow (planks, yoga, etc)
- **Upper-Body Exercise:** Exercise at a given percentage of $V{\cdot}O_{2max}$ increases blood pressure substantially more in upper-body compared with lower-body exercise (same for lower body, BP increases more in lower body then)
- **In Recovery:** After a bout of sustained light- to moderate-intensity exercise, systolic blood pressure decreases below pre-exercise levels for up to 12 hours in normal and hypertensive subjects



For Your Information

LIFESTYLE CHOICES THAT LOWER BLOOD PRESSURE

Advice	Details	Decrease in Systolic Blood Pressure (mm Hg)
Lose excess weight	For every 20 lb you lose	5–20
Follow the DASH diet	Eat a lower fat diet rich in vegetables, fruits, and low-fat dairy foods	8–14
Exercise daily	Get 30 minutes a day of aerobic activity (e.g., brisk walking)	4–9
Limit sodium	Eat no more than 2400 mg a day (1500 mg is better)	2–8
Limit alcohol	Have no more than 2 drinks a day for men or 1 drink a day for women *(1 drink = 12 oz beer, 5 oz wine, or 1.5 oz 80-proof liquor)*	2–4

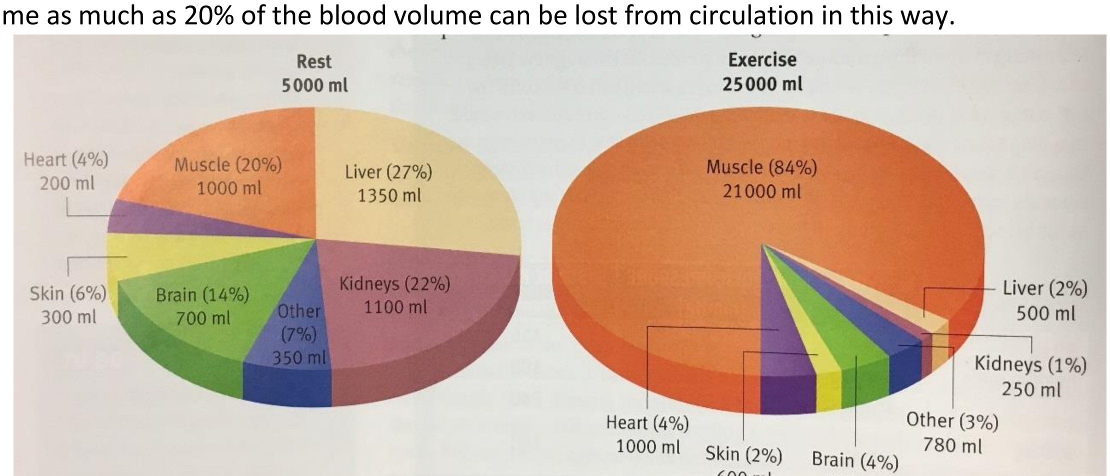
2.2.12 Compare the distribution of blood at rest and the redistribution of blood during exercise

- During exercise, and at rest, the diameter of arteries, arterioles, and capillaries needs to be regulated to keep blood pressure at a sufficient level.
  - Involuntary smooth muscle cells that lines the walls, and control blood in and out of capillaries contract or relax to change the diameter and blood pressure.
  - Circulatory and nervous system work in sync to maintain blood flow and pressure.

- During exercise, muscles demand more oxygen and nutrients. They also produce more waste and $CO2$
  - Thus, more blood flow to where it's needed.
  - The capillaries in the muscle where more blood is needed become dilated (opened) to a greater extent letting more blood come in.
  - Unnecessary capillaries are constricted, reducing blood flow to noncritical organs and parts of the body.

- It takes little pressure to force the blood through veins because they offer little resistance to blood flow. There diameters are large and vein walls are so thin they can hold large volumes of blood.

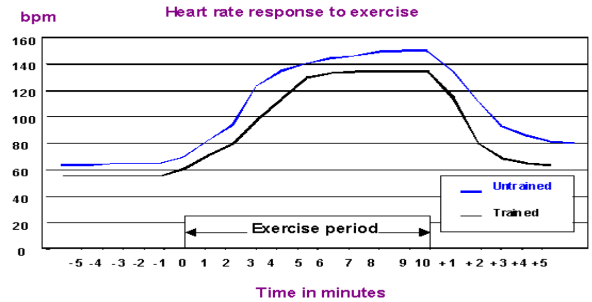
- On the other hand, when one stands still for a long period of time blood pools in the veins.
  - Within a few moments, pressure increases in the capillaries (veins are not accepting blood from them because they are dammed up with their own), and some plasma is lost to interstitial fluid (fluid in/around cells & organs).
  - After a short time as much as 20% of the blood volume can be lost from circulation in this way.
  - Arterial blood pressure falls and blood supply to the brain is diminished, sometimes resulting in fainting.



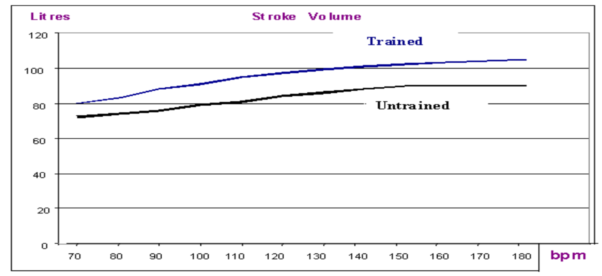
↑ Figure 2.7

2.2.13 Describe the cardiovascular adaptations resulting from endurance exercise training

- Resting heart rate decreases as a result of aerobic training. This is due largely to an increase in stroke volume.



- Stroke volume increases due to an increased cardiac hypertrophy (muscle size)/left ventricular volume from aerobic training. Therefore, for every heartbeat, a trained athlete can pump more blood from the heart to the working muscles



- Arterio-venous oxygen difference
  - The difference between the oxygen content of arterial blood and mixed venous blood. It may be expressed as milliliters of oxygen per 100 mL of blood. The value represents the extent to which oxygen is removed from the blood as it passes through the body.
  - Usually, the arterial oxygen concentration is measured in blood from the femoral, brachial, or radial artery, and the oxygen content of mixed venous blood is measured from blood withdrawn from the pulmonary artery.
  - At rest, the average arterial-venous oxygen difference is about 4-5 mL per 100 mL of blood, but it increases progressively during exercise reaching up to 16 mL per 100 mL of blood, indicating that more oxygen is extracted from the blood by active muscles.
  - The maximum arteriovenous oxygen difference of a trained athlete usually exceeds that of an untrained person. The training effect may be due to adaptations in the mitochondria, increased myoglobin (O2 binding protein in muscle cells) content of muscles, or improved muscle capillarization.

2.2.14 Explain maximal oxygen consumption

- Maximal oxygen consumption represents the functional capacity of the oxygen transport system and is sometimes referred to as maximal aerobic power or aerobic capacity.