

NATURAL SCIENCE AND ISLAMIC PREVIEW OF CARDIOVASCULAR SYSTEM

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Abstract: *Interesting to discuss that in the first verse that was revealed that is al-Alaq verse 1-5, Allah SWT uses the term blood as an inseparable part of the process of human creation. This proves that blood has an important role in human life. The purpose of writing this article is to determine the circulatory system or cardiovascular system by using Islamic science studies. The cardiovascular system of the human body consists of the heart, arteries, capillaries and veins which have various transportation methods in the process of transport and disposal of waste substances. In the heart there is an active transport process which causes the heart muscle to contract, from the contraction the heart provides the pump pressure needed to circulate the blood through the two main circulatory systems. The blood flowing through the vessels of each vessel has a constant discharge with a different flow velocity depending on the cross-sectional area of the vein being passed. Blood arteries are channeled to the capillaries. In capillaries there is an exchange of substances in each cell caused by hydrostatic pressure and osmosis. When blood reaches the vein the pressure is affected by the heart. This is because blood experiences resistance due to a lot of passing through the capillary vessels. The total pressure in the capillary drops from the end of the artery to the tip of the vein, so that blood flows along the capillary from the end of the artery to the vein. The flow of blood through the veins is the result of muscle work, so when the muscle moves it will put pressure on the blood vessels so that blood can flow back to the heart.*

Abstrak: *Menarik untuk membahas bahwa dalam ayat pertama yang diturunkan yaitu al-Alaq ayat 1-5, Allah SWT menggunakan istilah darah sebagai bagian yang tidak terpisahkan dari proses penciptaan manusia. Ini membuktikan bahwa darah memiliki peran penting dalam kehidupan manusia. Tujuan penulisan artikel ini adalah untuk mengetahui sistem peredaran darah atau sistem kardiovaskular dengan menggunakan studi sains Islam. Sistem kardiovaskular tubuh manusia terdiri dari jantung, arteri, kapiler dan vena yang memiliki berbagai metode transportasi dalam proses transportasi dan pembuangan zat limbah. Di jantung ada proses transportasi aktif yang menyebabkan otot jantung berkontraksi, dari kontraksi jantung memberikan tekanan pompa yang dibutuhkan untuk mensirkulasi darah melalui dua sistem sirkulasi utama. Darah yang mengalir melalui pembuluh masing-masing pembuluh memiliki debit konstan dengan kecepatan aliran yang berbeda tergantung pada luas*

penampang pembuluh darah yang dilalui. Arteri darah disalurkan ke kapiler. Di kapiler ada pertukaran zat di setiap sel yang disebabkan oleh tekanan hidrostatik dan osmosis. Ketika darah mencapai vena, tekanan dipengaruhi oleh jantung. Ini karena darah mengalami resistensi karena banyak melewati pembuluh kapiler. Tekanan total di kapiler turun dari ujung arteri ke ujung vena, sehingga darah mengalir di sepanjang kapiler dari ujung arteri ke vena. Aliran darah melalui pembuluh darah adalah hasil dari kerja otot, jadi ketika otot bergerak akan memberi tekanan pada pembuluh darah sehingga darah dapat mengalir kembali ke jantung.

Keywords: *Natural science and islamic preview;cardiovascular system.*

INTRODUCTION

In many functions, the body can be likened to a super sophisticated machine. This human "machine" is actually composed of trillions of very small "machines", living cells in the body. Collection of various types of cells forms a network, tissue forms organs, a collection of organs forms a system. Each system has its own form and function which is a whole unit to support the life of every human being.

The system consists of a system of motion, respiration, excretion and circulation. If likened to a collection of machines, each part of the living machine requires fuel, the cell itself is a miniature engine that requires fuel. In motor engines, the energy source used is gasoline; gasoline is mixed with air and burned in the engine cylinder to produce kinetic energy to rotate the wheel. The remaining products in the form of exhaust gas and heat are released through the exhaust and radiator. In the body, the source of energy is food; food is processed in the digestive system and then burned with oxygen in body cells to produce energy. Each of these miniature machines must have fuel, oxygen, and a way to dispose of waste products.

Blood and vessel-vessels or the so-called cardiovascular system function as an oxygen transport system and food extracts to meet the nutritional and burning needs of the human body and function to dispose of residual products.¹ The cardiovascular system of the human body consists of the heart, arteries, capillaries and veins which have various transportation methods in the process of transporting and removing waste materials.

The role of blood for human life is also explained by Allah SWT in the letter al-Alaq verse 1-2 which means: *Read by mentioning the name of your god. He has created humans from a lump of blood.* It is interesting to discuss that in the

¹ Campbell, *Biologi* (Jakarta: Erlangga, 2007), 87.

first verse that was revealed, Allah (swt) commanded humans to learn and know (*iqra* ') about the sign of God's greatness in terms of creation.² In that verse Allah SWT uses the term blood as an inseparable part of the process of human creation. This proves that blood has an important role in human life.

Why did Allah SWT mention the term blood in the process of creation?, what is the importance of blood for human life? What is the mechanism of blood circulation? These questions can be studied more deeply with the help of multidisciplinary science consisting of Physics to discuss the circulatory mechanism, the importance of blood for humans through a review of biology, material / blood structure through chemical review, and the relationship between blood and creation which is examined integrally across science of science. As Muslims, who make the Qur'an and Sunatullah a guide, then some of the existing discussion needs to be studied based on the Qur'an and from Hadith. Because of the importance of blood for life, it is necessary to study natural science and islamic review about the cardiovascular system. Through natural science and islamic preview are expected to strengthen faith and increase scientific knowledge for Muslims.

DISCUSSION BLOOD

The term blood (*'alaq*) is mentioned in the Qur'an. This can be found in the verse which states blood connection with the creation/process of formation of the fetus which is found in the letter Al-Mu'minun verse 12-14, which reads as follows.

"And certainly did We create man from an extract of clay. Then We placed him as a sperm-drop in a firm lodging. Then We made the sperm-drop into a shed of blood, and We made the a shed of blood into a lump [of flesh], and We made [from] the lump, bones, and We covered the bones with flesh; then We developed him into another creation. So blessed is Allah, the best of creators."

and Sura al-Baqarah verse 84 which reads:

"And [recall] when We took your covenant, [saying], Do not shed each other's blood or evict one another from your homes. Then you acknowledged [this] while you were witnessing."

two verses discuss blood, in the first verse discusses "a shed of blood" as part of the process of human creation, while the second verse deals with "shedding blood", meaning someone will die if His blood spilled out of the body in large quantities. However, if viewed from the aspect of activity, shows

² Colle, S, "Paradigma Pendidikan dalam Perspektif Surah Al-'Alaq Ayat 1-5", *Hunafa: Jurnal Studia Islamika*. Vol. 13, No. 1, (2017), 91-118.

that blood has a vital role for human life, because as an element of life support and also as an element that if not there will cause death.

Appropriate function of blood is needed to transport materials needed by the body, such as oxygen, water, and food substances. Besides the material needed by the body, blood also transports cell wastes, such as carbon dioxide gas.³ Blood can be referred to as a fluid, because it can flow through very small blood vessels and pumped by the heart and then circulated throughout the body to supply the materials needed by the body's cells. Fluid in general there are two types, namely true fluid and ideal fluid. Physically blood is an ideal fluid where the ideal fluid properties are not compressible, meaning that the volume cannot be compressed. When the ideal fluid moves, the fluid does not experience friction and the flow is stationary.⁴ That is, ideal fluid particles flow in certain flow lines which have the same speed or also called laminar flow. In ideal fluid such as blood has a constant mass density because the volume is always constant. The mass of blood type is almost the same as water, which is 1054 kg / liter.⁵

The blood tissue is composed of plasma, red blood cells, white blood cells, and blood platelets. Approximately 55% of human blood is composed of plasma. Plasma is a liquid part of blood that functions to transport food saris. Most of the blood plasma is composed of water. The rest are solutes consisting of plasma proteins such as albumin, prothrombin, fibrinogen, and antibodies, mineral salts, and blood-borne substances such as food substances, metabolic waste.⁶

Red blood cells are formed in the bone marrow. These red blood cells function to transport oxygen gas and carbon dioxide. Each normal red blood cell has a bikonkaf disc shape which has an average diameter of about 8 microns with a thickness of 2 microns on the side and 1 micron in the middle. The function of red blood cells is to carry oxygen from the lungs to cells throughout the body. The part of red blood cells that has a role to transport oxygen and carbon dioxide is hemoglobin. Hemoglobin is a blood pigment that contains a lot of iron. Because it contains iron, hemoglobin is very reactive to oxygen which is useful for combustion of ADP / ATP that comes from food extracts into energy.⁷

In addition to red blood cells, the blood component that is important for humans is white blood cells. The amount of white blood cells in the blood is

³ Campbell, *Biologi edisi 3* (Jakarta: Erlangga, 2007), 80.

⁴ Tripler, P.A, *Fisika Untuk Sains dan Teknik* (Jakarta: Erlangga, 1991), 364.

⁵ Gabriel, J. F., *Fisika Kedokteran* (Jakarta; EGC, 1988), 43.

⁶ Cameron, J., Skotronic, J. & Grant, R. *Fisika Tubuh Manusia Edisi 2* (Jakarta: EGC, 2007), 34.

⁷ Karim, S., *Belajar IPA*, (Jakarta; Pusat Perbukuan Diknas, 2008), 23

very different when compared to red blood cells. The ratio is around 1: 500. White blood cells have the function of fighting bacteria, viruses and foreign objects that enter the body. White blood cells play a role in maintaining health and protecting the body from various hazards, namely functioning as a major player in the immune system by fighting infections and surrounding and destroying foreign organisms that enter the body.

Another important part of the blood is blood platelets. Blood platelets are parts of cells or cell fragments that can stop blood flow from ruptured blood vessels. When liquid forms, blood has the ability to change shape according to its place. The motion of particles in the liquid causes the liquid to flow and take shape like the container. The nature of blood as a liquid is to have particles that can spread in all directions and their volume is constant. When clotting occurs, blood is solid. Solid blood particles are close together and are tightly bound by the forces between the particles. This causes the volume of solid blood to be compressed to be smaller. The particles are able to vibrate the nearest particle, but do not have enough energy to get out of position in breaking away from the bond, so that solid blood will retain its shape.

Besides having a tight blood type also has viscosity or viscosity. Viscosity of fluid sharing is expressed in the viscosity coefficient. The viscosity coefficient unit is N.ms. The greater the viscosity of a fluid, the greater the friction force experienced by an object if it moves into the fluid. If a metal ball is finger r moving at a fixed rate v in a fluid that has a viscosity coefficient it will experience friction of $F = 6\pi\eta vr$. Blood viscosity is usually 3 to 4 $\times 10^{-3}$ PaS, but depends on the percentage of erythrocytes in the blood. Blood viscosity also depends on the temperature. As the blood cools, the viscosity increases and this decreases the blood supply to cold hands and feet. Changes from 37° C to 0° C increase blood viscosity by 2.5 times.⁸

The impulse carried out by the heart causes blood to flow at a certain speed in the tube pipe which is also called blood flow. The force in the blood is caused by the mass and motion of the particles that make up the blood. In liquids and gases have constituent particles that are not dense. So the particles are more free to move. The constituent particles of blood continually move in all directions. When moving, the particles pound other particles and blood vessel walls with a force whose size depends on the mass and acceleration of the particle.

With the circulation of blood throughout the body, it allows food and oxygen extracts to be distributed evenly in each cell. With the fulfillment of these two ingredients, the performance of the organ will be able to function

⁸ Cameron, J., Skotronic, J. & Grant, R. *Fisika Tubuh Manusia Edisi 2* (Jakarta: EGC, 2007), 36.

optimally. For pregnant women, blood also plays a role in fetal health. When linked to the letter al-Mu'minun, verses 12-14 show that blood is the source of life for the fetus in the womb.⁹ In the uterine wall there are many open capillaries, so that in the event of fertilization, the placenta will attach to one part of the capillary vessels in the uterine wall so that food and oxygen intake can be guaranteed until the birth process. If the fetus is not appropriately attached to the uterus that contains a lot of blood vessels or is usually called pregnant outside the womb, it can interfere with cell division in the fetus. This event will have an impact on the development of the fetus properly.

THE HEART

Heart is a muscular organ about the size of a fist. The heart is located behind the breastbone and between the lungs, which are almost completely enveloped by the lungs, but are covered by a double membrane called the pericardium, and attached to the diaphragm. The human heart has four spaces. Two rooms at the top are called the porch (*atrium*) which consists of the right and left portico. Each porch is related to the vein. Two large spaces below are called *ventricles* which consist of right and left chambers.¹⁰

The two types of heart described in the Qur'an are the heart spiritually and physically. The scholars say there are 2 types of spiritual heart: Shubhat (doubt because something whose argument is still in talks or there are still disputes, then it is better to avoid this as a form of caution) and lust / lust which when excessive will bring ugliness. Emotion, behavior, knowledge, disease, desire, honesty, action and reaction are all rooted in the heart. Thus, the role of the heart in Islam is not only seen as physiological but also in terms of psychology.¹¹

Al-Qur'an and hadith analogize the heart as an emotional regulator that makes the heart have many characteristics which in modern medicine are thought to originate from the brain. In addition to looking at the heart from a psychological standpoint, Islam also looks at the heart in terms of anatomy and physiology. In the hadith of the Messenger of Allāh SWT said:

"Remember, in the human body there is a lump of flesh. If a lump of meat is good, then the whole body will be good. However, if it is damaged, it will undoubtedly damage the entire body. A lump of meat is called qolbu (HR. Bukhari and Muslim)".

⁹ Khoirudin, A, "Sains Islam Berbasis Nalar Ayat-ayat Semesta", *Jurnal At-Ta'dib*, Vol. 12. No. 1, (2017) 195-127.

¹⁰ Campbell, *Biologi*(Jakarta: Erlangga, 2007), 93.

¹¹ Thayyib, *Keajaiban Sains Islam. cetaka I* (Yogyakarta: Pinus book Publisher, 2010), 28.

From the hadith, it can be seen that it turns out that the heart is a collection of muscles (a lump of flesh) and not liquid like blood or solid and hard like a bone.¹²

If viewed from physical, the heart can be likened to a double pump producing the force needed to circulate blood through the two main circulatory systems. The right heart of the pulmonary circulation is associated with pumping blood to the lungs to exchange oxygen gas and carbon dioxide. While the systemic circulation in the left heart is related to circulatory function throughout the body because the left heart pumps blood throughout the body. As an automatic blood pump, the heart is a mechanical device controlled by electrical symptoms¹³. In the heart there is an active transport process which causes a difference in electrical potential, because the potential difference arises an electric current that causes the heart muscle to contract. The electrical potential that causes this heart rate is a unique combination of electrochemistry and the semipermeable nature of cell membranes.¹⁴

The cell wall can selectively pass or block the flow of physiologically important ions, especially ions Na^+ , Ca^{2+} , and K^+ . As a result, the concentration of these ions inside and outside the membrane will be different. The difference in concentration causes a difference in electrical potential, so that there is an ion flow that opposes the normal flow of ATP.¹⁵ This flow certainly results in changes in ion concentration inside and outside the cell so that cardiac contractions are different each periodically, this heart contraction is also called a heart rate that can pump blood. The heart contractions provide the force needed to circulate blood through the two main circulatory systems. As a result of the force carried out by the contraction of the heart muscle, the fluid in this case the blood will put pressure in all directions on each wall of the blood vessel cell. This is in accordance with the principle found by French scientist Blaise Pascal (1623-1662) which states that the pressure inside the fluid is moved in all directions with the same magnitude.¹⁶

Blood flowing due to pressure from the heart flows through the arteries, the blood flow with a certain volume has a different velocity in each area of the arteries (continuity principle). As a result of blood flow with high speed the pressure becomes smaller (Hk Bernoulli). So that the continuity of blood flow

¹² *Ibid.*, 29.

¹³ Kaskel, A., Hummer, Jr., P. & Daniel, L. *Merrill Biology An Everyday Experience. Teacher Wraparound Edition* (New York: Glencoe/McGraw-Hill, 1995), 112.

¹⁴ Goerke, J., & A. H. Mines, *Cardiovascular Psychology* (New York: Raven Press, 1988), 40.

¹⁵ Cameron, J., Skotronic, J. & Grant, R. *Fisika Tubuh Manusia Edisi 2* (Jakarta: EGC, 2007), 38.

¹⁶ Tripler, P.A, *Fisika Untuk Sains dan Teknik* (Jakarta: Erlangga, 1991), 366.

from the arteries to the capillaries will be maintained. The blood supply with a fixed volume in the arteries flows slowly in the capillary vessels because of the total large cross-sectional area (principle of continuity). In capillaries there is a substance exchange characterized by the entry and exit of capillary blood due to hydrostatic pressure and osmotic pressure.¹⁷The total pressure in the capillary drops from the end of the artery to the tip of the vein, so that blood flows along the capillary from the end of the artery to the vein. When blood reaches the vein the pressure is affected by the heart. This is because blood experiences resistance due to a lot of passing through the capillary vessels. The flow of blood through the veins is mainly as a result of muscle work, whenever we move the skeletal muscle suppresses back causing blood to flow through it and return to the heart.¹⁸ In the vein there is a valve that prevents blood from flowing back and forth.

The heart sounds that are heard with the stethoscope are caused by vibrations coming from the heart and the large arteries (aorta). Through good hearing a lot of information can be obtained from the sound of the heart. Heart sounds can be heard through a stethoscope because there is vibration in the heart and blood vessels. Opening and closing the heart valve is very instrumental in producing heart sounds; when that turbulent flow occurs and some of the vibrations that occur are within the range that can be heard. The heart is mentioned several times in the Qur'an and hadith. The difference in the state of the heart is described in the Qur'an into three: the state of the heart of the believers, infidel, and hypocritical. Believers are described as having a living heart, infidels have dead hearts, while hypocrites have a sick heart.

BLOOD VESSELS

Blood Vessels are distributed to blood vessels, blood vessels consist of arteries, capillaries and veins. Allah SWT said in al-Qaaf verse 16 which reads:

"And We have already created man and know what his soul whispers to him, and We are closer to him than [his] jugular vein."

If we look anatomically, the *jugular vein* carries blood from the head and neck to return to the heart so it can be concluded how important and vital this vessel is. We can see from that verse if Allah Almighty really knows how important blood, blood vessels, and blood circulation throughout the body are.

¹⁷ Gabriel, J. F., *Fisika Kedokteran* (Jakarta; EGC, 1988), 44.

¹⁸ Cameron, J., Skotronic, J. & Grant, R. *Fisika Tubuh Manusia Edisi 2* (Jakarta: EGC, 2007), 38.

In addition to the blood vessels as mentioned above, there are also blood vessels that have an important function in the circulatory system throughout the tubut. These blood vessels are also called large blood vessels or aorta. In the Qur'an this blood vessel is called *al-Aatiin* (aorta)¹⁹. The aorta is a large blood vessel that drains blood directly from the heart to be spread throughout the body. In Sura al-Haqqah verses 45 and 46 God says that means:

"Surely, truly We hold him in his right hand. Then really we cut the heart cord."

The verse can be interpreted as saying that the aorta has a fast blood flow because the pressure comes directly from the contraction of the heart, besides that the blood volume is still very much, therefore when the aorta is cut, the consequence is that there will be bleeding very great then shock and easily cause death.²⁰

The blood supply is always important for all parts of the body. Pumping blood by the heart produces blood pressure needed to push blood in the blood vessels²¹. In order to maintain blood pressure, the vessels must be filled with blood. The physical transport method in blood vessels can be seen in the arteries, capillaries, and veins.

When the heart pumps blood, the highest blood pressure is in the arteries.²² The aorta is the largest diameter artery. A thicker pulse wall provides strength and elasticity that accommodates blood flow by pumping fast and high through the heart's pulse. If the diameter of a pipe changes along the pipe the liquid will flow faster through a narrower segment than when flowing through a wider segment. The flow volume per second must be constant along the pipe so that the liquid flows faster when the cross-sectional area of the pipe narrows.

Because of the many capillaries, the blood flowing through the arteries has a faster flow than in the capillaries. Blood flowing through the arteries will move quickly then slow down in the capillaries and move even faster in the veins. As a result of blood flow with high speed the pressure becomes smaller. This is in accordance with Bernoulli's principle, so that the continuity of blood flow from the arteries to the capillaries will be maintained. The small arteries (*nadiols*) that supply the capillaries have circular muscle cuffs (*sphincter*) that control blood flow in the capillary tissues. If there is an increase in blood demand, the cuff loosens so that the muscles can receive more blood and certainly oxygen.

¹⁹ Ibid., 12.

²⁰ Kaskel, A., Hummer, Jr., P. & Daniel, L., Merrill Biology. *An Everyday Experience. Teacher Wraparound Edition* (New York: Glencoe/McGraw-Hill, 1995), 56.

²¹ Gabriel, J. F., *Fisika Kedokteran* (Jakarta; EGC, 1988), 45

²² Ibid., 46.

Capillary vessels are pipes that have very narrow cross-sectional areas. Capillary length is usually 1 mm. Capillary size is almost the same as the diameter of a red blood cell, 7×10^{-6} m.²³ Therefore, red blood cells push in through the capillaries and flow one by one. Contraction of the smooth muscle layer in the nadiola wall places the nadiola so that it has blood flow to the expanse of capillary vessels. The total pressure in the capillary drops from the tip of the pulse to the back end so that blood flows along the capillary vessels. When the muscle layer relaxes the capillary vessels also relax so as to allow blood to enter the capillary vessels. This is also due to the presence of a smooth muscle ring or sfingtes which control blood flow between the nadiola and venules.

The total pressure in the capillary drops from the tip of the pulse to the back end so that blood flows along the capillary. The liquid flows out of the capillary at the upper end near the nadiola, but re-enters the estuary near the venula. Approximately 85% of the fluid that leaves the blood at the end of the capillary artery is reentered from the interstitial fluid at the back end and 15% of the remaining fluid lost from the capillary vessels finally returns to the blood through the lymphatic system vessels.²⁴

Entry and discharge of blood in the capillary vessels is caused by hydrostatic pressure and osmotic pressure. The movement of fluid at each point along the capillary wall depends on the difference between the two opposite pressures on hydrostatic pressure and osmotic pressure. Blood pressure forces the fluid out of the capillary vessels. Osmotic pressure is a tendency for water to force out from the capillary vessels because the concentration of solutes in the blood is relatively higher. Blood continues to flow throughout the capillaries due to resistance (pressure) and loss of fluid volume.

Outside the capillary there is an interstitial fluid that cleanses the cell. The concentration of protein molecules in interstitial fluid is much lower than in capillaries. the flow of nutrients and water can go through osmotically permeable capillary walls from high concentrations to lower concentrated interstitial fluids. The transfer of substances is very important between the blood and the interstitial fluid which inundates the cells and passes through the endothelium in vesicle form and then frees its contents through exocytosis on the opposite side. Other substances just diffuse between blood and interstitial fluid. Small molecules such as oxygen and carbon dioxide diffuse down the concentration gradient across the membrane of the endothelial cells. Diffusion

²³ Cameron, J., Skotronic, J. & Grant, R. *Fisika Tubuh Manusia Edisi 2* (Jakarta: EGC, 2007), 41.

²⁴ Gabriel, J. F., *Fisika Kedokteran* (Jakarta; EGC, 1988), 46.

can also occur through a gap between adjacent cells. However, transport through these gaps mostly occurs through mass flow, namely the movement of fluid due to pressure.

Hydrostatic pressure in the capillary vessels pushes liquids containing water and solutes such as oxygen, urea salts through the capillary cleft.²⁵ Blood cells that are suspended in the blood and most of the protein dissolved in the blood are too large in size to easily pass through the endothelium so that they remain in the capillaries. The result is an outflow of plasma (without large proteins) through the capillary wall in the first half and inward flow in the second half. The outflow is a little more. This fluid returns to the circulation through the lymph system, a system of vessels and lymph glands that run parallel to the back and enter the reverse circulation near the heart.²⁶

Back vessels with thinner walls send blood back to the heart with low speed and and pressure after blood through the capillaries. When blood reaches the vein, the pressure is not much affected by the heart. This is because blood experiences resistance due to a lot of very large and narrow capillaries passing through so that the force from pumping the heart is no longer able to push blood in the veins. When blood has to fight gravity the rhythmic contraction of smooth muscle in the wall of the venula and back contributes partially to the movement of blood, besides that skeletal muscle activity also affects blood movement. When breathing air while breathing pressure changes in the chest cavity cause the vessels to return near the heart to dilate and fill with blood. The flow of blood through the back is mainly as a result of muscle work, whenever we move our skeletal muscles push back causing blood to flow through it and return to the heart.

CONCLUSION

Blood is a vital network for humans because it functions as a carrier that circulates/releases oxygen/carbon dioxide and food extracts throughout the body with the help of a heart pump, besides the carrier also functions for body immunity. Surat al-Mu'minun, verses 12-14, provides guidance for humans that blood is the source of life for the fetus in the womb. In the uterine wall there are many open capillaries, so that if fertilization occurs, the placenta will attach to one of the capillaries in the uterine wall so that the food and oxygen intake for the fetus can be guaranteed until the birth process.

²⁵ Kaskel, A., Hummer, Jr., P. & Daniel, L., Merrill, *Biology An Everyday Experience. Teacher Wraparound Edition* (New York: Glencoe/McGraw-Hill, 1995), 60.

²⁶ Goerke, J., & A. H. Mines, *Cardiovascular Psychology* (New York: Raven Press, 1988), 42.

The mechanism of blood circulation starts from the heart. In the heart there is an active transport process which causes a difference in electrical potential, because the potential difference arises from an electric current that causes the heart muscle to contract, because the heart contraction provides the force needed to circulate the blood through the two main circulatory systems. The force that the heart gives to blood is moved in all directions with the same magnitude (Pascal Laws). Blood flowing due to pressure from the heart flows through the arteries, the blood flow with a certain volume has a different velocity in each area of the arteries (continuity principle). As a result of blood flow with high speed the pressure becomes smaller (Bernoulli Laws). So that the continuity of blood flow from the arteries to the capillaries will be maintained.

The blood supply with a fixed volume in the arteries flows slowly in the capillary vessels because of the total large cross-sectional area (principle of continuity). In the capillary vessels there is an exchange of substances which is characterized by the entry and exit of capillary blood due to hydrostatic pressure and osmotic pressure. The total pressure in the capillary descends from the end of the artery to the tip of the vein regulated by the smooth muscle ring so that blood flows along the capillary from the end of the artery to the vein. When blood reaches the vein the pressure is affected by the heart. This is because blood experiences resistance due to a lot of passing through the capillary vessels. The flow of blood through the veins is mainly due to the work of the muscles, when the muscle moves, it will put back pressure on the blood vessels so that blood can flow back to the heart.

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