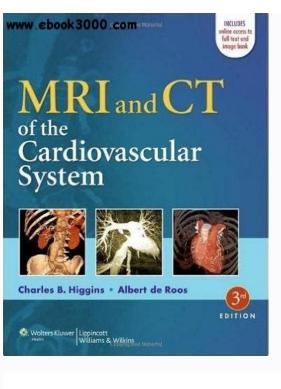
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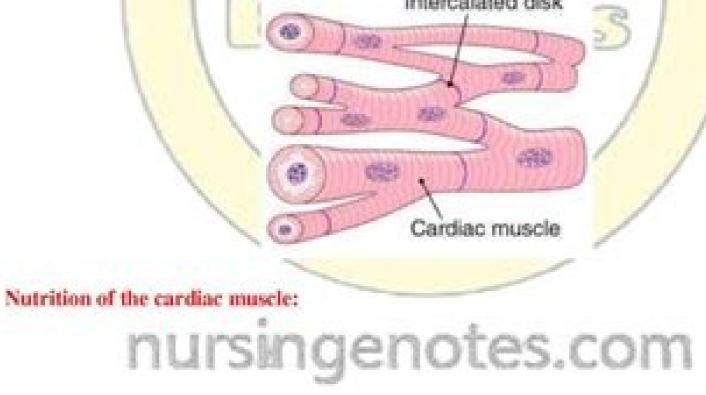
- 3. A.V. node receives impulses from SA node and conducts it to the ventricle through the bundle of His., it starts from AV node and ramifies in the interventricular septum.
- The bundles of His gives Right & amp; left branches, and passes to the right ventricle and to the left ventricles. They merge into purkinjee fibres.

Functions of conducting system:

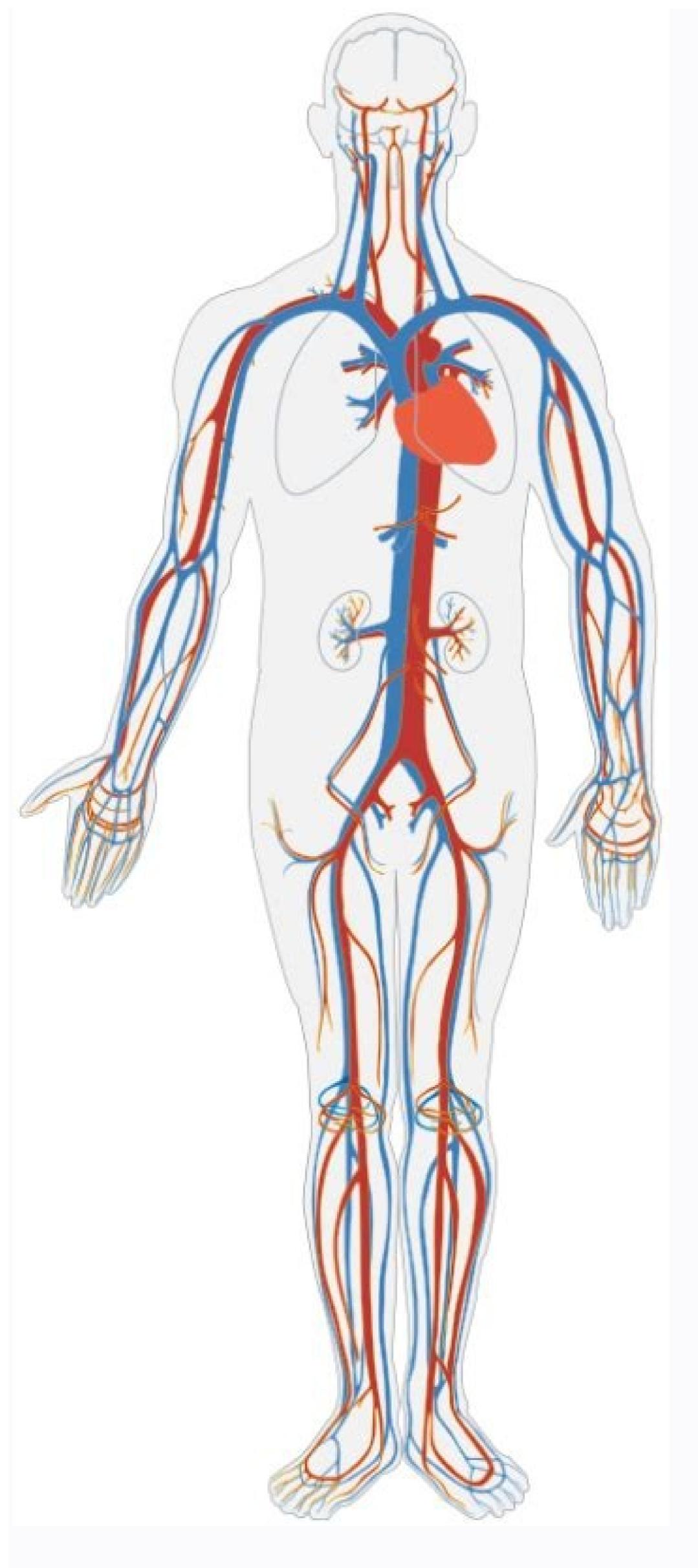
- 1. Prevent overlapping of the atrial events with ventricular events(systolic)
- 2.
- Participates in syncytial nature of myocardium. Initiates impulses rhythmically and automatically. 3.
- 4. Conducts the impulse at a rapid rate.)

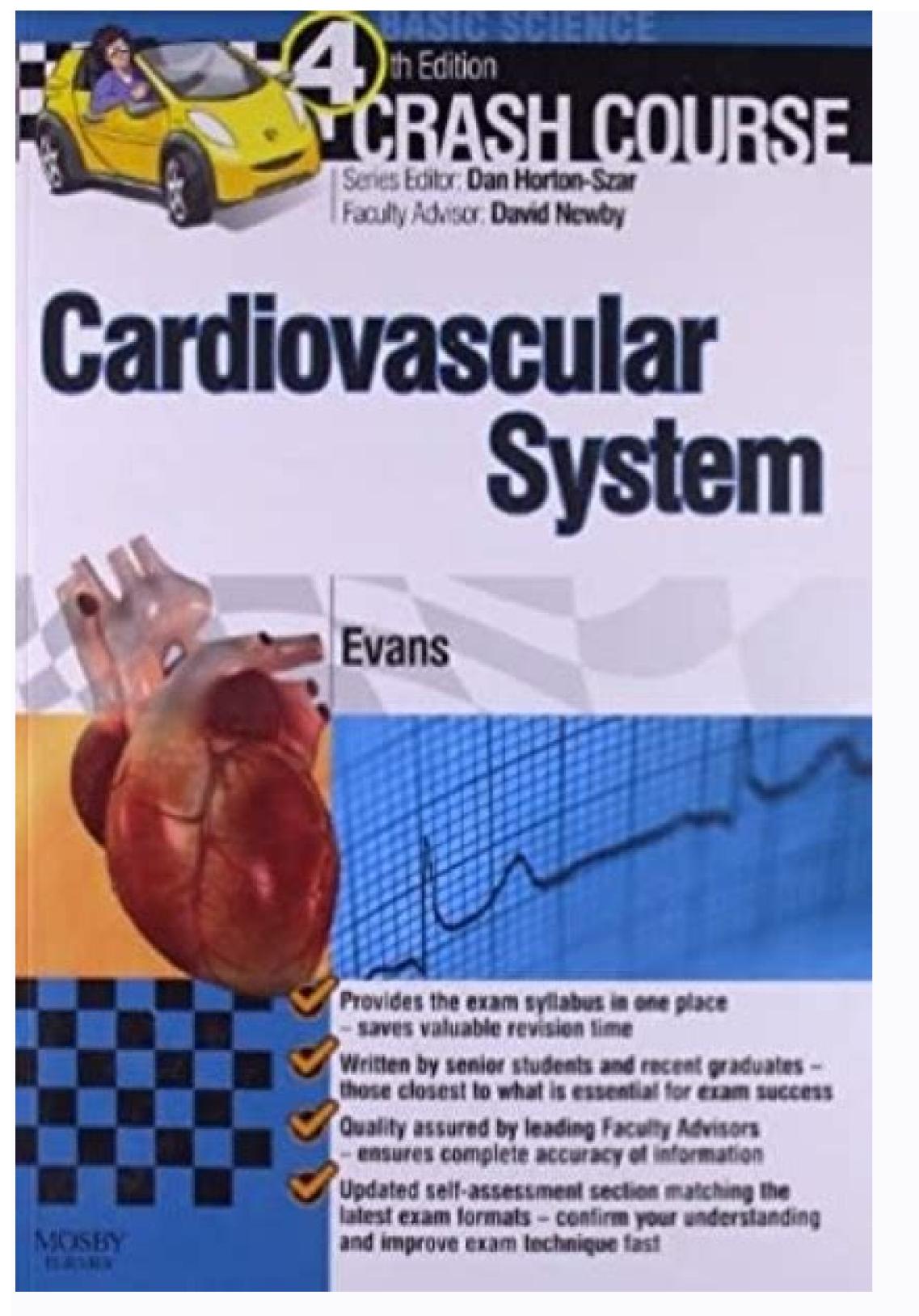
The properties of the cardiac muscle are

- 1. Excitability and irritability .
- Conductivity. 2.
- Contractility . 3.
- Rhythmicity and automaticity 4.
- Refractory period 5.
- Indefatigability. 6.
- Tonicity and 7.
- Nur 8. All or none phenomenon
 - Intercalated disk









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In addition, chapters integrate molecular and cellular data with the growing body of knowledge on heart and in vivo cardiovascular function, and as a result, provide insights into some of the most important questions that still need to be answered. Presents a comprehensive overview of cardiovascular structure and function in fish physiology and for audiences within the fields of comparative morphology, histology, aquaculture and ecophysiology Provide insights into some of the most important questions that still need to be answeredUndergraduate students, graduate students Physiology and Function Anthony P. Farrell and Frank Melvin Smith 5. Hormonal and Autacoid Control of Cardiac Function Sandra Imbrogno and Maria Cerra 6. Cardiac Function Sandra Imbrogno and Maria Cerra 6. Cardiac Function Sandra Imbrogno and Maria Cerra 6. Cardiac Function Sandra Imbrogno and Control of Cardiac Function Sandra Imbrogno and Maria Cerra 6. Cardiac Function Sandra Imbrogno and Sandra EnglishCopyright: © Academic Press 2017Published: August 21, 2017Imprint: Academic PresseBook ISBN: 9780128041666Hardcover ISBN: 978 research are the role that blood oxygen transport, cardiac function, stress and humoral and/or biochemical factors play in mediating fish "performance" under varied environmental conditions. Memorial University of Newfoundland, CanadaDr. Todd Gillis studied marine biology at the University of Guelph where he became fascinated by the biochemical and physiological adaptations that allow animals to live under extreme environments. He completed an MSc at Guelph looking at temperate marine bivalves. His PhD, at Simon Fraser University, focused upon the mechanisms that enable cardiac function in trout at their comparatively low physiological temperature. This work at low temperatures. As a NSERC Post-Doctoral Fellow in the lab of Dr. Mike Regnier in the Department of Bioengineering at the University of Washington, he worked on a variety of projects looking at the thin filament regulatory proteins and their role in controlling cardiac contractility. At the moment, his research program is focused upon the vertebrate heart and the role this plays in determining the physiological scope of organisms. Associate Professor, University of Guelph, CanadaDr. Tony Farrell is a professor in the Department of Zoology & Faculty of Land and Food Systems at the University of British Columbia and a Fellow of the Royal Society of Canada. His research had provided an understanding of fish cardiorespiratory systems and has applied this knowledge to salmon migratory passage, fish stress handling and their recovery, sustainable aquaculture and aquatic toxicology. He has co-edited of 30 volumes of the Fish Physiology series, as well as an award-winning Encyclopedia of Fish Physiology. As part of his application of physiology to aquaculture, he has studied the sub-lethal impacts of sea lice and piscine orthoreovirus on the physiology of juvenile salmon. Dr. Farrell has received multiple awards, including the Fry Medal, which is the highest honour to a scientist from the Canadian Society of Zoologists, the Beverton Medal, which is the highest honour to a scientist from the Fisheries Society and the Murray A. Newman Awards both for Research and for Conservation from the Vancouver Marine Sciences Centre. He is a former President of the Society of Experimental Biologists and a former Editor-in-Chief for the Journal of Fish Biology. He served as a member of the Federal Independent Expert Panel on Aquaculture Science. Professor, Department of Zoology and Faculty of Land and Food Systems, University of British Columbia and Fellow, Royal Society of Canada, Vancouver, CanadaDr. Colin Brauner was educated in Canada at the University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia and Fellow, Royal Society of CanadaDr. Colin Brauner was educated in Canada at the University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus University of British Columbia (Ph D), followed by a Post-doctoral fellowship at Aarhus (Ph D), followed by a Post-doctoral fellowship at Aarhus (Ph D), followed by a Post-doctoral fellowship at Aarhus (Ph D), followed by a Post-doctoral fellowship at Aarhus (Ph D), followed by a University. He is a Professor of Zoology, UBC and Director of the UBC Aquatics Facility. He has been a Co-Editor of the Fish Physiology series since 2006. His research investigates environmental adaptations (both mechanistic and evolutionary) in relation to gas-exchange, acid-base balance and ion regulation in fish, integrating responses from the molecular, cellular and organismal level. The ultimate goal is to understand how evolutionary pressures have shaped physiological systems can adapt/acclimate to natural and anthropogenic environmental changes. This information is crucial for basic biology and understanding the diversity of biological systems, but much of his research conducted to date can also be applied to issues of aquaculture, toxicology and water quality criteria development, as well as fisheries management. His achievements have been recognized by the Society for Experimental Biology, UK (President's medal) and the Canadian Conference for Fisheries Research (J.C. Stevenson Memorial Lecturer) and the Vancouver Marine Sciences Centre (Murray A. Newman Award for Aquatic Research). He is a former President of the UBC Aquatics Facility, CanadaWrite a reviewThere are currently no reviews for "The Cardiovascular System" 5. HemodynamicsBy Ali Nasimi 4,1971 Blood circulation consists of a central pump and a conduit system. Blood is pumped by the heart towards the arteries, and after tissue irrigation the veins ensure the filling of the cardiac chambers. This circulation system ensures human body cell survival by carrying all the necessary nutrients and removing the waste products of tissue metabolism. Cardiac and vessel structures can be studied from a mechanical point of view. In this chapter, the heart and blood vessels will be described anatomically, emphasizing their mechanical role. Blood circulation is possible by means of a central pump—the heart and a conduit system—arteries and veins. This circulation system ensures human body cell survival by carrying all the necessary nutrients and removing the waste products of tissue metabolism. The study of blood and the cardiovascular structure is called hemodynamics, and can be analyzed from a biophysical point of view. Similarly, cardiac and vessel structures can be studied from a mechanical point of view (Feher 2012, Fung 2004, Peterson and Bronzino 2008, Ross Ethier and Simmons 2011). In this chapter, the heart and blood vessels are mostly muscle cells and extracellular elements, such as collagen and elastin. Smooth muscle cells can be found in the vessel wall, and myocardial cells in the atrial basis for an understanding of circulatory dynamics. Figure 1.1 shows large vessels towards the top and the right, and ventricular structures towards the bottom and the left (Netter 1997). Figure 1.1. Structure of the heart and its main vessels. SVC: superior vein cava, Ao: aorta, PA: pulmonary artery, RA: right atrium, RV: right ventricle, RC: right coronary artery and LAD: left atrium, RV: right ventricle, RC: superior vein cava, Ao: aorta, PA: pulmonary artery, RA: right ventricle, RC: right coronary artery and LAD: left atrium, RV: right ventricle, RC: superior vein cava, Ao: aorta, PA: pulmonary artery, RA: right ventricle, RC: right ventri image High-resolution image The diagram of the frontal view of a normal heart shows the superior vein cava and the aortic and pulmonary arteries at the bottom (Iaizzo 2005). The right margin of the cardiac silhouette is formed by superior vein cavae, which are joined to the right atrium (see figure 1.1). On the contralateral side, the left atrium and left ventricle complete the cardiac apex belongs to the left anterior descending artery runs approximately between the left and right ventricles. The left atrium is an a posterior structure that only appears as a small appendage in a frontal view, whereas the right ventricle appears in an anterior position. The cardiac apex lies, approximately, in the intersection of the left midclavicular line and the fifth intercostal space (laizzo 2005). The heart is located above the diaphragm, between the right and left lungs, and behind the sternum and costal cartilages. A pericardial sac surrounds it. The esophagus and the descending aorta are found behind the pericardium is two serous layers: visceral and parietal, separated by a lubricating fluid that facilitates the movement of the heart during its contraction and relaxation. The inferior parietal pericardium is fused to the diaphragm (Netter 1997). The heart is a double pump that receives blood from vessels and circulates it to the left and right atria; blood volume is periodically passed through valves to the corresponding ventricles (see figures 1.1 and 1.2). Blood received by the right ventricle is pumped towards the lungs, and the blood collected by the left ventricle is ejected towards the aorta. Figure 1.2. A frontal view of the heart, its valves and main vessels. SVC: superior vein cava, Ao: aorta, PA: pulmonary artery, RA: right atrium, LA: left atrium, RV: right ventricle, TV and MV: tricuspid and mitral valves, PuV and AoV: pulmonary artery, RA: right atrium, RV: right atrium, RV: right ventricle, LV: left ventricle, TV and MV: tricuspid and mitral valves, PuV and AoV: pulmonary artery, RA: right atrium, RV: right ventricle, LV: left ventricle, LV: septum.Download figure: Standard image High-resolution image The cardiac structure can be represented as a pair of pumps, a right one and a left one, each of them with one atrium and one ventricle. Deoxygenated blood reaches the right atrium from the cava and coronary veins. This blood is delivered to the right ventricle through the tricuspid valve and arrives at the pulmonary artery after a right ventricle through the left atrium and reaches the left ventricle through the mitral valve. Once a left ventricular contraction has occurred, oxygenated blood is pumped to the aortic valve (Burton 1965). The heart has a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary and aortic valves, i.e. each valve is inserted into a fibrous structure with four annuli for the mitral, tricuspid, pulmonary annuli for the mitral, tricuspid, pulmonary annuli for the mitra Furthermore, the upper interventricular septum has a short membranous extension that acts as anchorage for the tissues of two atrial chambers connected to two ventricles. The arteries are communicated to the ventricles through valves. There are no valves between the right and left atria and the entering veins. All heart valves) and from the ventricles into the ventricles into the atria (tricuspid and mitral valves) (Kroemer et al 2010).1.2.1. Heart valves) and from the ventricles into the ventricles into the ventricles into the ventricles (are unidirectional and prevent blood flow from the ventricles) (Kroemer et al 2010).1.2.1. dynamic anatomical structure and it is important to consider all its constituents. The mitral annulus acts as anchorage for the antero-septal and posterior leaflets. Each mitral leaflet is connected to both papillary muscles through the chordae tendineae (MV) includes an annulus (a), two leaflets (l) attached to papillary muscles (m) through chordae tendineae (t). A is the apex of the left ventricle, S is the interventricular septum, and Ao is the apex of the left ventricle, S is the interventricular septum. three leaflets, one more than the mitral valve. The aortic valve is positioned between the pulmonary valve has a similar role between the pulmonary artery and the right ventricle (Iaizzo 2005). Both the aortic and the pulmonary valve has a similar role between the pulmonary valve has a similar valve. valves have three leaflets or cusps that remain closed during the diastolic period, and open towards to the arterial wall during systole (see figure 1.4. Cross-sectional (left panel) and in the open position (lower panel) during ventricular ejection. Download figure: Standard image High-resolution image Describing the heart valves before the cardiac structure includes annulus for the valves, the pedagogic strategy is clearer. Thus, the atrial and ventricular structures are described as follows.1.2.2. Cardiac chambersThe left atrium receives blood from four pulmonary veins that arrive from the left and right lungs. There are two right atrium by the interatrial septum. The thickness of the left atrium wall is approximately 3 mm. The right atrium lies between the superior and inferior cava veins. Its wall thickness is slightly smaller than the left atrium (Lunkenheimer et al 1985). The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. The ventricular structures are made of striated muscle cells, except control of the former is involuntary. input and output valves are placed laterally to each other, which means that the ventricular contraction must start distally to the output valve. The left ventricular lumen is not at all smooth: a great number of trabeculae are observed. The right ventricle is in the cardiac midline, and has an anterior (ventral) position. It has thinner walls (3-4 mm) than the left ventricle has a complex shape, which could be described as a crescent moon in cross-section. As in the left ventricle has a complex shape can be observed in the inner surface of the right ventricle (Lunkenheimer et al 1985).1.2.3. Microscopic structures The heart walls contain elastin and collagen fibers, it is considered a muscular structure from a quantitative point of view. The cardiac architecture includes pacemaker cells. Muscular cells, miocytes, are the most important constituents of ventricles. They are combined with elastic and collagen fibers that contribute to a complex architecture, together with fibroblasts, endothelium and pacemaker cells. Myocytes have nuclei in a central position, contractile fibers and a large number of mitochondria surrounded by a membrane called sarcolemma. The contractile apparatus is formed by filaments of actin and myosin. These protein molecules are responsible for the muscular contraction that occurs by a sliding mechanism in which actin and myosin filaments take part (Iaizzo 2005, Feher 2012). The ends of the thin actin filaments are attached to structures called Z lines. The sarcomere is the segment of myofibrils between Z lines. according to the degree of muscle contraction and relaxation (Fung 2004). The degree of overlap of actin and myosin fibers determines the distance between 1.5 and 1.6. Figure 1.5. Mitochondrial and sarcolemmal structures viewed through electron microscopy. The arrows indicate the dark lines Z of the sarcomere (the contractile units of heart muscle). Between the Z lines that determine the distance between 2.2 and 3.3 microns. Download figure: Standard image High-resolution image Figure 1.6. Diagram showing vertical Z lines that limit the sarcomere. The sliding of actin and myosin filaments determines a shortening of the distance between Z lines (arrows) during muscular contraction. Download figure: Standard image 1.2.4. Electrical systemThe dynamic function of the heart begins with a biologically generated electrical signal that contracts the atria first, and then the ventricle. The stimuli that determine cardiac muscle contraction are synchronized by an automatic system that produces and conducts electrical signals. This is the cardionector system, made up of specialized cells that generate electrical activity in pacemaker cells. The electrical impulse is generated by an action potential, and is rapidly transmitted through a specific conduction system, towards the myocardial muscle mass to cause rhythmic contraction. It is true electrical wiring (Iaizzo 2005). Anatomically, the nerve fibers of the heart begin in the right atrium, where a cellular node of pacemaker cells is found (also called Keith and Flack node). From this sinoatrial node, in physiological conditions, rhythmic pulses are generated, which travel to the left atrium and connect to the atrioventricular node (see figure 1.7). The impulse is delayed before going towards the ventricles. This delay determines that the atria contract before their respective ventricles, achieving optimal ventricular filling (Feher 2012). Figure 1.7. Electrical impulses begin in the Keith and Flack node (KF), then spread towards the right and left atria. Then, the impulse atrives at the Aschoff-Tawara node (AT), also called the atrioventricular node. Next, the impulse passes to the bundle of His (H), which diverges into a right branch (RB) and a left branch (LB). The latter has two divisions: posterior (P) and anterior (A) branches. Download figure: Standard image High-resolution image The atrioventricular node (also called the Aschoff-Tawara node) in the cardionector system is followed by the His bundle. It is a one-centimeter long collection of cardiac cells that is divided into a right and a left branch. The latter is divided into two branches: anterior and posterior. The terminal branches of the above-described divisions are called Purkinje fibers are in direct contact with the myocardial contractile cells (Jaizzo 2005). It is important to consider that a ventricle acts as a pump in a truly hydraulic sense. This is particularly relevant when the left and right ventricles, respectively, determining a dynamic vascular adaptation that can be explained by a biophysical analysis (Li 2000). This function depends on the viscoelastic properties of the smooth muscle cells, elastin and collagen of the arterial wall. A cross-section view of the arterial wall. A cross-section view of the analysis (Li 2000). media and adventitia. The thickness of these layers changes as the arterial diameter decreases (Clark and Glagov 1979, Ross 1992). The inner layer has cellular and extracellular constituents between the endothelial cells (which are in contact with blood) and the internal elastic lamina (a tubular elastic structure). This innermost layer is called tunica intima and contains collagen, laminin and fibronectin. The tunica intima is thinner than the media laver. The endothelial cells are capable of modifying the entire arterial wall dynamics, as will be explained in the next chapter (Rhodin 1980). Between the tunica intima and the adventitia layer, is the tunica media, a complex structure linked to the mechanical properties of the arterial wall. The most important constituent of the aortic wall. The amount of collagen, is the tunica media and the adventitia layer, is the tunica media and elastin and smooth muscle varies along the arterial tree, with a significant increase of smooth muscle cells distally to the heart (Clark and Glagov 1979); see figure 1.8. The arterial lumen is shown at the top (B), the inner layer is the intima, followed by the media (M) and adventitia (A). stained artery is taken from a laboratory animal. Download figure: Standard image Arteries have the ability to retain their tubular shape, even when they are empty; the opposite happens to veins, which collapse. However, in humans the physiological diameter is given by the relationship between intraluminal pressure and smooth muscle tone. In elastic arteries (i.e. the aorta and the brachiocephalic trunk), most of the elastin is arranged in the walls of these structures are called lamellar units and are fenestrated. The number of elastic lamellae is in the range of 50-80 in the aorta but only 2 in the muscular arteries (figure 1.10). In the latter, only the internal elastic lamellar unit limit the tunica media (Bia et al 2014, Zócalo et al 2013). Figure 1.9. Left panel: schematic model of the structural constituents of the arterial wall, showing elastic lamellae. Right panel: schematic model of the structural constituents of the arterial wall, showing elastic lamellae. tubular elastic structures. The right panel illustrates the structure of smooth muscle cells placed between two elastic fenestrated lamellae and collagen fibers (thin black lines). Download figure: Standard image Figure 1.10. Image of a stained artery from a laboratory animal, showing the elastic lamellae in the tunica intima. The lack of distending intraluminal pressure explains the winding shape of the elastic units shown in figure 1.9. Download figure: Standard image High-resolution image The space between the elastic lamina is occupied by smooth muscle cells and collagenous fibrils. Vascular smooth muscle cells have two important physiological roles: (a) to determine the arterial diameter and (b) to produce elastin and collagen. Smooth muscle cells are oriented longitudinally, circumferentially and obliquely, which impact on the mechanical role of the vessel (Wolinsky and Glagov 1969, Fischer et al 2009). Collagen fibers are made of the most abundant protein in the human body: collagen. There are several types of collagen, and in arteries it is, quantitatively, the most important constituent of the abdominal aorta (Fischer et al 1991). The outermost tunica is the tunica adventitia, for which the thickness changes in the different arterial territories. This outermost tunica has a fibroelastic matrix and adipocytes. It also contains vasa vasorum and nerves that ensure vessel wall blood perfusion and innervation, respectively. Interestingly, the word 'adventitia' derives from adventicius, which means 'coming from abroad, foreign' in Latin (Wolinsky and Glagov 1967, Fischer 2006). Veins and arteries have similar constituents: elastin, collagen and smooth muscle cells. Nonetheless, there are quantitative differences and some anatomical details to take into account. Veins have thinner walls and a larger diameter than arteries. However, three layers can be differentiated in the veins is close to 65% of the total content of the circulatory system. The venous wall is thinner than the arterial wall, and accordingly, venous pressure is lower than arterial pressure. The most important difference between arteries and veins is possibly the existence of valves in the latter. Also, veins on the upper limbs are thinner than the lower limbs. Furthermore, veins have more connective tissue than arteries. Blood supply in the vein wall is ensured by the vasa vasorum that can be found in the left atrium. blood passes to the left ventricle and through the aortic value to the aortic, the capillaries, the capillaries, the veins, to start over the same cycle. Evidently, any other point can be chosen as a starting point. Furthermore, two different subcircuits can be identified within the circulatory system: the pulmonary and the systemic systems (Li 2000); see figure 1.11. Figure 1.11. Schematic representation of the human blood circulatory system. IVC: inferior vena cava, RV: right ventricle, PA: pulmonary artery, PC: pulmonary capillaries, PV: pulmonary vein, LV: left ventricle, K: kidney showing artero-arterial portal system and SC: systemic capillaries. Download figure: Standard image High-resolution image The pulmonary circuit goes from the left ventricle to the right atrium through arteries, capillaries and veins. The above-described cardiovascular arrangement enables the maintenance of blood flow that ensures an adequate perfusion of all of the tissues of the human body. As shown in figure 1.11, pulmonary blood circulation is connected in series with systemic circulation. The circulatory system determines the path used by the blood, but tissue fluid reabsorption is completed by the lymphatic vessels that carry the lymph has a liquid nature and has no red blood cells. The lymphatic wall structure is similar to that of the capillary wall. This system carries the large molecules of the interstitial space including large proteins and lipids. The lymphatic fluid eventually drains into the venous system. The most important lymphatic vessel is the thoracic duct that is situated between the aorta and the esophagus, ending in the left confluence of the subclavian and jugular veins. Human blood has cells and plasma that can be separated using a simple technique that consists of centrifuging a sample obtained from a peripheral vein. Centrifugation allows one to separate the solid (cellular) from the liquid phase (plasma). The Hematocrit is the volume of erythrocytes expressed as a percentage of the total centrifuged blood volume. It is valuable data that helps one to diagnose blood diseases such as anemia. In humans, the normal value of the hematocrit ranges from 40% to 45%, and is higher in males than in females (Fung 2004).1.5.1. Blood plasma would be a part of the interstitial space. The solutes present in plasma are: proteins (albumin, fibrinogen, globulin among others), ions (Na+, Ca++, Cl-, K+), metabolites, hormones, platelets are formed elements of human blood whose concentration is in the range of 1.8-4.0 × 105 mm3 of blood (Feher 2012).1.5.2. Blood cells There are two types of circulating cells in the bone marrow. In a static condition, red cells are symmetrically disc-shaped. The most important intracellular constituent of an erythrocyte is hemoglobin, and it has no nucleus. Erythrocytes in humans range from 5 to 6 × 106 cells per mm3 of blood (Fung 2004); see figure 1.12. Figur where the erythrocyte is traveling. Download figure: Standard image The different types of leukocytes account for only 1% of the cellular constituents of human blood; they have morphological and functional differences among them. Different leukocytes include neutrophils, lymphocytes and monocytes. Leukocytes in humans range from 5000 to 11 000 cells and plasma total a volume of approximately 5.5 l in a healthy adult human. This volume is distributed as follows: 64% is in the venous system, 15% in the systemic arteries, 9% in the lungs, 7% in the cardiac chambers and 5% in microcirculation. As can be seen, the larger volumes of blood are contained in the low pressure reservoirs (i.e. the venous system). The above-described cardiovascular structures are distributed in every human body territory in order to irrigate the perivascular parenchyma, i.e. the tissue that surrounds vessels. The general operating scheme is that of an artery entering an organ and then dividing itself into smaller arteries, arterioles and capillaries, followed by small venues and veins. The latter ensure that blood returns to the cardiac structures. There are certain territories in which microcirculation shows particular characteristics. For example, lung capillaries are very close to the alveolus, which contain a modified atmospheric air (e.g. different pressure and relative humidity conditions); in the skin, vessels participate in body temperature regulation; in the digestive system a vein portal system enables the carrying of nutrients from the intestines to the liver lobules. 1.6.1. Capillaries are vessels that have two important characteristics: (a) they are the smallest vessels, with a 7-10 µm diameter, and (b) they provide the largest vessels that have two important characteristics: (a) they are the smallest vessels that have two important characteristics: (b) they are the smallest vessels with a 7-10 µm diameter, and (b) body. The capillary wall consists of endothelial cells surrounded by a tubular structure with no smooth muscle cells. The diameter values of capillaries are described below (Tedgui 1994). Continuous capillary: the wall of these capillaries is constituted of endothelial cells joined to each other with no fenestrated capillary. Fenestrated capillary has certain small areas in which the wall has fenestrated endothelial cells. Fenestrated capillary: the capillary has certain small areas in which the diameter is approximately 100 nm.Discontinuous capillary: these capillaries have the largest diameter of all capillaries (from 30 to 70 µm). Endothelial cells have gaps that allow free communication between the intravascular space and the surrounding tissues.1.6.2. William Harvey, and pulmonary circulation was discovered and characterized by Ibn al-Nafis (1213-88), an Arab physician. The pulmonary circuit has several features regarding other organs of the human body. In fact, lungs are organs that receive the greatest amount of blood, since the right ventricle pumps the same volume as the left ventricle (Feher 2012, Despopoulos and Silbemagl 2003).Lung parenchyma is perfused by oxygenated blood provided by the bronchial arteries, and blood that is involved in gas exchange is pumped by the right ventricle through the pulmonary artery. plasma and erythrocytes. Carbon dioxide is a well-known product of the Krebs cycle that easily diffuses through the soft tissues of the human body. Gas exchange takes place at the lungs alveoli, which are surrounded by pulmonary capillaries. The oxygen contained in an alveolus passes through several barriers in order to oxygenate the hemoglobin contained in the red blood cells (figure 1.13). The first barrier is the aqueous lining containing surfactant in the alveolus, the second is the pneumocyte type one cell, the third is the interstitial space, the fourth is the endothelial cell that is part of the capillary vessel, the fifth is the blood plasma and last, the erythrocyte membrane (see figure 1.13). Figure 1.13. Barriers that the oxygen passes through from the alveolus to red blood cells (erythrocytes) to combine with hemoglobin molecules. L: aqueous lining containing surfactant, N: neumocyte Type 2 cell, I: interstitial space, E: Endothelial cell and P: blood plasma. Oxygen transport is linked to hemoglobin while carbon dioxide is

transported by plasma and erythrocytes. Download figure: Standard image High-resolution image 1.6.3. Portal venous systemThere is a portal venous systemThere is a portal venous systemThere is a portal venous system. spleen and intestine to the liver. Other veins are also anastomosed to this system: the right and left gastric, gastro-epiploic, cystic and pancreatic-duodenal veins. This venous portal system receives blood from the esophagus, the stomach, the spleen, the spleen, the gastric and pancreatic-duodenal veins. This venous portal system receives blood from the esophagus, the stomach, the spleen and intestinal tract. branches that enters the liver and originates from the veins of the liver lobule. The blood supply to the liver lobule contains nutrients that are obtained from intestinal absorption and splenic activity. The latter is very important in the iron recycling process carried out by the splenic macrophages out of old erythrocytes. The portal vein blood received by the hepatic lobule goes to the central vein and finally joins the inferior vein cava. Summarizing, the blood that perfuses the digestive tract is the same as that which arrives at the liver, that is to say, there is a capillary barrier in the intestines and another one in the hepatic lobule (Feher 2012, Despopoulos and Silbernagl 2003). The physiological role of this portal system is to provide a direct pathway for nutrients that are metabolized in the hepatic tissue has a very different function to that provided by systemic arteries to body tissues. Another venous portal system is involved in the secretion of the hypothalamic-pituitary pland function after traveling through a portal venous system. The superior hypophyseal artery perfuses the median eminence and this blood enters the capillaries, which after merging into each other form a venous network that carries releasing hormones. These portal veins split into capillaries that perfuse the anterior pituitary gland, stimulating or inhibiting the production of several hormones. Later, these hormones are released into the systemic circulation and travel to specific organs in order control physiological functions. 1.6.4. Arterial portal systemThe basic function of kidneys is to produce urine. This complex liquid is produced in the nephron, which is the basic structures. Histologically, the nephron begins in the glomerulus that is a tuft of capillaries that originate from afferent arterioles. These capillaries drain blood onto the efferent arteriole; see figure 1.14. BC: Bowman's capsule, PCT: proximal convoluted tubule, LH: loop of Henle, DCT: distal convoluted tubule, CD: collecting duct. Note that the peritubular capillaries originate from the efferent arterioles that drain in a vein. Download figure: Standard image Each glomerulus is embraced by a Bowman's capsule receives a filtrated modified plasma from the glomerulus. The proximal convoluted tubule is continued by the loop of Henle. The loop of Henle is followed by the distal convoluted tubule, which ends in the collecting duct. At the end of the collecting duct, the fluid contained in the tubular lumen is urine. With respect to blood vessels, the glomerulus receives blood from the afferent arteries and the constitutive capillaries; in other capillary beds they are followed by a venule, but in this case they are continued by the afferent arteriole. Efferent arteriole perfuse the renal parenchyma including the tubules and loop of Henle through the vasa recta. Blood contained in the capillaries that constitute the peritubular network is drained by venules (Schrier 2008). The arterial portal system described above has a set of capillaries (glomerulus) that filtrates plasma into the Bowman's capsule. This capillary network is continued by the efferent artery that originates from the peritubular capillary network starts in the arterioles, which drain their contained blood into the venules. However, there are certain territories in which arteriovenous shunts avoid the capillary network. These anatomical findings have physiological connotations and are usually linked to adaptive mechanisms. An example of a shunt is the skin, in which arteriovenous shunts avoid the capillary network. in fingers. In this case, this dynamic shunt participates in the control of body temperature (Despopoulos and Silbemagl 2003). According to several authors, another example of arteriovenous fistula is uteroplacental circulation. In the lungs, there is a functional shunt in which blood provided by bronchial arteries to pulmonary parenchyma are drained in the pulmonary veins.1.6.6. Splenic circulationCapillaries that allow blood cells to go through the vessel wall are only found in splenic circulation and in bone marrow. As red blood cells are trapped by splenic structures. After an approximate period of 120 days, the old erythrocyte is destroyed in the spleen. As an adult human being has a blood volume of 5 l and each mm3 contains 5 000 000 erythrocytes, the production and elimination of blood red cells is a very dynamic process. This involves the erythrocyte is destroyed in the spleen. (Despopoulos and Silbemagl 2003). An interesting physiologic phenomenon occurs during active physical exercise; hematocrit increases due to a splenic contraction that releases red blood cells into the circulatory system. 1.6.7. Myocardial circulatory system. 1.6.7. nearest and shortest circuit of the human circulatory anatomy; consequently, it is the blood of the human body recirculating (Despopoulos and Silbemagl 2003). Usually, an artery is a vessel that enters an organ and branches into smaller vessels. This is impossible to attain in the myocardium of the left ventricle since it reaches 120 mmHg during the systolic period and the muscular contraction occludes the arterial lumen. Indeed, the coronary intraluminal pressure can never be higher than the ventricular wall rather than being inserted in the muscular coronary arteries are a pathologic entity that sometimes determine ischemic episodes or myocardial infarction. There are cases in which coronary arteries have muscular 'bridges' and are partially intramuscular small arteries are called 'perforators'. This is the case of septal branches of the left anterior descending artery. The coronary flow is strongly influenced by anatomical factors due to left ventricle, in which intramural pressures are lower than the coronary arterial pressure. During myocardial contraction, the external compression of small coronary branches is maximal in endocardium, and decreases towards the epicardium. Since large coronary arteries are not surrounded by myocardial tissue, no lumen decreases are observed on them during heart contraction.

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