Bio 12 **Blood Pressure Lab Name:**

**Normal blood pressure varies with age** and from person to person. It also varies depending on whether a person is lying, sitting, or standing, and is affected by such factors as time of day, fullness of bladder, amount of recent exercise, and recent intake of caffeine, nicotine, or alcohol. Some average blood pressures at different ages are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Age in years | 4  | 6 | 12 | 16 | 18 | 30 |
| BP (sys/dias) | 99/66 | 110/56 | 113/56 | 120/61 | 120/74 | 126/79 |

High blood pressure is a pressure reading of 140 systolic or higher and 90 diastolic or higher. If either or both of systolic or diastolic pressures continually exceed the 140/90 mm Hg readings, the person is considered to be hypertensive.

**Measuring Blood Pressure**

 A **sphygmomanometer** or a blood pressure cuff is a device used to measure blood pressure. Blood pressure (BP) is the force of blood pumped by the heart against the arterial walls.

Blood pressure is measured in millimeters of mercury (mmHg), and is recorded as two separate values: systolic blood pressure and diastolic blood pressure. The systolic BP occurs when the ventricles contract and eject blood into arteries; and the diastolic BP occurs when the ventricles relax and fill with blood from the atria. The average blood pressure of healthy young adults (about 20 yrs old) is 120 / 80 mmHg. The first value (120) represents systolic and the second value (80) represents the diastolic BP. In this lab you will use a sphygmomanometer placed over the brachial artery of the arm to measure blood pressure.

**The Effect of Changing Body Posture on Blood Pressure**

There are gravitational forces acting on physiological systems such as the cardiovascular and circulatory systems. Any fluid columns, like blood vessels, are subjected to large pressure gradients when subjected to sudden changes in body posture, especially in humans which are designed for upright posture. There are physiological adaptations in the human cardiovascular system designed to counteract the effects of gravity on the circulatory system under postural changes such as when in a standing, sitting, or lying down (supine) position. Some of the things occur in the body in response to changes in posture are heart rate (number of heart beats per minute) and blood pressure (pressure of blood against arterial vessel walls).

When you lie down in the **supine position**, your heart is at the same gravitational level as the blood vessels in our head and limbs. Therefore, when lying down your blood pressure is similar along your entire body and blood return to the heart is less influenced by the pull of gravity.

When you stand for a long period of time without moving, or when you have lain down for a long time and stand up suddenly, you might experience a feeling of faintness or dizziness that passes quickly. This slight dizziness is due to the effects of gravity on the cardiovascular system. This sudden posture change from a supine to an upright posture creates a strong vertical gradient of gravitational pull on the fluid (blood) in our circulatory column. The heart is now below the head and neck, and the heart is approximately 2-4 ft above the legs. Blood pressure decreases briefly in the head and neck while pressure increases in the legs. Furthermore, the increased blood pressure in our lower limbs causes blood to **pool** in our venous system because the **veins** are **elastic and stretchy**, unlike the rigid-walled arterial vessels. The venous system stores about 80% of your total blood volume while the arterial system stores about 10% at any one time. Thus, the **venous system is a blood reservoir**.

There are several things that occur in your body when you change from a supine to a standing position quickly:

1. there is a decrease in venous return of blood to the heart. Blood pools in the elastic-walled venous vessels due to the sudden increased gravitational pull on blood within your lower limbs;
2. there is a decrease in cardiac blood volume (end diastolic volume) due to the decreased venous return; and
3. there is a decrease in arterial blood volume and blood pressure within your head and neck. These changes are sometimes accompanied by feelings of dizziness or light-headedness, and might even lead to fainting (**syncope**).

When you change quickly from a supine to an upright posture there are several things that your body will do immediately to counteract the change in blood pressure and pooling of blood in the veins.

 (1) Your heart rate increases and pumps a greater volume of blood. This will increase blood pressure (BP) so that you avoid fainting.

(2) The valves in your veins maintain a one-way flow of blood to the heart which aids venous return of blood to the heart.

(3) Your skeletal muscles contract and help compress the veins providing resistance to pooling of blood. These muscle twitches act much like a flight suit of jet pilots which squeeze the body and provide resistance to the elastic-walled veins.

(4) The nervous system elicits several compensatory and autonomic responses to restore normal blood volume and pressure. Your medulla oblongata has two autonomic centers: the cardiac and vasomotor center. The cardiac center responds by increasing sympathetic stimulation, by epinephrine/norepinephrine, of increased heart rate by increasing cardiac pacemaker cell depolarization rates. The medulla also stimulates vasoconstriction of smooth muscle within arterioles, especially those leading to the brain, to increase blood pressure against the force of gravity.

**Measuring Blood Pressure Responses to Changes in Body Posture**

 The **sphygmomanometer** is a tool to measure systemic blood pressure in the brachial artery. It attaches around the upper arm and has a pump with a valve, and a pressure gauge. Blood pressure is expressed as 2 numbers: the upper number or **systolic blood pressure** is the highest blood pressure resulting from **contraction of the left ventricle**. The **lower number or diastolic blood pressure** results from **relaxation of the left ventricle**. Note that while the pressure in the left ventricle may drop to zero, the pressure in systemic arteries is maintained by the elastic recoil of the artery walls.

When the pressure in the blood pressure cuff is increased to greater than the systolic pressure, the brachial artery will be temporarily occluded. As the pressure in the cuff is gradually decreased it will reach a stage where it is just below the systolic pressure. At this time blood will push through the artery in spurts at the end of ventricular contraction. At this time the blood can be heard rushing through the artery by auscultation distal to the blood pressure cuff. Sounds are detected first when pressure in the cuff approximates the systolic blood pressure. As the cuff pressure is reduced sounds of blood being pushed through the constricted artery will be heard until its pressure falls below the diastolic blood pressure. When sounds of blood moving in the artery can no longer be heard, the pressure in the cuff approximates the diastolic blood pressure.

**Exercise 1: Measuring Heart Rate**

 Use two fingers (index and second finger) and lightly press them against the wrist below the thumb. Do not use your thumb as it has its own pulse. Do not press too hard or you will block blood flow in the radial artery. Once you detect the pulse, record the number of beats in 15 seconds. Then multiply that number by 4 to get the beats per minute. The pulse can also be palpated in the carotid artery on the side of your neck. Record in Observations below.

**Exercise 2: Procedure for Measuring Blood Pressure:**

1. Work with your lab partner and have them roll up their sleeve exposing their arm. Place the cuff of the BP cuff snugly around the biceps of the arm (not too tight!). Keep the chords of the BP cuff on the upper arm surface pointing towards the elbow. The arm should be resting comfortably on the lab table, palm up. Have the person hold the pulse monitor in the hand of the arm not having the BP cuff. Try and record resting heart rate at the same time as you perform the following steps.

2. Attach the BP cuff with the Velcro strap and keep the gauge where you can read it easily.

3. Use a stethoscope placed underneath the cuff to listen through the ear pieces for the sound of blood in the arteries of your partner. You will not hear anything until you perform step 5.

4. Close the valve on the BP cuff by turning it clockwise. Pump air into the cuff by squeezing the rubber bulb until the pressure reading reaches about 150 – 180 mmHg. Please listen to your partner and stop if this hurts. The pressure will collapse the brachial artery, so do not keep this pressure on the arm for more than 30 seconds!

5. Open the bulb SLOWLY. The needle on the pressure gauge should fall at a rate of 2-3 mmHg per second. You need to listen carefully as you observe pressure falling.

6. At the FIRST SOUND in the stethoscope, record the pressure. This is the systolic BP or the pressure at which the heart’s ventricular contraction can again force blood through the brachial artery in the upper arm. You might also see the dial on the pressure gauge begin to jump with each heart beat.

7. You will hear the sound of the blood pressure increase, and then fade. When the SOUNDS STOP, record the diastolic pressure.

8. Trade places with your partner and repeat the process.

**Exercise 3: Comparing Heart Rate and Blood Pressure Between Supine and Standing Postures.**

 Now you will examine blood pressure and heart rate while in a supine position followed by a sudden change to an upright posture. This will require your use of both the pulse monitor to record heart rate and the blood pressure cuff to record systolic and diastolic blood pressure.

1. Have your partner rest comfortably with sleeves rolled up on their arm. Place the BP cuff on their arm and secure

 gently with the Velcro strap. Place the stethoscope in position over the arm, under the cuff. Have a finger placed on the pulse monitor using the hand of the arm not wearing the BP cuff. Let the person lie quietly for 5 minutes without moving or raising the limbs.

2. After 5 minutes of resting, record the supine heart rate.

Supine Heart rate = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bpm

3. Now pump up the cuff (making sure the valve is closed) to about 150 – 200 mmHg and then slowly release the

pressure. Record the Systolic BP and Diastolic BP.

4. Keep the blood pressure cuff (with pressure released), stethoscope, and pulse monitor in position and let the person rest in the supine position for 5 more minutes.

5. You are now going to have the person get up quickly to an upright posture (standing). Please watch your partner for any sign of fainting! Within 10 seconds of standing you must repeat the above procedure and record the following:

6. Switch places with your partner and repeat the supine and standing measurements of heart rate and blood pressure.

Observations

**Part 1: Measuring Heart Rate**

|  |  |
| --- | --- |
| Supine (lying down) |  |
| Sitting |  |
| Standing |  |

Part 2: Measuring Blood Pressure

|  |  |
| --- | --- |
| Resting Blood Pressure (Sitting) |  |

Part 3: Effect of Fast Posture Change on Heart Rate and Blood Pressure

|  |  |  |
| --- | --- | --- |
|  | Supine | Standing up <10s |
| Heart Rate |  |  |
| Systolic BP |  |  |
| Diastolic BP |  |  |

Questions

1. Compare the systole to diastole.
2. Compare your blood pressure with the normal values in your age group.
3. Why is using your thumb to measure pulse not ideal?
4. List several factors, which may influence blood pressure on a short term basis.
5. List several factors, which may influence blood pressure on a long term basis.
6. What changes occur in the circulatory system when a person stands up from a prone position?
7. How do these changes (from #6) affect the heart rate and blood pressure of the individual?
8. What is syncope?
9. Why would a jet pilot or astronaut wear a tight suit when embarking on a flight?