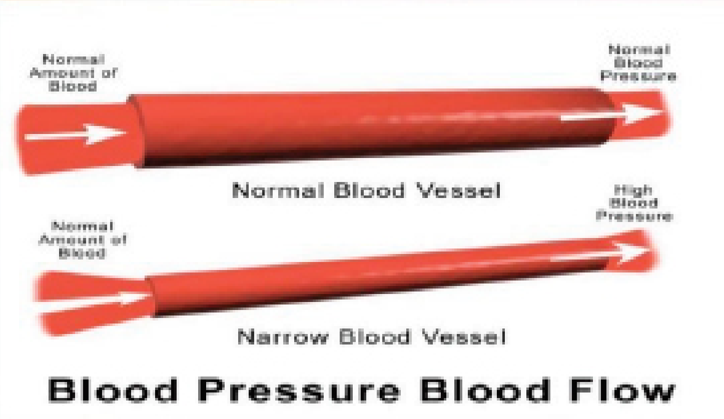
Blood Pressure and its Regulation



Blood pressure in your blood vessels is closely monitored by baroreceptors; they send messages to the cardio regulatory center of your medulla oblongata to regulate your blood pressure minute-by-minute. In this lesson you will learn how baroreceptors regulate your short term blood pressure.

Blood Pressure.

Your cardiovascular system must maintain an adequate blood pressure in order for blood to be delivered to all of your organs and tissues. If the pressure drops too low, the organs will not receive an adequate perfusion of nourishing blood. If the pressure rises too high, it could damage the delicate inner lining of your blood vessels and eventually lead to heart disease or a stroke. In this lesson, you will learn how the body regulates the blood pressure to keep it from going too low or too high.

Mean Arterial Pressure

Pressure fluctuates with each beat of your heart, what we call one cardiac cycle. We remember that a cardiac cycle has two phases: diastole, which is the phase where the heart is filling with blood, but not pumping, and systole, which is the phase when the ventricles contract and pump blood. Blood pressure is defined as the pressure exerted by the blood against the walls of the blood vessels, and it's at its lowest point during diastole and reaches a peak at systole.

Blood pressure is recorded in millimeters of mercury (mmHg) with systolic pressure written first, followed by diastolic pressure. Therefore, a normal blood pressure would be written like this: 120/80. Instead of trying to consider the constant fluctuations of blood pressure, we will look at blood pressure in terms of mean arterial pressure (MAP). Mean arterial pressure is defined as the average arterial blood pressure during a single cardiac cycle.

There are three important factors that affect mean arterial pressure: cardiac output, total peripheral resistance, and blood volume. If not compensated by a decrease in any other variables, we can say that when these three factors increase, so does the mean arterial pressure. We previously learned that cardiac output is the amount of blood pumped per minute by each ventricle. The higher the cardiac output, the higher the mean arterial pressure, because there is more blood being pumped out of the heart and flowing into the arterial system.

We also learned that total peripheral resistance is the total resistance to flow of blood in the systemic circulation. We see that as resistance increases, so does the pressure within the blood vessels. For example, if an arteriole constricts, its lumen will decrease in size, but the blood will pass through the arterial with more force or pressure. Just like a hose nozzle - if you make it smaller, it's going to cause the water to shoot out under higher pressure. Blood volume is also directly related to blood pressure. We know that the circulatory system is a closed system. The more fluid a closed system holds, the greater the pressure.

Baroreceptors

Blood pressure is constantly monitored by your body and adjusted constantly to meet the needs of your body. This monitoring is performed by baroreceptors. Baroreceptors are special receptors that detect changes in your blood pressure. Baroreceptors are found within the walls of your blood vessels. Theaorta and the carotid sinus contain important baroreceptors which constantly monitor blood pressure fluctuations. These baroreceptors transmit their data to the central nervous system, and more specifically, to the cardio regulatory center of the medulla oblongata.

Determinants of Blood Pressure

There are four major determinants of blood pressure. They are:

Blood Volume – the more volume of blood present means that the vessels and heart have to work hard to pump that blood through the Circulatory system.

Overall Compliance – the elastic characteristics of the vessels contribute to the overall pressure in the vessels. When the vessels have expanded the blood pressure is lowered and if it recoils blood pressure will increase.

Cardiac Output – CO is related to two other factors: heart rate and stroke volume. When the heart rate is fast, CO is increases and when stroke volume is high, CO also increases. Therefore when CO increases, then the arterial pressure will also increase.

Peripheral Resistance – the resistance of the arteries is related to the Overall Compliance Characteristic. When peripheral resistance increases, the overall compliance decreases and thus the arterial blood pressure increases

Blood Pressure Regulation

If blood pressure within the aorta or the carotid sinus increases, the walls of these arteries stretch and stimulate increased activity within the baroreceptor. This information is then sent via the nerves to the cardio regulatory center within the medulla, which responds by initiating mechanisms that decrease the blood pressure to a normal level. Let's take a look at what happens to bring your blood pressure back down to a normal level when it gets too high.

To lower blood pressure, we first see a decrease of sympathetic input and an increase in parasympathetic input to the heart. We previously learned that the sympathetic nervous system can increase heart rate and stimulate the heart muscle to pump with more force. We also learned that the parasympathetic nervous system can decrease the heart rate. Therefore, by shutting off the sympathetic stimulation and boosting the parasympathetic stimulation, we decrease the heart rate and stroke volume, which decreases the cardiac output and decreases blood pressure. Second, if the baroreceptors are detecting that blood pressure is too high, the cardio regulatory center of the medulla will also decrease sympathetic input to the blood vessels. This causes vasodilation, which decreases total peripheral resistance and decreases blood pressure.

The opposite happens when the baroreceptors of the aorta or carotid sinus detect a drop in blood pressure. A decrease in blood pressure causes a decrease in action potentials sent to the cardio regulatory center of the medulla. Therefore, to raise blood pressure, the body will first cause an increase in sympathetic nerve activity to the SA node, causing it to fire more frequently, which increases the heart rate. The heart muscle is also stimulated to pump with more force, and this increases the stroke volume. When heart rate and stroke volume increase, we see an increase in cardiac output. As we learned, an increase in cardiac output causes an increased blood pressure, restoring blood pressure back to a normal level. Second, this causes an increased sympathetic input to the blood vessels, which stimulate the smooth muscle to contract, causing vasoconstriction, which increases total peripheral resistance and increases blood pressure.

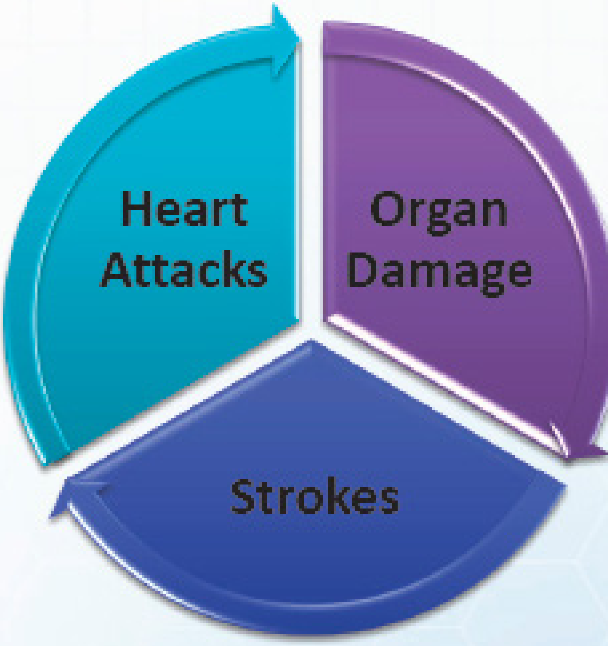
Importances of Regulation

As blood is pumped from the heart to the various blood vessels, enough pressure is generated in order to send blood to all parts of the body. As the blood travels further from the heart, they branch off and gradually decrease in size, much like the branches of the tree. One branch may travel to the stomach, while another may transport blood to the muscle and yet another to the brain, etc.

Blood pressure keeps the blood flowing through all these branches so that the cells of the body can receive the oxygen and nutrients needed to sustain life.

When the heart contracts, pressure built up in the blood vessels increases as the blood passes through, while the opposite is true when the heart relaxes in between heart beats. For the blood to be able to reach all of the vitals organs, healthy, elastic blood vessels that will stretch and recoil as the pressure goes up and down respectively, are needed.

Persons who suffer from **hypertension**, their small blood vessels in vitals organs are most often affected over time. These vessels become scarred, harden and inelastic, which means they are more likely to get blocked or worse rupture which could lead to organ damage and even the failure of these organs in some cases. So it is important to regulate hypertension to reduce the risks of:



In the case of **hypotension**, the blood pressure is abnormally low. When the pressure is this low, blood is not pumped effectively through the systemic circuit of the body. This leaves the body with a lack of blood supply getting to major/vital organs. With organs not receiving optimal blood supply, it's cells do not receive the proper amounts of oxygen and cannot carry out fundamental metabolic processes efficiently, which reduces the amount of energy the cells produce to power the body, this will lead to a host of problems such as, fainting, dizziness, seizures etc.

So, we see regulation of blood pressure is of utmost importance for our survival!

How is Blood Pressure Regulated?

Both divisions of the Autonomic Nervous system, the Parasympathetic and Sympathetic Nervous systems regulate blood pressure. They act like the gas and brake pedals in a vehicle by increasing and decreasing the blood pressure when it begins to move outside of the bounds of normalcy, the Sympathetic is the gas pedal and the Parasympathetic being the brake.

Reference:

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