II. Organ System Physiology

4 CARDIOVASCULAR PHYSIOLOGY leanne L. Seagard, Ph.D.

BLOOD

1. What are the components that make up blood?

What are the components

Hood is a two-phased fluid consisting of formed cellular elements suspended in a liquid Blood is a involunce of the formed elements are red cells (erythrocytes), white cells (leukocytes), and platelets.

2. What are the parts of the plasma?

What are the parts of the blood, normally occupies about 55% of the blood vol-The plasma, or nation that the constituents of plasma are as follows:

The normal content		plastia are as follows:		
		PLASMA (mOsm/L OF H ₂ O)		
Na*		142		
K*		4.2		
Ca++		1.3		
Mg+		0.8		
CI-		108		
Hco,-		24		
HPO, H,PO,		2		
SO ₄ 2		0.5		
Amino acids		2		
Creatine		0.2		
Lactate		1.2		
Glucose		5.6		
Protein				
Urea		1.2		
Others		4		
Total mOsm/L		4.8		
		301.8		
Corrected osmol	ar activity (mOsm/L)	282.0		
Total osmotic pe	essure 37°C (mmHg)	5443		

3. What is the hematocrit?

If a blood sample from an adult is centrifuged in a graduated test tube, the relative volume of the packed red cells is termed the hematocrit. For a normal adult, this volume is about 40-45% of the total. That is, the red cells occupy about 40-45% of the total volume of the blood in the boy, The white blood cells, which are less dense than the red cells, form a thin layer (the soalled buffy coat.) The remaining 55-60% of the volume is the plasma. An increase in hematocrit fours in people acclimatized to high altitude, where there is an associated decrease in oxygen hel The hematocrit in this case can be 60-65% of the total blood volume.

How many red blood cells are there?

In a normal adult, there are between 4.5 million and 6 million red blood cells per million, and a control adult, there are between 4.5 million are control to the control of the co 4. How many red tonos—

A How many red tonos—

I have a second adult, there are between 4.3 million as a greater hematicerit is known as anemia.

A decreased hematocrit is known as anemia.

5. How many white blood cells are there?

How many white blood cells are there?

How many white blood cells are the circulation can be quite variable. In a normal indirection of white cells in the circulation can be quite variable. In a normal indirection control of the circulation of the circulation can be controlled to the circulation of the circulation can be controlled to the circulation can be controlled to the circulation can be controlled to the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be quite variable. In a normal individual can be called the circulation can be called the cir 5. How many write.

The number of white cells in the circulation cell on quarter variable. In a normal admits a member of white cells in the circulation cell per millilities of normal personal admits, and the cell of the cells are mainly involved in the immune process. Thus, an infection personal results are mainly involved in the immune process. Thus, an infection in ormality cells are mainly involved in the immune process. Thus, an infection in ormality cells are mainly involved in the immune process. The cells are mainly involved in the immune process. there are between now.

The white cells are mainly involved in the immune process, a man, an intection promally to the white cells are mainly involved in the immune process. A reduction in white cells known as leukocytosis. A reduction in white cells below to the standing in an increase in white cells known as leukocytosis.

6. How many platelets are there in the circulation?

How many platelets are there in the CITCUBLUSTION.

There are about 150,000–300,000 platelets per milliliter in normal peripheral blood, Because in the plate of the blood volume, Plate in the plate of the blood volume, Plate in the plate of the blood volume, Plate in the plate of the plate 6. How many there are about 150,000–300,000 piateiers per manner and peripheral blood, Because from the are about 150,000–300,000 piateiers per manner and peripheral blood volume. Pitteling the free results of their small size (2–3 μ), they make up only a small fraction of the blood volume. Pitteling the results of their small size (2–3 μ).

7. What is the blood volume of a normal person?

What is the blood volume of a not unarrange constant over time, but there is considerable normal blood volume of an adult remains constant over time, but there is considerable.

The normal adult generally range for the values in a normal adult generally range for the value f The normal blood volume of an above variation from one person to another. The values in a normal adult generally range from 70 to 75 to 150 to variation from one person to another. The values is a state of the person of body weight. Thus, a 70-kg adult might have a total blood volume of about the per kilogram of body weight. Thus, a 70-kg adult might have a total blood volume of about the person of this blood volume is plasma, and about the person of the person o 5000 mL. About 55%, or 2750 mL, or una choose of volume is dramatically increased is in total red cell mass. One situation in which blood volume is dramatically increased is in pearly 50% above baseline by about 32 week. is total red cell mass. Une struation in many 50% above baseline by about 32 weeks, wherea te nancy. Blood volume can increase to nearly 50% above baseline.

8. How does the blood carry oxygen?

How does the plood carry oxygen.

The vast majority of oxygen carried in the blood is bound to hemoglobin, a protein consignation of the control of the cont The vast majority or oxygen containing heme groups, which are ing of globin, your puryo-peace. Which are the binding sites for oxygen. Hemoglobin is the primary constituent of the erythrocyte and conthe binning sites to toxygen to form oxyhemoglobin. In normal whole blood, the concentrates of hemoglobin is about 15 g/dL. When blood is exposed to high oxygen pressure, all the housglobin combines with oxygen to form oxyhemoglobin. Under these conditions, the hemoglobin is said to be fully saturated. Fully saturated hemoglobin can accommodate about 1,39 mi at oxygen per gram of hemoglobin. Thus, blood with a hemoglobin concentration of 15 gidl, has as oxygen capacity of about 20.8 mL/dL of blood, or 20.8 volume percent. The amount of capacity that is carried by hemoglobin depends on the partial pressure of oxygen (PO₂) to which the he moglobin is exposed. This relationship is defined by the oxygen dissociation curve. Under onmal conditions, the Po. level found in the lungs results in blood being about 97% saturated in this case, when arterial blood has a hemoglobin concentration of 15 g/dL, the oxygen contents about 20 mL/dL

9. What is the venous oxygen content after the blood has given up oxygen to the tissue! When the blood has reached the large veins, a lot of the oxygen has been given up to the tasues. Blood in the large veins is referred to as mixed venous blood, and its PO, value falls to about 40 mmHg. This mixed venous blood has an oxygen saturation of about 75% and therefore a blood oxygen content of about 16 mL/dL. Under this condition, blood releases about 4 mL of oxygen for each 100 mL of blood flow to the tissues.

10. What other factors determine the oxygen content of the blood? pH. PCo₂, temperature, and the concentration of 2.3-diphosphoglycerate (2.3-DPG) may cause a shift in the oxygen hemoglobin dissociation curve and cause the additional

of oxygen from hemoglobin. Decreased pH, increased PCo, increased temperaof oxygen normal and an arightward shift of the oxyhemoglobin dissociation in a shift allows more oxygen to be unloaded at the level of the tissue. On the latest a shift allows more oxygen to be unloaded at the level of the tissue. reliable increased 2... reliable to the unloaded at the level of the issues. Conversely, the net which allows more or a surface of the ussues. Conversely, the curve to the left, which aids in oxygen delivery to fetal receive of the ussues.

IL How do white blood cells contribute to the properties of blood? How do white Blood cells represent only a small portion of the cells in the blood, they may
Although white blood relist of the blood to flow through the vessels because the ability of the blood to flow through the vessels because the same than the blood. Atheugh white cross a contract of the blood to flow through the vessels. Because white cells are have given differ and because under some conditions they may view to. have a great effect us us. The same and the same conditions they may stick to the venular endothers the blood cells can contribute dramatically to the resistance of the conditions they have the same blood cells can contribute dramatically to the resistance of the conditions they have been same of the conditions the conditions they have been same of the conditions there is have large and stift, and occurrently an action and contribute dramatically to the resistance of blood flow. Although at clist we will be blood cells can contribute of armatically to the resistance of blood flow. Although at clist. I conditions the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of white cells to the viscosity of the contribution of the contribution of white cells to the viscosity of the contribution of the contribut white blood cents and contribution of white cells to the viscosity of the blood is walthough the contribution of white cells to the viscosity of the blood is small, unsight reference when white cell counts become high, this effect may be dream to the blood is small, unsight reference. user normal continuous when white cell counts become high, this effect may be dramatic and may cause droubilitions when writer resistance. large increases in vascular resistance.

12. How much do the red blood cells affect the viscosity of the blood?

How much do the real which the hematocrit is about 40%, the contribution of red blood ligher normal conditions in which the hematocrit is about 40%, the contribution of red blood Under normal consultation of red blood under the viscosity of blood is relatively small. A rise in the hematocrit ratio from 40% to 70%, reds to the viscosity of blood hemia, can increase the viscosity normal and the viscosity of blood hemia. edis to the viscosity or observations, can increase the viscosity more than twofold, with direct ef-edich may occur in polycythemia, can increase the viscosity more than twofold, with direct efshich may occur in proye-, such may occur in gastial effect on the arterial blood pressure.

13. What is the difference between viscosity and shear stress?

What is the unifer the work of as the thickness of the blood or the difficulty in forcing it to flow Viscosity may be thought of as the thickness of the blood or the difficulty in forcing it to flow Viscosty may be about it composed of a suspension of formed elements and plasma, the group a tube. Because blood is composed of a suspension of formed elements and plasma, the drough a tipe. Decay writes as a function of the hematocrit. Increasing hematocrit causes an inviscosity of use used the local state of the local cress in 1986-014.

That means the street at 1986-1984 the same amount of blood through that stort 4.2.5 times greater pressure drop is required to drive the same amount of blood through that stort 4.2.5 times greater pressure. a given tube as it would for water.

well more as a mount for that the blood exerts on the vessel wall as it flows. The greater the neer blood flow in a vessel, the greater the force on the vessel wall, or the shear force. This shear next through the cause it is the force sensed by endothelial cells that line the blood vessel. It force is important because it is the force sensed by endothelial cells that line the blood vessel. It las ben suggested that shear sensitivity is a major mechanism by which endothelial cells sense the representation and after such functions as permeability of the vascular wall and biosynthetic activity of endothelial cells.

14. What is a blood type? Blood type refers to the presence of antigens on the surface of red blood cells. Hundreds of such antigens have been found in human blood cells, but most of them are weak. Two antigtts-type A and type B - occur on the surfaces of red blood cells and are those commonly measured in blood typing. Another antigen, the type D Rh antigen, is the basis for most Rhipping. A person who has the D antigen is said to be Rh positive, whereas a person who tes not have the D antigen is said to be Rh negative. There are antibodies in the plasma that can utract with the antigens on the red cells to cause agglutination. Because of this, the antipass are referred to as agglutinogens, and the antibodies are referred to as agglutinins. In menal, transfesions are made with the same type of donor blood as that of the recipient. Bower, type O blood has no agglutinogens to be agglutinated, and therefore type O to be given to any recipient. Type O is called the universal donor blood. Conversely, type AB individuals have no agglutinins in their plasma; therefore type AB plasma is referred to a universal plasma, and type AB subjects are called universal recipients. The agglutropics against and type AB subjects are called universal recipients are shown before, against and percent of the population that have each blood type are shown

The state of the s				
***************************************	AGGLUTINOGEN	AGGLUTININ	RH ANTIGEN	PERC
A positive A positive B positive B positive O positive AB positive AB positive AB positive	A B B B nounc toute A and B A and B	anti B senti B senti B anti A senti A senti A and B senti A send B none none	present absent present absent present absent present absent	PERCENT IN PORTULATION 36.0 6.0 8.5 1.5 37.0 7.0 3.4 1.0

15. How does blood clot?

How does blood clot?

An injury to a vessel disrupts the endothelium and results in exposure of connective is an injury to a vessel disrupts the endothelium and results in exposure of connective is an injury to a vessel disrupt in the contractive is an injury to a vessel disrupt in the contractive is an injury to a vessel disrupt in the contractive is an injury to a vessel disrupt in the contractive is an injury to a vessel disrupt in the contractive in the contractive is an injury to a vessel disrupt in the contractive is an injury to a vessel disrupt in the contractive is a contractive in the 15. How more several disrupts the endouncement and research in exposure of connective and an injury to a vessel disrupts the endouncement and research where they adhere and the research including collagen. Platelets are attracted to the collagen, where they adhere and the research including collagen. Platelets are attracted to the collagen, where they adhere and the research including adherent and the research in the research sue, including collagen. Plateiers are must sue, including collagen. Plateiers and are us, gered to release adenosine diphosphate (ADP) and a prostaglandin, thromboxane A gered to release adenosine diphosphate (ADP) and a prostaglandin, thromboxane A legister and cause the adhered platelets to become "stiple, A legister and cause the adhered platelets to become "stiple, A legister and cause the adhered platelets to become "stiple, A legister and the stiple and a prostaglandin, thromboxane A legister and the stiple and a prostaglandin, thromboxane A legister and the stiple and a prostaglandin, thromboxane A legister and the stiple and a prostaglandin, thromboxane A legister and the stiple and a prostaglandin, thromboxane A legister and the stiple and gered to release adenosine uphrased and cause the adhered platelets to become "sticky" gerea or a substances attract more platelets and cause of the substances attract more platelets and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. If the injury is small, his hap platelets adhere to the old ones and a platelet plug is formed. platelets adhere to the old ones and a piece-with a larger injury, a clot may be needed. Also may be sufficient to stop bleeding. However, with a larger injury, a clot may be needed. Also may be sufficient to stop bleeding. However, with a larger injury, a clot may be needed. Also may be sufficient to stop bleeding. Towards may be needed. Acquired may be needed. Acquired may be needed. Acquired may be needed acquired may be needed acquired may be needed acquired from a cascade of activation of third needed acquired from the needed acquired from th results from a cascade of activation of the conversion of prothrombin (plasma process) to plasma. The final steps of the cascade are conversion of prothrombin (plasma process) to plasma. The final steps of factor X in the presence of calcium. Thrombin conversion of prothrombin conversion of factor X in the presence of calcium. plasma. The final steps of the cuseauc control of calcium. Thrombin converts fibring thrombin by activation of factor X in the presence of calcium. Thrombin converts fibring thrombin by activation of factor A in the policy and the strands). Strands of fibrin combine to fibrin (insoluble strands). Strands of fibrin combine to fibrin combine to fibrin combine to fibring the strands of the gen (soluble plasma protein) to turn (manufacture) and of the combine to form a network that traps red blood cells and platelets, producing a clot. Activation of factor X on a network that traps red blood cells and platelets. a network that traps red blood cent and process the activation of factor X can result from activation of either an intrinsic or extrinsic clotting pathway. The intrinsic pathway is blood, whereas the activation of either an intrinsic pathway. result from activation or enter all present in blood, whereas the extrinsic pathway includes way consists of factors that are all present in blood, whereas the extrinsic pathway includes way consists of factors that are all present in blood, whereas the extrinsic pathway includes the present in the present in the present in blood. way consists of factors that are an in product the intrinsic pathway includes release of tissue thromboplastin from damaged tissues. For the intrinsic pathway, exposure release of tissue thromboplastin factor XII which are release of tissue information and plasma protein called factor XII, which triggers a cascaling of plasma to configen activates a partial plant of factor X. For the extrinsic pathway, tissue activation of other factors leading to activation of factor X. For the extrinsic pathway, tissue activation of other factors reading thromboplastin serves as the initiating factor for the cascade of activation. Vitamin K is a new thromboplastin serves as the introduced for production of many clotting factors by the liver

16. What is hemophilia?

Hemophilia is an inherited genetic disorder that is linked to the X chromosome. Blood from hemophiliacs is slow to clot, due to delayed formation of fibrin. Hemophilia A results from a defective factor VIII, whereas hemophilia B results from a defective factor IX (Christmas factor).

17. How do anticoagulants work? Common anticoagulants are heparin and the coumarin derivatives warfarin (Coumain)

and dicumarol. Heparin prevents clotting by activating a plasma protein called antithrombin III. a serum protease inhibitor that prevents activation of needed serum proteases at several stees in the clotting cascade process. Coumarin derivatives are competitive inhibitors of vitamin K that prevent the vitamin-induced production of clotting factors by the liver. Dicumarol was the first anticoagulant that could be administered to humans orally. The successor to dicumarol was warfarin, which first became known after it was introduced as a rodenticide. Warfarin's effectiveness led to its widespread success, and it has become the most widely prescribed anticoagulant drug in the nation. Anticoagulants do not break up clots that already have formed in the vessels.

18. How does aspirin "thin" the blood?

Aspirin does not actually thin the blood, but it does interfere with the production of them boxane A₂, a platelet aggregator. Therefore, aspirin will decrease the ability of platelets to after to each other and form a platelet plug.

HEART _

18. What is the basic anatomy of the heart? Had is the basic anatomy or separate pumps: a right heart and a left heart. The right heart for comprises two separate pumps are right heart pumps the blood through the lungs, and the left heart pumps the blood through the man and the left is the way of the companies of the companie The leavest abrough the usuge, and use, see a result pumps the blood through the perity and the left, is composed of two pumps in series; one side blood the blood through the perity and the left, is composed of two pumps in series; one is the self-blood through the perity and the control of the attitum is primarily to move the self-blood through sides that the perity of the per the period of the heart, the rights are one text, to composed of two pumps is series; one is the period of the heart control of the arrival is primarily to move the returning spin and the ventricle to propel the blood through either the pulmonary or the returning spin and in the period of the pe See Substitute of the cheer is the ventrue. The top of the autum is primarily to move the returning and the other rishes to propel the blood through either the pulmonary or the systemic state of the cheer with the cheer of the runs us " and be ventrale as proper the section around either the pulmonary or the systemic sections into the ventrales mission mechanisms within the heart provide the rhythmicity of the cardiac muscle straight intrinsic mechanisms bearing. to cause the heart's constant beating.

M Wast are the major types of cardiac muscle?

• Arrial muscle

Ventrealer manue.
 Ventrealer manue.

11 How do cardiac muscles contract?

Hor do tardine muscle muscle is similar to that of skeletal muscle, ex-Connection of airras and

Connection of the contraction is much longer and that some of the calcium that particular that the duration of the contraction carrying ion during denolarization. of that the duration on the calcium that partic-off that the duration enters as a current-carrying ion during depolarization. The conductive fibers gues in contraction emosts significantly; however, they provide pathways for the electrical acti-side bear do not contract significantly; however, they provide pathways for the electrical actiusion to spread throughout the heart.

2. What is responsible for the spontaneous rhythmic excitation of the heart?

What is responsive to the neart?

What is responsive to the contractile and electrical generating cells in the heart are capable of spon
Virtually all of the contractile and electrical generating cells in the heart are capable of spon-Virtally all of the constant of the sinoatrial (SA) node, which is located in the sunames extraording will of the right atrium, have the highest rate of spontaneous activation. These cells descripte the intrinsic heart rate.

23. What is the mechanism of the sinus node rhythmicity? Wise to the increasing inward current of Pacensker activity of cells of the SA node is due to a slowly increasing inward current of

recursed which slowly depolarizes the cells. This slow depolarization takes the cells from a restis generalized potential of only about -55 mV to a threshold potential of -40 mV, at which point one channels become activated. This leads to a rapid entry of both calcium and sodium ions. cassing an action potential. Repolarization occurs when the sodium channels become inactivated and potassium channels open.

14. How is the cardiac action potential transmitted throughout the heart? The electrical discharge from the SA node travels outward from the node and across the atrial

muscle mass at a velocity of about 0.3 m/s. Because the ventricles are electrically isolated from the arm, the depolarization from atrium to ventricle must travel through a specialized conductive nuz. This pathway is known as the atrioventricular (AV) node and is located in the posterior equal wall immediately behind the tricuspid valve. Transmission of the electrical impulse through & AV sode occurs only in one direction from the atrium to the ventricle and introduces a delay of apprecinately 100 ms, which allows time for the ventricles to fill after atrial contraction. Once to depolarization passes through the AV node and into the ventricles, it is carried by a specialand conductive system known as the Purkinje fibers. These fibers carry the depolarization and the ventricle, resulting in a uniform contraction of ventricular muscle.

E. How is the rhythmicity of the heart controlled?

The heart is supplied with both sympathetic and parasympathetic nerves. The parasympathetic nerves. The parasympathetic nerves. bee, arret, which run in the vagus, are distributed mainly to the SA node and the AV node. The separete serves are distributed throughout the heart.

Stimulation of parasympathetic nerves to the heart decreases the rate of depolarization of parasympathetic nerves to the heart decreases the rate of depolarization across the AV node. Parasympathetic nerves to the rate of depolarization of the rate of decreases th Simulation of parasympathetic nerves to us. A mode, Parasymputer use of department of the condition across the AV node, Parasymputer use of department of the condition of the c Semination of passes, mode and down the med conduction across the conductance, which shows the rate of a coloratrasses medicance, which shows the rate of a coloratrasses medicance an increase in potassium conductance, which shows the rate of a coloratrasses of the conductance and the conductance of the conductance o

node and dayors the reason and a constraint of the constraint of t nerose in potassum.

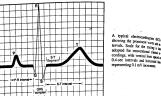
The constraint of the nodal cells. These enumges a common potentials of a three potation of a three potations of a three potations of a fining of the SA node, reducing the delay across the role of the SA node, reducing the delay across the role of the same of t an insembrane potential of usmembrane potential of usSympathetic stimulation causes the opposite creates an insent rate py increasing and
Sympathetic stimulation of the SA node, reducing the delay across the AV note that the sense rate of fine photostrates at minimum of the sense of the sense of contraction of cardiac muscle. Sympathetic stimulation produces as the sense of the sense of contraction of cardiac muscle shows the rate of depolarization and ratios the sense of the s neous rate on mine-force of contraction of cardiac muscle. Sympathy of the products and inches conductance, which increases the rate of depolarization and raises the resing the conductance, which increases the rate of depolarization of a faster heart rate.

26. What is an electrocardiogram (ECG)?

What is an electrocarding and the electrical activation of the heart. It represents a transfer and the electrical activation of the heart. It represents a transfer and the electrical activation of the heart. It represents a transfer and the electrical activation of the heart. It represents a transfer and the electrical activation of the heart. It represents a transfer and the electrical activation of the heart. It represents a transfer activation of the heart. 26. What is a management of the electrical activation in the EGG is a record of the electrical activation for the EGG is a record of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As this wave of excitation properties are action potentials of the individual cardiac cells. As the properties are action potentials of the individual cardiac cells. As the properties are action properties are action properties. The ECU is a security of the individual cardiac cets. As this mark to excitation proposed back action potentials of the individual cardiac cets. As this mark to excitation proposed back action proposed back as the propo action potentians of the properties of the prope heart, the area unso. This makes the heart a dipore, or an execution against consisting of the payet depolarized. This makes the heart a dipore, or an execution against a dipore of the payet depolarized activity generated by the same conductor, which allows the electrical activity generated by the heart is a conductor, which allows the learning depolarized currents are conductor. yet depolarate.

An analysis with the decirical charge. Due to use tools and the property generated by the kind is decired as a volume conductor, which allows the electrical current generated by the kind is decired as a volume conductor, which allows the electrical current generated by the kind is decired to the property of the prop cally distributed to the surface of the body. This permits the electrical current generated by the beautiful duted to the surface of the body. This permits the electrical current generated by the beautiful duted to the surface of the body. The ECG THE EC acts as a vertice of the body. This permiss are consistent of the ECG. The ECG appearance of the ECG. The ECG appearance recorded on surface electrodes, resulting in recording of the ECG. The ECG appearance of depolarization-reporting to ducted on the Error resulting in recording to the ECG representation recorded on surface electrodes, resulting in recorded on surface electrodes, resulting in recording to the ECG representation repolation to the characterized pattern of activity produced by the sequence of depolarization repolation to the characterized pattern of activity produced by the sequence of depolarization repolation to the characterized pattern of activity produced by the sequence of depolarization repolation to the characterized pattern of activity produced by the sequence of depolarization repolation to the characterized pattern of activity produced by the sequence of depolarization repolation to the characterized pattern of activity produced by the sequence of depolarization repolation to the characterized pattern of activity produced by the sequence of depolarization repolation repolation to the characterized pattern of activity produced by the sequence of depolarization repolation re

- P-wave, which represents atrial depolarization (80-100 ms)
- ORS complex, which represents ventricular depolarization (60-100 ms)
- T-wave, which represents ventricular repolarization (100-250 ms)



showing the prominent waves and a tervals. Scale for the tracing is to adopted for conventional clinical a cordings, with vertical lines special 0.4-sec intervals and horizonal inrepresenting 0.1 mV increment

Heart rate is often estimated by the R-R Interval, or the time that occurs between the kwaves of sequential beats in the ECG. The R-wave is selected because it is one of the most subing features of the ECG. The appearance of the ECG is greatly influenced by the positions of the leads on the surface of the body, and thus twelve conventional arrangements have been adopted to standardize the lead arrangements.

- Three standard limb leads, which are bipolar recordings because they display the difference of the control of the ence in electrical activity between two different points on the body:
 - Lead I Electrodes on the right arm and left arm Lead II - Electrodes on the right arm and left leg Lead III - Electrodes on the left arm and left leg

170 augmented limb leads, which are unipolar recordings because they record volumes are point on the body relative to an indifferent reference point; There augmentes the body relative to an indifferent reference point; of point on the body relative to an indifferent reference point; of plectrode on right arm ouy reason right arm

AVI Electrode on left arm AVF-Electrode on left leg

AVE. Electrode us which are unipolar recordings in which the active electrode is placed as positions in an are pattern on the chest around the heart, Marting at the conditions of its positions. Ave see of six positions in an are pattern on the chest around the heart, starting at V₁ located to the right of the sternum, and ending at V₂ located SNP of six positions in the place just to the right of the sternum, and ending at V₁ located in the sternum, and ending at V₂ located in the sternum and ending at V₃ located in the sternum and ending at V₄ located in is the fourth state of the left midaxillary line the fifth intercostal space at the left midaxillary line

If what is the structure of cardiac muscle? what is the structure of the skeletal muscle in that the cardiac muscle fibers are arranged like confidence of the skeletal muscle in that the cardiac muscle fibers are arranged like confidence of the skeletal muscle in that the cardiac muscle fibers are arranged like It was muscle ditters from secretar muscle in mat the cardiac muscle fibers are arranged like Cardis. The fibers divide then recombine to form what is known as a syncytium. Similar to secretary of muscle is striated and contains typical myofibrits muscle is striated and contains typical myofibrits muscle. Cash. The fiber civiles used recomments to rornt what is known as a syncytium. Similar to proposed suck, cardiac muscle is striated and contains typical myofibrils made up of actin and sixtual minerals. myosa filaments. Had is the significance of the syncytial nature of cardiac muscle?

Had is the significance of view, the syncytial nature of cardiac muscle?

Wast is the signarcane.

Wast is the signarcane of view, the syncytial nature of cardiac muscle?

The signarcane potentials so that when one cardiac cell become 1. Proma functional point or view, and syndy that nature of cardiac muscle provides easy move-form a function potentials so that when one cardiac cell becomes excited, the action po-cell of fundamental to all the adjoining cells, moving from one cell to another through the or crafting action potentials so that which one cartilac cell becomes excited, the action popular crafting to all the adjoining cells, moving from one cell to another throughout the entire trial areas to the control of the areas syncytium and the ventricular syncytium are actually control. gett words to all the aujouring cens, incoming from one cell to another throughout the entire until spreytium and the ventricular syncytium are actually separated from the control of fibrost tissue around the valvular openings. Normally action as parated from the arran syncytom and the ventricular syncytium are actually sparated from both from the arran syncytom and the valvular openings. Normally, action potentials are not only in form the arrain into the ventricle except through the Purkinis system. of by a ring of abrous usous arounts are very unar openings. Normally, action poor to the ventricle except through the Purkinje system, conducted from the atrium into the ventricle except through the Purkinje system.

3. What is the nature of the cardiac action potential? What is the nature of the cardiac action potential represents a depolarization from the Strike to Skeletal muscle, the cardiac action potential represents a depolarization from the Similar to strictar museum and an approximate represents a depolarization from the raing numbrane potentials.

The most important feature of the cardiac action potential is a long plateau phase and 105 mV. The most important feature of the cardiac action potential is a long plateau phase and 105 mV. The most important feature of the cardiac filling. and 100 ms, which provides time for cardiac filling.

31. What is the refractory period of cardiac muscle? Wall is use seemed during which normal cardiac impulses cannot reexcite an area of cardiac the interval of time during which normal cardiac impulses cannot reexcite an area of cardiac the interval of time during which normal cardiac impulses cannot reexcite an area of cardiac the interval of time during which normal cardiac impulses cannot reexcite an area of cardiac impulses. The nurvau of the left ventricle is about 250 ms. This period of the left ventricle is about 250 ms. This period is imporgack. The manual state that the wave of electrical activation passes in an organized fashion to caragricance is easiered the individual muscle cells of each chamber to contract almost as a single or news, and a syncytium." This produces an efficient contraction to eject blood. If dam-BEACH IS A SECOND TO PRODUCE THE SECOND TO SECOND TO SECOND TO SEC groups of the failure), conduction may follow an abnormal pathway, and the refractory periods of the mast cells may no longer line up with respect to time. The wave of depolarization may then right ness of the heart out of synchrony, leading to inefficient contractions or even arrhythmias.

31. What are the phases of the cardiac contraction?

- Systole—the period during which cardiac contraction occurs
 - · Dissole-the period during which relaxation and filling occur

32. During what phase of cardiac contraction is the volume in the heart the greatest? The cardiac chambers fill during diastole; therefore, volume of the heart is at a peak at the

end of diastole.

31. Why is the left ventricular wall so much thicker than the right ventricular wall? The mixtuess of the walls of the cardiac chambers is indicative of the work that they must to part the walls of the cardiac chambers is indicative or the work and circulation. The pressure in the systemic circulations. The pressure in the systemic circulations. supplicantly higher than that of the pulmonary circulation, although the blood flow through both 70

Circulations is equal. Thus, the left ventricle needs a larger muscle mass to overcome the circulation.

Circulations is equal. Thus, the left ventricle needs a larger muscle mass to overcome the left ventricle in the systemic circulation.

34. What are the pressures in all of the chambers of the heart?

what are the pressures in all of the channoes that serves to absorb the blood at a what are the pressures in a highly compliant chamber that serves to absorb the blood at a three right atrium to a highly compliant chamber that the pressure within the right atrium does not cut under the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the pressure within the right atrium does not consider the righ 34. What are the pressure is a highly compliant craumors under the blood of the pressure of the high degree of compliant. The right artism does not return to the heart. Because of its high degree of compliant from the systemic circulation to return to the heart of the right artism does not compliant from the systemic circulation to return the systemic circulation to return the right artism does not consider the systemic circulation to return the right artism does not consider the right artism does not 4. Winam. The right arrium is a more than the region of the right arrium does not change from the systemic circulation to return to the new minim the right arrium does not change flush to from the systemic circulation, the pressure minimal to the results of the control of the results of the control of the results of the control of the results of from the systemic circumserion, the pressure within the systemic circumserion of the pressure within the systemic circumserion of the weakness of its contraction, the pressure rises from approximately 0 to about 6 mmHg with a mean of the weakness of its contraction of the systemic chamber fills, pressure rises from approximately 0 to about 6 mmHg.

months fills, pressure user fills, pressure the fills pressure in the pulmonary artery, has higher play 4 mmHg. The right ventricle, which pumps the blood into the pulmonary artery, has higher play 4 mmHg diastolic to 25 mmHg diastolic to 2 mately 4 mmHs.

The right ventricle, which pumps the moon into our pounts are yet a higher remaining a right ventricle, which pumps the moon in the pulmose remaining from mmHg diastole to 25 mmHg systolic pressure. Pressures in the pulmose remaining from mmHg diastole to approximately 28 mmHg at the pumps approximately 4 mmHg during diastole to approximately 4 mmHg at the pumps approximately 4 mmHg during diastole to approximately 4 mmHg at the pumps approximately 4 mmHg during diastole to approximately 4 mmHg at the pumps approximately 4 mmHg during diastole to approximately 4 mmHg at the pumps approximately 4 mmHg during diastole to approximately 4 mmHg at the pumps approxima

The right venue of the pulmanage of the Form approximations of form approximation of the first atrium. Similar to be golden of a proximation of a pr

systole.

Blood returning from the pulmousey to the Blood returning from the pulmousey is small with a mean pressure of approximately 8 to the atrium, the left atrial pulse pressure is small with a mean pressure of approximately 8 to the atrium, the left atrial pulse pressure is made atrium. Blood returning must be pressure is summer the left ventricle. The left ventricle pumps the bird atrial pulse pressure is a training blood leaves the left atrium and enters the left ventricle pumps the bird in Blood leaves the left atrium and enters the left ventricle pumps the bird in the left ventricle pumps the left ventricle pumps the bird in the left ventricle pumps arrium, the text and the systemic circulation; therefore, pressures in the left ventricle rage in the agrand the rest of the systemic circulation; therefore, pressures in the left ventricle rage in the agrand the rest of the systemic peak of systole to approximately 8 mmHg during the peak of systole to approxim ground the rest of the systemic curcumstance of approximately 8 mm ent vernice mag to the acrts and the rest of the systemic for approximately 125 mmHg during the peak of systole to approximately 125 mmHg during dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve to approximately 120 mmHg systolic to 80 mmHg dissolve the acra and approximately 125 mmHg during the pean of the pean of

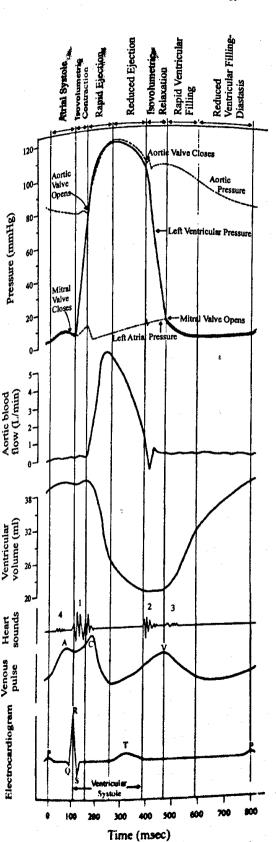
35. What are the functions of the valves of the hear? What are the functions of the values are the arria from the ventricles (AV valves) and the valves (av valves) and the ventricles (av valves) and the ventricles (av valves) and the valves (av valves) The valves in the heart separate the and relatives) into which they pump. The valves on the chambers from the circulations (semilunar valves) into which they pump. The valves on the left of the left chambers from the circulations (seminanary semilunar valve. Those on the left side at side are the tricuspid valve and the pulmonary semilunar valve. Because the valves one and partic semilunar value. Because the valves one side are the tricuspid valve and aortic semilunar value. Because the valves open only in one of mitral (bicuspid) valve and aortic semilunar value. Because the valves open only in one of mitral (bicuspid) valve and aortic semilunar value. mitral (bicuspid) valve and atoric seminary in the heart during contraction. Valve defects rection, they force the blood to be propelled out of the heart during contraction. Valve defects rection, they force the blood to be please reflux of blood from the circulation back into the heart of fan damage to the valves may cause return the free of the open chamber to another, resulting in inefficient delivery of blood from the heart to the circulate, one chamber to another, resulting in inefficient delivery of blood from the heart to the circulate. one champer to another, to the leaking valve may be heard as a heart murmur.

36. What are the functions of the papillary muscles?

What are the functions of the papillary muscles, which arise from the inner wall of the ventricle, are connected to a The papillary muscles, muscles, the chord at tendinae. During cardiac contact valve leaflets via tendinous structures known as the chordae tendinae. During cardiac contact valve reamers via renumbus substance contraction of the papillary muscles helps to mintains moner positions of the valve leaflets and prevent the valves from inverting at higher pressus.

37. What are the key features of the cardiac cycle?**

The events of the cardiac cycle are summarized in the accompanying figure for the left side of the heart (see figure, next page). Similar events occur for the right side of the heart, but the ressure are all reduced accordingly. One cardiac cycle refers to the period comprising the beginning of one heart beat through the beginning of the next heart beat. The cardiac cycle is initiated by the spotsneous generation of an action potential in the SA node. This action potential spreads across but atria resulting in atrial contraction and a rise in atrial pressure (atrial systole). This increase is atrial pressure ejects blood into the left ventricle. As the depolarization spreads through the AV bank into the ventricles, the ventricles contract with a delay of approximately 100 ms after the smalce traction. Ventricular pressure increases, resulting in closure of the mitral valve and a period of the volumetric contraction, when the ventricular muscle begins to contract but both valves are closed Ventricular contraction results in a rise in pressure within the ventricular chamber and when we tricular pressure exceeds aortic pressure, the aortic valve opens and ejection of the blood into the aoria occurs (rapid followed by slower ejection). After ejection, the cardiac muscle begins to real and pressure drops, allowing the aortic valve to close (isovolumetric relaxation). When pressure within the ventricle falls below that of atrial pressure, the mitral valve opens and ventricals files begins (rapid followed by slower ventricular filling), preparing the heart for the next beat.



Ventricular

Heart

Depiction of the events of the cardiac cycle demonstrating the relationships between the electrical and mechanical events. The upper panel shows the left atrial, left ventricular, and aortic pressures. Note that left ventricular and aortic pressure are equal to each other only during the ejection phase when the aortic valve is open. The aortic blood Now tracing in the second panel illustrates the pulsatile nature of cardiac output and shows that, for the majority of the cardiac cycle, blood flow leaving the heart is zero. Finally, as can be seen by comparing the electrocardiogram in the lower panel with the volume tracing above, changes in electrical activity precede mechanical changes in the

heart that lead to contraction.

38. How much of the oxygen required for cardiac contraction comes directly and as opposed to from the coronary circulation? How much of the experiments of the coronary community reliciate and self ventricle are carrying highly oxygenated. Although the left arium and left ventricle are carrying highly oxygenated when the control of the oxygen required for the cardiac countricling displayed to the cardiac countricling and the ca Although the left arrium and left ventrues are onlying rightly systemated by Although the left arrium and left ventrues are onlying rightly systemated by Although the left arrium and left ventrues, which is a complete on the left of the carried by Although the left of the carried by Although the Carried State of the Carrie Nationally the left atrium Although the left atrium anousts, virtually note of the oxygen required for the cantine contraction deals body amounts, virtually note of the oxygen required to the carried so that the vertice for similar to other tissues, the heart has a complete contraction of the virtual of the vertice of the virtual of t amounts, vistaally noneamounts, vistaally nonewall of the vestricles Similar to other tissues, use uses, use a complete circulation. As in other vascular bods, coronary vestric branch, as in other vascular bods, coronary
coronary circulation. As in other vascular bods, coronary
where oxygen exchange occurs. Complete biolocation, to other bods, to other
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coronary circulation. As in other vascular occos, coronary versuels branch, diffuse of coronary circulation. As in other vascular occurs. Complete blockage of coronary business, and therefore ultimately to die, leading to a capillaries where oxygen exchange occurs. On the coronary versues of coronary versues of coronary versues of coronary versues. coronary circums.

coronary circums.

coronary c

39. Explain Starling's law of the heart.

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Explain Starting's law of the hearts.

The Frank-Starting mechanism, or Starting's law of the heart, describe the interaction of the form of the frank-Starting mechanism, or Starting's law of the heart to changes in the amount of blood returned to it by the the form of the frank of the frank of the form of the frank The Francesco-tion of the heart to adapt to changes in the amount of non-continuous or at of the system of the heart to adapt to changes in the principle that as cardiac muscle is specified on the Starling mechanism operates on the principle that as cardiac muscle is specified on the Starling mechanism operates on the starling mechanism of the specified of the Starling mechanism operates on the starling mechanism of the specified of the starling mechanism of the specified of the starling mechanism operates on the starling mechanism of the specified of the starling mechanism operates on the specified of the specified of the starling mechanism operates on the specified of t of the heart to ways.

The Surling mechanism operates on the principle uses as valence, trained is stretched, should be sufficiently as the surface of the surface and the surface of the contract is augmented. Thus, when an extra amount of social returns into the ventrice, a chambers are stretched, resulting in a more vigorous contraction that propels the entrice, a chambers are stretched, resulting in a more vigorous contraction that propels the entrice consists the chambers are stretched, resulting in a more vigorous contraction that propels the entrice consists the chambers are stretched, resulting in a more vigorous contraction that propels the entrice contraction th contract is augument.

Authority are streethed, resulting in a more vigovous contraction, man propen the event when the cardiac coupt a few the heart. This relationship between the filling of the heart and the cardiac coupts are the heart. This relationship between the filling of the heart ardiac coupts in a graph referred to a second of the cardiac coupts in a graph referred to a second of the cardiac coupts in a graph referred to a second of the cardiac coupts in the second of the cardiac coupts in the second of the cardiac coupts in the card chambers are su-chambers are su-the heart. This relationship between the filling or use 1000 at all use caronac output is designed fied by graphing filling pressure or preload against cardiac output in a graph referred to a se-fied by graphing filling pressure or preload against cardiac output in a graph referred to a se-tion of the supplementation of the suppl the heart, was seeing filing pressure or preload against causes. Suppose in a graph referred to a beautiful disast function curve. The mechanism ensures that both ventricles pump the same who is be to disast function curve. The mechanism ensures that both ventricles pump the same with its beautiful disast function curve. The mechanism ensures that both ventricles pump the same with its beautiful disast function.

40. Clarify the distinction between preload and afterloads

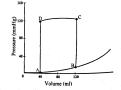
Clarify the distinction between pressure attractions and acceptance during dissole. Perload refers to the pressure or stretch of the cardiac chambers during dissole. The pressure of the heart prior to contraction. Increases in preload cause more described by the pressure of the pressur Preload refers to the pressure or success or an account of an auring diasole. The preload is the load on the heart prior to contraction. Increases in preload cause more vigoration to the beauty of the preload cause more vigoration.

contractions by the Frank-Statung measurement.

Afterload is the pressure or resistance into which the heart pumps. Thus, afterload is the pressure or resistance into which the heart pumps. Thus, afterload is the pressure or resistance into which the heart pumps. Afterload is the pressure or research to eject blood. We often refer to the artiful or a relation of the load the heart must overcome to eject blood. We often refer to the artiful or at the respective to the respective to the artiful or at the respective to the re monary pressure as the afterload for the left and right ventricles, respectively, 41. Is the preload for the right ventricle equal to the preload for the left ventricle? Is the precoad not the right heart is matched; that is, it is equal Their

Carolac output from some defeated filling pressure because left weatricular afteriority heart operates at a significantly elevated filling pressure because left weatricular afteriority. Beart operates at a signature of the state o

42. What is a pressure volume loop? The pressure volume loop charts the changes in ventricular pressure and volume throughout one beat of the cardiac cycle. The element of time is not considered in a pressure volume is As shown in the accompanying figure of the left ventricle, one loop represents one bear



grigated a point A and processing in a commerciockwise direction around the loop, we grigated already the phase in which the left ventricle is filling without a large rise in present the filling phase.

"This is the "A married begins to contract, which leads " — " and and an ore phase in w

and the second s This is the left ventricle begins to contact, which leads to mitral valve closure; how, the left ventral wave closure; how, and the left ventral between B and C is the isovoluoff and the left ventral between B and C is the isovoluoff contraction phase.

the second phase, and the second phase is a second phase of the second phase is a second phase in the second phase is pumped from the ventricle into the aorta. The new particular second phase is pumped from the ventricle into the aorta. The new particular second phase is the ejection phase. purity comments the sortic valve opens an authorizing pressure has been generated to overcome purity of the sortic valve opens and blood is pumped from the ventricle into the aorta. The period of time state of the point of the ventral purity of the point of the ventral pressure has been been to relax, and the many serie pressure, and autous is pumped from the variet point C to point D is the ejection phase, from point D is the ejection phase.

sets Ps. Copoint I) is the executor primer in the period of time from 500 the vertical has begun to relax, and the pressure rapidly falls, resulting in the sets of the active valve. The mittal valve remains closed until point A as the control of the active valve. The mittal valve remains closed until point A as the control of the active valve. son pour the ventricle has organ to teras, and the pressure rapidly falls, resulting in the Affair D the active valve. The mitral valve remains closed until point A, at which point district the active exceeds ventricular pressure and the valve opens to permit 6111. A print of the actic valve. The mutan varve remains closed until point A, at which point down of the actic valve opens to permit filling. Thus, at many point of pressure seconds ventricular pressure and the valve opens to permit filling. Thus, at many point of pressure according to the property of the dismit pressure excess ventratural pressure and the valve opens to he mainly pressure and the valve opens to he mainly pressure and the valve opens to he mainly pressure B.C and C.D represent systole, whereas the se-

kh first D and A is the Estimated the retaxation phase.

Thus, the phase between D and A is the Estimated the Regiments D-A and A-B represent the segments D-A and A-B represent the segments.

a pit the work of the heart in perspective. put the work of the near support 2.5 ounces of blood on every beat. Each day it pumps at least 2500 to blood. This amount of blood weight 2.000 L of blood. This amount of blood weight 2.000 8 PR September of the point and the point of The more and the searty 10,000 L or outcome. This amount of blood weights 20 tons. The average gloss which is early 10,000 L or outcome animate. Generally, the smaller the size of the heart, the faster the size of the heart, the faster the size of the searts in general beat six to eight times per minute more size. glas. 74.75 times a timum. Ownerany, the smaller the size of the heart, the faster the six leaf betts women's hearts in general beat six to eight times per minute more than men's beat six to be set this women's hearts in general beat six to eight times per minute more than men's beat six to eight times per minute more than men's beat six to eight times per minute more than men's

44. What is the medical term for a heart attack?

Myocardial infarction.

45. What is a beart attack?

What is a Bears assumed.

Some of the heart muscle cells die as a result of reduced blood flow through one of the main some of the heart muscle cells die as a result of reduced blood flow through one of the main some of the mai Some of the mean understanding and the retired of the damage. In the United States of arteriosclerosis). The outlook for a patient depends on the size and logger (den) because of the extent of the damage. In the United States greet (often occurred) and the extent of the damage. In the United States, 33% of patients who goto of the trockage and are controlled to the tockage and are controlled states, 35% of patients have hear attack die within 20 days. It is the leading cause of death in the United States.

46. What is cardiac contractility?

What is curvant to the performance of the heart at a given preload and aftarens commented and precisely as the change in peak isometric force at a given initial fiber test. Contractility is an index that measures the ability of the heart to pump blood. It should not legit contracting as an analysis measurement of the force of cardiac contraction because that depends te consecution and depending mechanism. There are several possible operational defimore of contractilists:

- 1. The slope of the cardiac function curve
- 2. The plateau level of the cardiac function curve The maximal rate of change of left ventricular pressure during systole (dp/dt___)
- Chically the ejection fraction is often used as a measure of contractility; however, no index s exirely satisfactory under all conditions.

ff. What is election fraction?"

The percentage of blood pumped by the heart on each beat. It is defined as the volume of lood ejected by one ventricle in one beat (stroke volume) divided by the total amount of blood with the ventricle prior to contraction (end-diastolic volume). A normal ejection fraction is about 60%.

4. What is the relationship among cardiac output, heart rate, and stroke volume?

· Cardiac output = stroke volume × heart rate

The stroke volume is determined primarily by the preload as defined by Sangal The stroke volume also increases until the stroke volume as preload increases, stroke volume also increases until the stroke volume as preload increases do sympathetic simulation as the stroke volume as t The stroke volume is determined primarily of the property of the stroke volume also increases until the stroke volume also can be increased by sympathetic stimulations of volume also can be operated by sympathetic and symp The stroke volume.

The stroke volume are stroke volumes are stroke volumes are stroke volumes also can be increased by sympathetic stringlishing to the stroke volume also can be increased by sympathetic stringlishing to the stroke volume also can be increased by sympathetic and sympathetic links to be a plateau. Stroke volume also can be stroke volume and the stroke volume are stroke volumes. The stroke volume are stroke volumes are stroke volumes are stroke volumes. The stroke volumes are stroke volumes are stroke volumes are stroke volumes. heart. That is, as present also can be increased by supermente stimulation to wish a plateau. Stroke volume also can be increased by parasympathetic and sympathetic influence of a plateau. Stroke volume in the plateau in the platea a plateau. Stroke vosaming plateau. Stroke vosaming in response to parasy in parasite in a sympathetic in five to the control of the control rate changes primary
rate changes primary
rate changes primary
rate changes primary
rate and cardiac output, the amount of blood ejected by one venty
rate can cause increases in cardiac output,

hatween heart rate and cardiac outputs

49. What is the relationship between heart rate and cardiac output?

What is the relationship between heart rate and continued output?

What is the relationship between heart rate increases, a When heart rate between the continued of the continu 49. What is the Learning traceses, causes observed an experiment near rate begins in largerial, as heart rate increases, cause to decrease significantly with increasing heart rate causes cardiac output to 8 heart rate. (> 50 bears/min), stroke volume with increasing heart rate causes cardiac output to 8 heart rate.

(> 50 bears/min), stroke volume with increasing heart rates is due to a date. See the second of the sec In general, as near the stock volume begins to occurate a general as near the stock volume with increasing heart rate causes cardiac output to begin in the cause with increasing heart rate is stock to do docrease in stroke volume with increasing the stock volume at high heart rates is due to a docrease in stroke volume at high heart rates is due to a docrease in stroke volume at high heart rates is due to a docrease in stroke volume at high heart rates is due to a docrease in stroke volume at high rate of the stroke volume at high rates of the stroke volume at high rate (> 150 personner of the color o decrease in succession in stroke volume. The reduction in the time available to the beat rates. The reduction in distole and thus a reduction in the time available to the beat spends in diastole and thus a reduction in the time available to the beat feet time the heart spends in diastole and thus a reduction rurve?

50. What is the use of the cardiac function curve?

What is the use of the cardiac function curve.

What is the use of the cardiac function curve.

Because cardiac output is proportional to stroke volume and end diamolic promote the cardiac path that tells us the pumping abolity of the cardiac function curve is a useful pressure, we can create a graph that tells us the pumping abolity of the cardiac function curve is a useful pressure, we can create a graph that tells us the pumping abolity of the cardiac function curve is a useful pressure. 50. What is use one of the support o portional to right atrial pressure, we can possible of the portional to right atrial pressure. This cardiac function curve is a useful tool that draw is a function of its filling pressure. the preload sensitivity of the heart in determining cardiac output.

51. How does the cardiac function change as contractility changes?

How does the cardiac function time.

Under normal conditions, the cardiac function curve may change both slope and the Under normal conditions, the cardiac function curve may change both slope and the University of the Universit Under normal conditions, the catonic in plateau level corresponds to an increase in slope or an increase in plateau level; an increase in slope or an increase of slope or a decrease in the plateau level. level; an increase in slope or an increase of slope or a decrease in the plateau level omnowed tility of the heart, whereas a decrease of slope or a decrease in the plateau level omnowed tility of the heart, whereas in the contractility also is a measure of the pumping tility of the heart, whereas a decrease of the pumping of the pump heart.

52. What is stroke work?

What is stroke work:

Stroke work is the amount of work done by the heart on each beat, proportional to he work is obtained to the stroke work is obtained to of the pressure volume loop. An approximation for stroke work is obtained by muliphings of the pressure volume toop. An applying on the higher the stroke volume times arterial pressure. The higher the pressure or the higher the stroke volume, the higher the pressure or the higher the stroke volume. the work done by the heart. Stroke work is also a function of preload because the stoke whe increases as preload increases. In fact, the amount of work done by the right and ich version differs not because the stroke volume differs, but because the load into which each water pumps is different. The right ventricle pumps into a low pressure in the pulmonary arter, and pumps is different. The right reaction pumps in a small amount of work, approximately 9 g-m. The left heart pumps into a significant higher load in the aorta; therefore, for the same stroke volume, its work is much greate, and imately 30 g-m. Thus, even though the output of a left heart and right heart is equal, strike and is much greater for the left heart because of the greater afterload.

53. If increases in preload increase cardiac output, what do increases in afteriord to uo diac output?

Both the left ventricle and the right ventricle are sensitive to changes in afterload homes afterload decreases stroke volume and therefore decreases cardiac output. Under confines which cardiac output is compromised, either by high afterload or by reductions in cariacise tion, one of the most effective means for increasing cardiac output is by using afterload rule tion. One interesting feature of the heart is that despite the fact that the right and left search are independently afterload-sensitive, the entire heart-lung compartment is remarkably r to reductions in stroke volume caused by increases in arterial pressure. It is resistant bears a sterial pressure. arterial pressure afterload is increased for the left ventricle, the right ventricle continues up blood through the pulmonary circulation, causing an increase in left ventricular probability of the compensation for the compensation f a compensation for the increase in left ventricular afterload. This compensation reads a supplication of the blood of the malization of the blood flow through the heart.

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Me and the mechanical properties of the heart change as it goes from the mechanical properties of the heart is in a relaxed state, its compliance is large, making it easy the mechanic who blood. As systole beginn, the cardiac muscle shortens, but it also make the mechanic and a stiffening of the heart recurrence. But it also make the mechanic and a stiffening of the heart recurrence and the mechanic and a stiffening of the heart recurrence. the state of the s the purish blood. As systome origins, the cardiac muscle shorters, but it also stiffens, and the purish stiffens are stiffens and the purish stiffens are stiffens and the purish the purish the purish stiffens are stiffens and the purish the p where the compliance and a suttening of the heart. This change in the mechanical many and the sufficient of the compliance in the mechanical control of the heart to fill with blood. Ejection of the blood, which occurs is a sufficient to the compliance is sufficient to the sufficient to the sufficient of the blood, which occurs is not sufficient to the sufficient of the blood, which occurs is not sufficient to the sufficient of the blood, which occurs is not sufficient of the series a robe that is important occause custotic filling is maximized when the mechanical of the filling is maximized when the compliance is series as easy for the heart to fill with blood. Ejection of the blood, which occurs in systole, the state of the blood is the blood of the blood which occurs in systole, the state of the heart shortens and stiffens.

Program it is easy for one neart to full with blood bight and it is easy for one neart shortens and stiffens, is grantinged as the heart shortens and stiffens, S. Art there conditions when the proportion of the heart do not though from diastole to

Are well after periods of ischemia in the heart, when significant damage occurs to yet amount in the period of ischemia in the heart, when significant damage occurs to gode: amediately arter person and uncert, when significant damage occurs to Yes model, the ischemic region may not change its mechanical properties. Under this con-tended moves into systole, the region that is ischemic remains highly con-Yes a missle, the ischemic regress may not change its mechanical properties. Under this con-yearing the heart moves into systole, the region that is ischemic remains highly compliant and the heart moves into systole the ventricle increases. Instantant and the pressure in the ventricle increases. be defined by the start moves into a parone, and to good uses its ischemic remains highly compliant and the forming an aneurysm as the pressure in the ventricle increases. Instead of moving any leg out. The forming an aneurysm which is the pressure in the saneurysm. During diastole. The saneurysm which is the saneurysm garde out, forming an analysis of the heart Africa can result in a reduced careful in a reduced careful in the short of the heart Africa can result in a reduced careful in a red

entry and the gradic outflow users, so the cardiac muscle can result in a reduced cardiac output as bed in a reduced cardiac output as bed in a reduced cardiac output as bed in a reduced cardiac output as of the best of the heart. This congrue of the heart. After some time goes by, that region of the wall of the heart. After some time goes by, that region of the wall and the presented damage to the wall of the heart. After some time goes by, that region of the wall wall as presented the presented best possible dimage to the state of the wall of the state of the wall spokes which has a much decreased compliance (i.e., an increased stiffness), and even stiffness of the wall may not contract, it no longer bulges. and form a SCAL, weather the name of the wall may not contract, it no longer bulges, but but part of the wall may not contract, it no longer bulges,

of What a bear failure?

Made to its cardiac function that can be caused by a metabolic impairment in the heart, an Adulton is cardiac function that can be caused by a metabolic impairment in the heart, an A reduction in customs and a reduction in the heart, an appared millomation, elevated arterial or pulmonary pressure, or cardiac ischemia. Heart failstrengths in a reduction in cardiac output, which sometimes may be compensated for by an iner reals in a reduction in least the street of the street priced, and decrease afterload

g. Why does exercise training cause a reduction in resting heart rate?

Why does exercise training results in an increase in the size of the heart, which is known as hypertro-Exercise training, the hypertrophy occurs in such a way as to increase the size of his indynamic exercise manning or a policy of the body at rest have not changed dramati-tic change. Because the metabolic needs of the body at rest have not changed dramatithe curine cranners and the control remains constant; therefore, the product of stroke volume and cally, the resume call the cause the heart is larger, stroke volume is increased. If stroke volume is larger, beart rate is lower.

Why is a reduction in resting heart rate beneficial?

Dring exercise performance, cardiac output must increase from approximately 5 L/min to nearly 35 L/min. an increase of nearly sevenfold. An increase in heart rate from a low level of 50 basis to a high level of 200 beats/min produces a fourfold increase in cardiac output. Under these conditions, stroke volume needs only to double to get an additional factor of two. If the resting heart rate were not reduced, the individual would quickly reach the point at which increases is been rate would cause reductions in stroke volume, and it would be difficult to increase carfac output to the required level.

9. What else does an expercise training program do to the cardiovascular system?

Exercise training also affects the vasculature. Increased use of skeletal muscle results in a Fown of capillaries in the skeletal muscle, known as angiogenesis. This increase in capillary denas increases the availability of oxygen to the skeletal muscle, thus reducing the rate at which skind made fatigues during exercise performance. In addition, the larger vessels improve in berakity to dilate, thus also facilitating the delivery of blood to working muscle during exercise.

 What commonly used diagnostic tests are available for evaluating cardiac function? Educatiography, gamma scanning, and cardiac catheterization.

61. What is cardiac catheterization?

What is cardiac catheterization?

Cardiac catheterization is the introduction of a catheter directly into the beautiful forces of the catheters may be immutated on the catheters may be immutated on the catheters may be introduced on the catheters of the catheters may be immutated on the catheters of the catheters may be immutated on the catheters of the cathete ef. What is extruse—

Cardiac enhermation is the introduction on a southern may be introduced on the cardiac chambers. The catheres may be introduced on the cardiac chambers and flows in the cardiac chambers. The catheres may be introduced on the cardiac chambers are cardiac chambers.

So of the circulation through the formoral enterty advanced into the sorts.

So of the circulation through the formoral enterty advanced into the sorts.

So of the circulation of the cardiac chambers are cardiac chambers. Curios cathetesterm the cardiac chambers. The contracts may be marchized on a progressive and flows the cardiac chambers. The contracts and into the right arising, and the contracts are stopped and the contracts of the circulation through the contracts of the contract of the contracts of the contract of pregates and flows us used to the the theorem when the second strength of the country and the pulmonary strength of the cathed the pulmonary strength of the and the primoral years or from the Jennoral arts; no make your use and and any and the primoral years of from the Jennoral can be used to evaluate the course, and the first of the first o and the pulmonatey have., and the pulmonatey have a second pulmonatey have a second pulmonate year. The results of cradiac cathleterization can be used to be valued in the heart. In addition, one and right ventricles as well as the competence of the values in the learning and the coronary arteries and dye injected to the pulmonate has the coronary arteries and dye injected to the pulmonate has a second pulmonate the pulmonate has a second pulmonate the pulmonate has a second pu cle: The results to sometimes as well as the competence of the variety of the universal to additional representation and right ventricles as well as the company arteries and dye injected to visualize the perfusion of a continuous distribution of the myocardium that may be underperfused.

62. What is echocardiography?

What is echocardiography?

Echocardiography is a noninvasive imaging modality based on the colo of seal to the color of th 62. What is executed by the annihilation of the second of

63. What is a gamma scan or a thallium scan?

What is a gamma scan or a manuful scan.

Gamma scanning is an imaging technique that relies on the injection of individual of the control of Gamma scanning is an imaging technique, under the out-the unjection of redouted are taken up specifically by the heart. Once the radioactive material is injected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically by the heart. Once the radioactive material is unjected and is taken up specifically be a specific material to the radioactive materia are taken up specifically by the heart. Unser use consecution to unique at a superted and is taken up special camera known as a gamma camera is used to record the emission of the heart, a special camera known as a gamma camera is used to record the emission of the heart that may be interpreted to the heart the heart, a special camera anown an amage of the heart that may be interpreted to demonstrate the dionuclides. A computer generates an image of the heart that may be interpreted to demonstrate the distribution of the man dionuclides. A computer generates an area that has a lack of emission by the rational gions that are poorly perfused, shown by an area that has a lack of emission by the rational gions that are poorly perfused, shown by an exercise test to evaluate changes. gions that are poorly perfused, snown by an exercise test to evaluate changes in perfusion and the hallium scan is often combined with an exercise test to evaluate changes in perfusion a particle of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine whether a region of the combination helps to determine the combination helps to determi A thallium scan is orien combination helps to determine whether a region of ischaria to the head

64. What does an ECG measure?

An ECG shows the pattern of electrical activation of cardiac muscle. Changes in the fire An ECO snows are parents or conduction of depolarizing activity in the heat, the prewhich may be assessed by interpreting the ECG. Although the mechanical function of the bar is not assessed by the ECG, experience allows inferences to be made about mechanical to malities that are affected by conduction abnormalities.

65. How is the ECG used to show cardiac problems?

Changes in the time needed for cardiac muscle activation or the pathway used for cardiac approximately activation of the pathway used for cardiac approximately activation activat larization, caused by local ischemia or damage to the heart muscle, are reflected by charges als ECG. For example, atrial tachycardia would be characterized by a decreased R-R intend adacreased P, QRS, and T waves. The rate may be high enough to cause coincidence of the I at P waves. A ventricular premature beat would produce a widened QRS complex with an unaxidate figuration. It would not necessarily interfere with other normal ECG patterns. Decrease in contra tion through areas of the heart are shown by prolonged intervals. For example, a conductor sive at the AV node (first-degree heart block) would result in a prolongation of the P-R moval in conduction block (third-degree heart block) at the AV node would result in complete discount of P waves and QRS complexes so that there would not be any consistent timing relationship level the two wave forms. A slowing of conduction in the bundle branches of the ventrous cross tion pathway would result in a notched QRS complex, because the synchrony of ventrials and th larization would be lost. Cardiac ischemia often produces an elevation or depression of the ST of ment. Carefully reading the ECG can give insights into cardiac functional problems.

66. Is cardiac output determined solely by the heart?

The assumption that if the body needs more blood (e.g., exercise), the heart needs only in harder is not true. pump harder is not true. Because of the high compliance of blood vessels on the venue set the circulation and a small pressure gradient from the capillaries to the right serium, as the state of the capillaries to the right serium, as the state of the capillaries to the right serium, as the state of the capillaries to the right serium, as the state of the capillaries to the right serium. attempts to increase blood flow by increasing stroke volume, the venous vessels collapse. 77

The property of the proper persons of blood returning to the control of the co begin in struct various, various reason, cardiac out blood that returns to the heart, and with another in the structure of blood that returns to the heart,

SYSTEMIC CIRCULATION

What is vascular resistance? What is vascular resistance; what impedes blood flow through the circulation. The resis-persistance is the force that impedes blood flow through the circulation. The resis-persistance individual vessel depends directly on its length (1) and the viscous control of the circulation of the circulation. (8) (an individual vessel depends directly on its length (1) and the viscosity (n) of the gradient resistance is the resistance in the resistance of the resistance of the resistance of the resistance of the fourth power (r). Thus the resistance of the resistance o The control of the property of the second of the control of the co see [67]. See and invested to the primary means by which resistance is regulated. This relationship seeds are the primary means by which resistance is regulated. This relationship seeds are seeds as the primary means of the primary means of the primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is regulated. This relationship seeds are primary means by which resistance is required.

is street in Poisseuille's law;

 $R = \frac{\pi r4}{8 nl}$

& Clarify the distinction between total peripheral resistance, venous resistance, and re-

to vegous return.

In the second return is the complete resistance that blood encounters as it flows from the second return is the complete resistance that blood encounters as it flows from the second return in the second return in the second return is the second return in the seco SUSPECE TO YEROUS PETURE. The period of the continues to the circulation of t as serial (eff ventrale) to use ventrale to the circulation ventral (eff ventrale) to use ventral to the circulation ventral to the circulation ventral to the ventral to the ventral to the ventral to the ventral to ventr ageruly defined as the resustance to venous returned a concept that incorporates the importance of tight amountained, and blood volume and thus describes the demendance of the companience, and blood volume and thus describes the demendance of the companience. PS a concept that incorporates the importance and blood volume and thus describes the dependence of blood flow in describes the dependence of blood flow in

at recommendation on these parameters.

ga. How long are all the blood vessels in the body? How long are an one would be laid end-to-end, they would extend about 60,000 miles, or nearly 100,000 kilometers. 왚

Define compositions is a term that describes the ease of stretching a vessel wall. The greater the com-71. Define compliance.

Compliance is a neuron management of the blood vessel. Compliance is defined as a change in space the grater the "stretchability" of the blood vessel. Compliance is defined as a change in page, the greater the safetiment as a change in pressure (mL per mmHg). Thus, a highly compliant vessel will warre guided by a change in pressure (mL per mmHg). Thus, a highly compliant vessel will water (1)002 by a complete in per a small change in pressure. Conversely, a low compliant vesser will be a large change in volume for a small change in pressure. Conversely, a low compliant vessers. but a large change. In which computant ves-civil have a small change in volume for a large change in pressure. A highly compliant vessel is like a balloon, whereas a noncompliant or stiff vessel is like a steel tube.

1]. How is distensibility different from compliance?

Distribility and compliance are similar, but they differ in one regard. Distensibility is the compliance divided by the resting volume, so it is a normalized measure of compliance. Complime releas the total amount of blood stored in a given part of the circulation and is more comnonly used than distensibility.

72. Can the compliance of blood vessels change?

Yes. The compliance, or stiffness, of blood vessels is under the control of a number of factors: Sympathetic nervous input

· Hormones

Changing components of the vessel wall, such as occurs in aging

73. List factors that cause compliance to decrease. · lacreased sympathetic outflow lacressed concentrations of vasoconstrictor hormones such as epinephrine and norepi-

tephrine lacreasing age

78
74. What is the relationship between the compilance of arteries and the convergence circulation are 20 times more compilant to... What is the removed the systemic circulation are 20 times more compliant than the systemic circulation are 20 times more compliant than the systemic of arteries and veins as you move as the systemic circulation are 20 times as you move as the systemic circulation are 20 times as you move as the systemic circulation are 20 times as you make a systemic circulation are 20 times as you make a systemic circulation are 20 times more compliant than their composition. veins? veiss?

In general, veits of the systemic Citeuanous and veins as you more along the state of arteries and veins as you more along there is some difference in the compliance of arteries and veins as you more along the there is some difference in the compliance of the veins are larger and more compliant than their compliance is the complex of the com In general, was as you more as the compliance or among anyou more as some difference in the compliant characteristic and their compliant characteristic and their compliants as almost every level, the veins are larger and more compliant than their compliants as a support of the compliants are larger and more compliants.

- List the functions of curvatures.

 Delivering nutrients, vitamins, oxygen, water, and electrolytes to the lissues of metabolism
 - Conducting hormones from one part of the body to another

76. What are the components of the systemic circulation? Venules

Arteries Veins Arterioles

Capillaries

Capillaries

The vessels in the circulation that transport blood at high pressure to the tissues are the vessels in the circulation that transport blood at high pressures within them. After several to the circulation of circulation of the circulation of the circulation of the circulat The vessels in the circulation that transport of the circulation that transport of the circulation that the circulation les. Arteries have thick walls to withstand use rugu pressures with unuser. After several table. Arteries have the same the same transport of the same tra branching and reductions in cualification of smooth muscle that responds to symbol a law.

• oles. Arteriolar walls have a thick component of smooth muscle that responds to symbol a law. oles. Arteriolar walls have a nuce compound and are the site of much of the count of walls and are the site of much of the count of wall and the count of wall and the count of walls are known as capillaries. ulation. They therefore can act as use counts.

They therefore can act as use counts are known as capillaries, which have very find flow in the circulation. The smallest vessels are known as capillaries, which have very find flow in the circulation. The smallest vessels are difficults. nutrients, electrolytes, hormone of fluids. flow in the circulation. The smallest vegetal fluids, nutrients, electrolytes, hormones, and offer the are responsible for exchanges of fluids, nutrients, electrolytes, hormones, and offer a charge are highly representations. They are responsible for excusurge on the state of the st stances between the 01000 and up in the order spaces or "pores" between adjacent opin een, and other substances, which can move through spaces or "pores" between adjacent opin een, and other substances, which can move through spaces or "pores" between adjacent opin een. gen, and other substances, who could be substanced in the cell membrane. After the blood has been endothelial cells or through motional and could be substanced by the substance of the substance endothelial cells or unrough indexed into small vessels known as venules. Venules have through the capillaries, it is collected into small vessels known as venules. Venules have the through the capitaires, it is smooth muscle in their walls that can contract to increase venous resistance and decrease was compliance, but venules are also highly compliant. Venules coalesce into progressively learner sels known as veins, which are important for the transport of the blood back to the hear, hours so much of the blood volume resides in the veins, they are important areas for storage of blood

77. What determines the rate of blood flow through a blood vessel?

. The pressure gradient between the two ends of the vessel

. The difficulty of the blood moving through the vessel, known as resistance The blood flow through a vessel can be calculated based on the following equation:

Flow = pressure gradient + resistance .

For the entire circulation, the flow is equal to the cardiac output, and the pressure grades the arterial pressure minus the venous pressure. Resistance to blood flow is often calculate units called peripheral resistance units (PRU). For the entire circulatory system, the resistance is 100 mmHg divided by a flow of approximately 100 mL/s or 1 PRU.

78. What is delayed compliance?

Delayed compliance is the response of the blood vessel to a sudden change in pressure. No a vessel experiences a sudden change in pressure or volume, the vascular wall slowly states accommodate that a suspen enange in pressure or volume, the vascular wall stories and accommodate that increase in volume. As the vessel wall stretches, the pressure within the sel falls, resulting in the appearance of an increase in compliance. This change in compliance time is referred to as delayed compliance, or stress-relaxation.

79. What are the normal levels of arterial and venous pressure in the body? The pressure in the arteries is highly pulsatile. The peak pressure, known as systak or sure, is approximately 120 mmHg. The trough pressure, known as glastelic pressure, in the proximately 80 mmHg. The differences a approximately 120 mmHg. The trough pressure, known as diastolic pressure is proximately 80 mmHg. The difference between the systolic and diastolic pressure is invested.

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The palse pressure depends on the amount of blood pumped by the heart on each surface and the compliance of the arteriole tree. As the compliance of the arteriole tree, as the compliance of the arteriole tree. The pulse pressure organisms on me amount of blood pumped by the heart on each complete or the complete of the arteriole tree. As the compliance of the arethe mark volume, and the compliance of the arethe mark volume. As occurs during aging, the pulse pressure will increase.

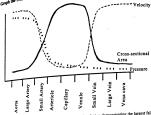
The pulse pressure of the compliance of the arethe mark volume, and mark lower than arterial pressure, ransing 6. of the survey such as occurs usung segme, one purse pressure will increase, such as occurs usung segme, one purse pressure, ranging from about 15 mmHg systems. Survey sur where a much cower unau arrenau pressure, ranging from about 15 mmHg ay-

her is the blood volume distributed throughout the circulation?
The blood is in the compliant venous and majority of the blood is in the compliant venous and majority of the blood is in the compliant venous and the blood v

her is the blood volume distributed in roughout the circulation?

Her is the blood is in the compliant venous circulation, with nearly 1000 mL the sal majority of the blood is in the compliant venous circulation, with nearly 1000 mL the sale majority venus (the vena cava), and approximately the same amount in the complete complete complete cavallations and the complete cavallation of the The value of the probability of the value of the valu he have a larged veins (the venus cava), and approximately the same amount in the venous of the basing the venules and the terminal veins. Although the number of capillaries is high, the basing the venules are small, so the total blood volume in the capillaries is proposed, that volumes are small, so the total blood volume in the capillaries is a proposed, that volumes are small, so the total blood volume in the capillaries is a proposed. which is the second of the capital volumes are sensitive to the capital volumes are sensitive to the capital volumes are sensitive to the capital volumes are sensiti 30 ml. Similarly, are small size and low complian where being on the arterial side of the circulation.

elocity, and cross-sectional area of the circulation. gl. Graph the relative press



blain groups, velocity, and cross-sectional area of the circulation demonstrating the largest fall in pressee a to small attribute and arterioles, as well as the large area and low velocity in the microcirculation.

& Box oos gravity influence the blood volume distribution in an upright person?

Because of the weight of the column of blood in an upright human and the high compliance of the verse, blood tends to accumulate in the lower extremities. Several mechanisms facilitate to the man of blood from the extremities to the heart:

Venous valves Connection of skeletal muscle

Value, which are found in the larger veins, allow blood to move only toward the heart. The need of the valves, combined with the squeezing of blood vessels by contracting skeletal acce valves, combined with the squeezing of blood vessets oy conduction of a vascu-lactic rate what is known as the skeletal muscle blood pump. This combination of a vascu-tage run.

tract an extra sknown as the skeletal muscle blood pump. This combination is a safety and a currenscular system results in active pumping of blood from the periphery back to the bag.

- rchangeably. What uses a dilation—an increase in the size of veins
 - Venodilation an increase in the size of either arterioles or veins
 Vasodilation—an increase in the diameter of care.
 - Vasoulision—an increase in the diameter of arterioles
 Arterial dilation—an increase in the diameter of arterioles
- Vasodilation—an increase in the unantition for arteries, venoconstriction for retrieve constriction, we refer to arterial constrictions for arteries, venoconstriction for retrieve for both. vasoconstriction for both

REGULATION OF CARDIAC OUTPUTAND VENOUS RETURN.

84. What is the normal value for cardiac output in a human?

What is the normal value for cardiac output and the metabolic demands of the organization conjunction in a 70-kg person. Cardiac output is nignry variations of the orgues of the body. At rest, cardiac output is approximately 5 L/min in a 70-kg person. 85. What happens to cardiac output when the body's need for oxygenincreases,

What happens to cardiac output when the state of the body increase, for example, during exercise, the amount of blood purple.

As the needs of the body increase, for example, during exercise, the amount of blood purple.

The increase in blood flow is exactly proportional to the increase. As the needs of the body increase. As the needs of the body increases in blood flow is exactly proportional to the increased design by the heart increases. This increase in blood flow is exactly proportional to the increased design. for oxygen by the tissues.

86. How do the systemic circulation and the heart receive signals to circulate more blood when needed?

en needed?

There are several mechanisms by which cardiac output can be increased as metabolisms in the area several mechanisms. There are several mechanisms by which the heart can increase both heart rate and contractility leads creased. Sympathetic outflow to the heart can increase both heart rate and contractility. Make creased. Sympathetic outflow to the reads that the state of the state to an increase in carunar output control of the systemic circulation as a result of functional hyperemia or attempt of the systemic circulation as a result of functional hyperemia or attempt. lation increases venous return and thus increases cardiac output.



Family of cardiac function curves showing onmal (solid), increased (dashed), and demand (dotted) levels of sympathetic outlow to be heart. Contractility of the heart is precentionly the slope of the cardiac function curve.

(mmHg) 87. What is functional hyperemia (active hyperemia)?

Active hyperemia is the increase in blood flow due to an increase in the rate of metabolism of the tissue fed by a given blood supply. As the metabolism of tissue increases, the requirement for oxygen and other substrates are increased. These requirements are met by increases in him flow that are precisely matched to the increased metabolic demand of the tissue.

88. Contrast active hyperemia and reactive hyperemia.

Although active hyperemia and reactive hyperemia.

Although active hyperemia and reactive hyperemia are similar in some respects, respectively. peremia is the excess blood flow that occurs after a period in which the tissues are not split with the appropriate blood. with the appropriate blood flow that occurs after a period in which the tissues are no specified with the appropriate blood flow to meet metabolic needs. After a period in which blood flow been occluded for example to the specified flow to th ьееn occluded, for example, by a tourniquet, release of the occlusion results in a blood ^{вор}

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Is greater than that which occurred before the occlusion. The magnitude of the increase in blood

is greater the occlusion is proportional to the duration of the period in which the flow was after the occlusion flow above control is sometimes said to be "party the occurred before the occlusion." is greater than that which occurred to the duration of the period in which the flow was inadflow. This increase in flow above control is sometimes said to be "paying back the overis greater use occlusion is proposed control is sometimes said to be "paying back the oxygen debt" equate. This increase in flow above control is sometimes said to be "paying back the oxygen debt" equate. 1700 the period of occlusion.

89, What is blood flow autoregulation? What is blood flow much anisms by which tissue regulates its own blood supply. For exactoregulation is the mechanisms by which tissue regulates its own blood supply. For exactoregulation is the mechanisms by which tissue regulates its own blood supply. For exactoregulation is the mechanisms by which tissue regulates its own blood supply. For exactoregulation is the mechanisms by which tissue regulates its own blood supply. For exactoregulation is the mechanisms by which tissue regulates its own blood supply. 89. When blood pressure is reduced, blood flow tends to fall. This decrease in blood flow is ample, when blood of arterioles throughout the body. This dilation reduces the resistance. ample, when blood pressure is throughout the body. This dilation reduces the resistance to blood flow is resisted by dilation of arterioles throughout the tissues. Autoregulation is generally distinct the myogenic response ample, will dilation of arteriology of blood to the tissues. Autoregulation is generally divided into flow, thus restoring the delivery of blood to the tissues. Autoregulation is generally divided into flow, thus reaconse and the myogenic response.

90. Compare the metabolic and myogenic responses in the local control of the circulation. Compare the metapolic response is a property of a blood vessel resulting in active constriction as presulting in active constriction as presulting in a given flow rote. The myogenic response and in dilation as pressure falls in an effort to maintain a given flow rate. This property sure rises and in dilation the vessel wall and thus does not require interaction with the tissue of the sure rises within the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and in the vessel wall and thus does not require interaction with the tissue of the sure rises and the sure rises are rises are rises and the sure rises are rises are rises and the sure rises are ri sure rises and in dilation as presented in dilation as presented in dilation as presented within the vessel wall and thus does not require interaction with the tissue that the vesoriginates within the vessels which causes constriction as flow increases and dilation to present the rise and dilation as presented in the rise and dilation originates within the vesses, which causes constriction as flow increases and dilation as flow selfeeds. The metabolic response, which causes constriction as flow increases and dilation as flow selfeeds. The metabolic response and washout of dilator metabolites by the tissue William State of the tissue within the vesses and dilation as flow selfeeds. sel feeds. The metabolic response and washout of dilator metabolites by the tissue. When flow is falls, arises from the products of tissue metabolism that are normally washed away build up in the state of tissue metabolism. falls, arises from the products of tissue metabolism that are normally washed away build up in the tissue and too low, products of tissue flow is too high, the dilator metabolite concentration cause vessels to dilate. When flow is too high, the dilator metabolite concentrations are reduced, cause vessels to anate. White to maintain tissue blood flow constant. resulting in vocation tissue blood flow constant.

91. How do extrinsic control mechanisms of vascular resistance and intrinsic controllers, 91. How do extracted and intrinsic control as functional hyperemia and the myogenic response, relate to one another?

Extrinsic control of vascular resistance (such as the sympathetic nerves and vasoactive hor-Extrassic control of an intrinsic autoregulation. This becomes important in many situations mones) is superimposed on intrinsic autoregulation. This becomes important in many situations mones) is superimposed in many situations when cardiac output must be shunted toward one region or another for the preservation of the orwhen carmiac output that is one that occurs with exercise. At the onset of exercise, there is an ganism. An example of this is one that occurs with exercise. At the onset of exercise, there is an ganism. All champed of checkers, there is an increase in sympathetic activity that causes a peripheral arterial vasoconstriction, leading to an inincrease in peripheral resistance that increases blood pressure. However, because of accumulation of metabolites in exercising muscle, blood flow to these sites is increased due to the local metabolic vasodilatory response.

92. How much do tissues (organs) rely on autoregulation versus extrinsic control mechanisms?

Some organs depend primarily on autoregulation to control blood flow, whereas other tissues are primarily regulated by extrinsic (neural) mechanisms. In general, organs that are thought to be immediately critical to sustain life utilize autoregulation to a greater degree. These include the (brain, kidney, and heart) Conversely, the cutaneous circulation is regulated primary by the level of sympathetic vasoconstrictor tone to its vessels. Many tissues utilize both autoregulation and sympathetic neural control, depending on circumstances. For example, skeletal muscle circulation is generally under sympathetic neural control, but this control can be overridden during times of increased metabolic demand by the tissues, such as exercise. Increased sympathetic stimulation of the splanchnic circulation can greatly reduce blood flow through this tissue and release stored blood volume, but over a period of time, the accumulation of metabolites will override the extrinsic neural regulation, and flow will be restored to meet the demands of the tissue.

93. If the amount of blood that flows through the body is regulated by the venous return, then what is it that controls the venous return?

The venous return, or the amount of blood that comes back to the heart, is determined by the following:

- Blood volume
- Compliance of the arteries and veins
- Resistance of the arteries and veins

The venous return curve desc ship between central venous pre nous return. The inverse slope of the resistance to venous return

Because vessels are distensible and the heart is preload-sensitive, we can define a relationship is known as a relation as a Because vessels are distensione and but also extends it. This relationship is known as the but, ship that includes Poiscuille's law but also extends it. This relationship is known as the but,

return relationship (see figure). mar feationship (see figure). The relationship we must first understand a concept called the value of the val To understand the venous return recurrence to the volume in the venous return recurrence to the volume in the venous return (MCFP), which is defined as the sum of the volume in the venue of the circulation. The Merita life, we want to the venue of the circulation. The Merita life, we want to the venue of the venue of the circulation. The Merita life, we want to the venue of the v

mean circulatory filling pressure (use.)

mean circulatory filling press the volume in the veins - un. MCFP also represents the pressure that drives blooding tive of the fullness of the circulation. MCFP also represents the pressure that drives blooding tive of the fullness of the circulation. to the heart. Therefore, the pressure gradient + the resistance across that gradient, the resistance has because flow = the pressure gradient + the resistance across that gradient, the resistance has because flow = the pressure gradient (MCFP — right arrive to the pressure gradient (MCFP) — right arrive to Because flow = the pressure grantent gradient (MCFP — right atrial pressure) nous return (RVR) is defined as the pressure gradient to the same as total peripheral arrivable to the same arriv nous return (RVR) is defined as an appropriate the nous return is not the same as total peripheral resistance or nous return. This resistance to venous return is not the same as total peripheral resistance or nous return. nous return. This resusance to resistance (R_V) , the arterial resistance (R_A) , and the complexe it takes into account the venous resistance (R_V) . of the circulation: $RVR = \frac{R_V + R_A}{20}$

$$VR = \frac{R_V + R_A}{20}$$

Clearly the venous return is equal to MCFP - the right atrial pressure + the resistance in a nous return. Thus, venous return is regulated by regulation of the MCFP (the fullness of the one lation) and the resistance to venous return (arterial resistance, venous resistance, and complane)

94. What are the factors that alter the MCFP? · Changes in blood volume

- - · Changes in arterial compliance
 - · Changes in venous compliance

Changes in vascular resistance do not affect the mean circulatory filling pressure.

95. What factors change the resistance to venous return? The resistance to venous return is determined primarily by constriction or dilation of arms

and veins. Increasing the resistance of the arteries or the resistance of the veins increase for sistance to venous return and therefore decreases the amount of blood returning to the heat be cause resistance of the arterioles can be controlled by local factors, changing the resistance in nous return provides a mechanism by which the needs of the tissues may be met with an increase blood flow.

96. How do vasoconstrictor hormones affect venous return?

Hormones such as norepinephrine, epinephrine, angiotensin, and vasopressin increase of the MCFP and the resistance to venous return. Conversely, hormones such as acetylcholic address such as socious as acetylcholic address such as socious as acetylcholic address such as socious acetylcholic address such acetylcholic address such as socious acetylcholic address such acetylcholic acet drugs such as sodium nitroprusside decrease the MCFP and the resistance to venous return

What do increases in sympathetic nerve activity do to MCFP and resistance to venous

 Increase resistance to venous return
 Increase resistance to venous return . Increase MCFP

98. What is the normal level of MCFP? What is the normal serves of the circulation when the flow is equal to 0, is approxi-MCPP, or the pressure that occurs in the circulation when the flow is equal to 0, is approxi-MCPF, or one pressure user occurs in a MCPF, or one pressure user occurs in martly 7 mmHg under normal conditions. 98. What factors can cause increases in the level of MCFP?

Increases in blood volume · Increases in sympathetic tone

• Increases in levels of circulating constrictor hormones

100. What is the maximal increase in the level of MCFP? 20 sumHg.

101. What factors may cause decreases in the level of MCFP?

Reductions of sympathetic outflow Vasodilators

102. What is the minimal level of MCFP?

REGULATION OF BLOOD PRESSURF

int. What is the normal value of blood pressure What is the normal with the many state of the systolic and 80 mmHg for diastolic. This may be quite variaged in the systolic and 80 mmHg for diastolic. This may be quite variaged in the systolic and 80 mmHg for diastolic. Approximately 120 minutes to a minute may be quite vari-the however. Normal blood pressures in infants may be as low as 90 over 40, and blood presthe however, Normal Mode programmer and the second programmer and the see tents to microsse under values occurring during sleep and higher values occurring during streep and higher values occurring during wang cycles in most sent normally regu-lated at about 100 mmHg, with fluctuations of approximately ± 20 mmHg. Despite these fluctuand it arous not in the stable over life and is well regulated on a moment-to-moment basis, a daily basis, and over the entire life span.

164. Why is regulation of mean arterial pressure needed?

• To provide the organs with blood flow at a constant perfusion pressure so that each organ system can alter its resistance to achieve the desired flow during altered metabolic needs. hydrostatic destabilization, and alter blood volume states

To optimize the cardiovascular work and minimize cardiac, vascular, and renal damage

16. How is the orderful processor cognitated? The basic scheme by which blood pressure is regulated is through a feedback control system occasing of pressure sensors and effector mechanisms that can alter the blood pressure. If pressee becomes altered, such as might occur during hemorrhage, a sensor, or baroreceptor, senses the reduction in pressure and activates an effector mechanism to return blood pressure toward its ## point. This response is termed negative feedback control. The degree of effectiveness with shick control system maintains constant conditions (homeostasis) is determined by the gain of the teginier feedback. Nearly all body control systems are operated by negative feedback. prints recursely. Nearly all body control systems are operated by negative barreceptor titles reflex that helps to control blood pressure on a beat-to-beat basis is the barreceptor titles.

84

106. What types of effector mechanisms are important for the regulation of blood prebacks.

Hormonal controllers:
Renin-anaiotensin system. Renin-angiotensin system Sympathetic nervous system

Vasopressin Parasympathetic nervous system Atrial natriuretic peptide Hormonal controllers Kallikrein-kinin system Intrinsic mechanisms:

Kallikrein-kinin system Myogenic response Metabolic response

107. How does the sympathetic nervous system act as an effector in blood pressure control to the How does the sympathetic nervous system and the sympathetic neurons from the rostral ventrolateral medulla (RVLM) descend through the sympathetic neuronal cell bodi.

Sympathetic neurons from the rostrial to Sympathetic neuronal cell bodies as spinal cord in the bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cord in the bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cord in the bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cord in the bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bodies as spinal cell bulbospinal pathway and synapse on preganglionic neuronal cell bulbospinal pathway and synapse on preganglion spinal cord in the bulbospinal pathway man spinal cord in the bulbospinal pathway man spinal cord in the bulbospinal pathway man spinal cord in the thoracic and lumbar spin intermediolateral cell column. Preganglionic sympathetic fibers exit the thoracic and lumbar spinal intermediolateral cell columns spinal intermediolateral cell column. Preganguome 5 monator and lumbar spate intermediolateral cell column. Preganguome 5 monator and lumbar spate cord and activate postganglionic nerve cells in ganglia located throughout the body. The Postgan cord and activate postganguome as sympathetic fibers on arterioles, venues and postganguome as sympathetic fibers on arterioles, venues are sympathetic fibers on arterioles, venues are sympathetic fibers on arterioles. cord and activate postganglionic nerve cers or good to the postganglionic sympathetic fibers terminate as sympathetic fibers on arterioles, venules, and the gain control of the neurotransmitter norepinephrine, cause a tool. glionic sympathetic fibers terminate as 3/10-2000 principles of the neurotransmitter norepinephrine, cause a tonic sympathetic fibers, through release of the neurotransmitter norepinephrine, cause a tonic sympathetic principle and can accelerate heart rate. The tonic construction These fibers, through release of the neurotransmitted from the tonic constriction of arteries and veins and can accelerate heart rate. The tonic constriction of along vascounstriction of arteries and veins and can accelerate heart rate. The tonic constriction of along vascounstriction of a second representation of a second representation of the second representa vasoconstriction of arteries and veins and can be vasoconstriction of story vessels is sometimes referred to as vasomotor or vascular tone. Vasomotor tone keeps vessels is sometimes referred to as vasomotor or vascular tone. Vasomotor tone keeps vessels is sometimes referred to as vasomotor or vascular tone. vessels is sometimes received to as the construct around this level of resting tone partly constricted so that they can both dilate and constrict around this level of resting tone

108. How does the baroreceptor reflex control blood pressure?

. How does the paroreceptor :

Two sites in the cardiovascular system contain baroreceptors, fine nerve endings that are accounted in the cardiovascular system contains the cardiovascular system contains before its the cardiovascular system contains the cardiov Two sites in the carusovas-construction of the vessel walls in which they lie: the carotid sinus and the acritic arch. These tivated by stretch of the vesses wants in visit of the pressure-sensitive receptors send afferent nerve activity through the minth and tenth craig pressure-sensitive receptors sent attractus solitarius (NTS), which activates neurous the nerves, respectively, to the nucleus of the tractus solitarius (NTS), which activates neurous the nerves, respectively, to the nursea or the serve as the first relay site of the baroreflex. These NTS neurons then activate neurons in the case. serve as the first reary size of the Cauchy ships in turn inhibit the neurons in the rostral ventrolateral medulla (CVLM), which in turn inhibit the neurons in the rostral ventrolateral medulla, which normally excite sympathetic preganglionic neurons in the spinal cord. Thus, ac. medulla, which normany corts a pressure, or increased stretch of the vessel walls, results in a decrease in sympathetic activity. This decrease in sympathetic activity reduces the way somotor tone, causing dilation of the blood vessels, and slows heart rate, both of which help to *lower blood pressure back to normal. In addition to decreasing sympathetic activity, activation of the baroreceptors increases parasympathetic nerve activity. Neurons in the NTS that are activated by baroreceptor afferent activity also innervate neurons in the nucleus ambiguus (NA) in the medulla, which are the preganglionic parasympathetic nerve cell bodies that have fibers in the vagus nerve. These neurons innervate postganglionic neurons contained in ganglia near the bear Thus, when the baroreceptors are activated, there is an increase in parasympathetic nerve arise.

Diagram of the baroreceptor reflex pathway in the medulla. Baroreceptor afferent activity first synapses on neurons in the nucleus tractus solitarius (NTS). These neurons activate other neurons in either the nucleus ambiguus (NA) or caudal ventrolateral medulla (CVLM). Neurons in the NA are cell bodies for preganglionic nerve fibers that innervate the heart. Thus, increases in baroreceptor activity will increase parasympathetic drive to the heart. Neurons in the CVLM inhibit neurons in the RVLM, which activate cell bodies of preganglionic sympathetic nerve fibers in the spinal cord. Thus, increases in baroreceptor activity will decrease sympathetic drive to the heart and blood vessels. The net effect of increases in baroreceptor activity is a decrease in heart rate and peripheral resistance.



95

Me hard, which helps to slow heart rate. If blood pressure decreases, the level of baroreme hard, which helps to slow heart rate. If blood pressure decreases, the level of baroreme hard which helps to slow heart rate. If blood pressure decreases, the level of baroreme hard property of the helps to be a solution of the property of the helps to be a solution of the property of the helps to be a solution of the property of the helps to be a solution of the property of the helps to be a solution of the property of the helps to be a solution of the property of the helps to be a solution of the the least, which helps to sayw nems rate. It follows pressure decreases, the level of barrorsmakes the least, which helps to sayw nems rate. It follows the least th of the second of or we will be a sometime of sympathetic activity and sees activation of parasympathetic activity. This results are a substituted in susmodor tone and heart rate, which help to delvate blood pressure back to a substitute of the sympathetic and parasympathetic are proving systems act reciprovals. and support in vacometor uses used react, which help to elevate blood presses these to all a person of the support of the supp gib it is a day the symptomero, and partisympathetic nervous systems act references and partisympathetic nervous systems act references and the symptoms of the systems act references are all the systems act references and the other systems act references from the systems are systems and the other systems are systems are systems as the other systems are systems as the sy

the horizontal space of the control "The source of the state of the source of th The actions such as pensual courages. One important feature of this control mechanism is graph and the such as th prel of blood pressure is changed.

Are there other types of sensors that are important in the regulation of blood pressure?

Me Are there other types of sensors that are important in the regulation of blood pressure? Architer other types or sensus a man as t important in the regulation of blood pressure?

Architer important neural control mechanism involved in blood pressure control is periphtype Architer important neural control mechanism involved in blood pressure control is periphtype and the property of th We shader injortant neural source and another involved in blood pressure control is perjudy.

We Another injortant neural source and located primarily in caroid and aortic bodies. They are end-demorphism of the properties are all the properties and the properties are all the properties. They are end the properties are the properties a endowneeders. Commerce page 100 per also may be stimulated by arterial pressures that fall below ap-sential by low arterial PO, but also may be stimulated by arterial pressures that fall below ap-sentially (i) mmHg. Simulation of chemoreceptors leads to an increased symmothetic and pressures that the commerce process of the commerce process and the commerce process of the commerce process and the commerce process ar Inly are substituted by low arterial Ivis, our about may be summatted by arterial pressures that fall below as substituted by some Simulation of chemoreceptors leads to an increased sympathetic tone (vaso-particular discreted waged tone (bradycardia). In addition, there are receivants and increased waged tone (bradycardia). processing to mattle communications because yours result to an increased sympathetic tone (viscos) and increased wagal tone (bradycardia). In addition, there are mechanoreceptors in the matterior of the terminal to the description of the des processory and increased vague was experienced an autumn, there are mechanocceptors in a discreased with the control of the co lest fairsily the left venare, or, una new moves more controcceptors and can contribute to regular fairsily the left venare, or una move much less than that of the anterial baroreceptors, greater, about the sain of this reflex is much less than that of the anterial baroreceptors.

ill. Summarize the nervous control of arterial pressure. Summarize me use soon of arterial pressure is accomplished primarily by baroreceptors, peripheral Nerrous control of arterial pressure and central nervous exceptions. Nervois control or aneutan pressure or accompanion primarily by baroreceptors, peripheral demonstration, cardiac mechanoreceptors, and central nervous system is chemic response. It acts demonstration of communication and variable for incommunication of control of total peripheral despections, vacuum and the second of total peripheral resistance, MCFP, and bright charges of sympathetic and vagal tone (control of total peripheral resistance, MCFP, and bright charges of sympathetic and vagal tone (control of the circulation acts or additional peripheral resistance, MCFP, and the circulation acts or additional peripheral resistance, MCFP, and the circulation acts or additional peripheral resistance, MCFP, and the circulation acts or additional peripheral resistance, MCFP, and the circulation acts of the circ thresholds on symposium or the circulation acts quickly; however, these algorithm is a factorist in cardiac function). Nervous control of the circulation acts quickly; however, these alerthrist in Lemma when exposed to extended periods of blood pressure changes, paters and to adopt when exposed to extended periods of blood pressure changes.

IX and X cranial nerves Central Nervous arotid and Aortic System hemo and Vagus nerve Baroreceptors SA node Efferent HEART (Cardiac Output) AP = otherin CO x TPR Blood Vessels (Total Peripheral Resistance)

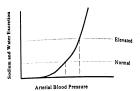
Disputed the noticel control of the circulation. IX = Glossopharyngeal nerve; X = vagus nerve; AP = artrail present; CO = cardiac output; TPR = total peripheral resistance.

Increase in blood volume cause increases in blood pressure by acting through cardiac out-because them. he geage blod volume cause increases in blood pressure by acting through cause he geage blod volume is controlled primarily by renal excretory mechanisms, the kidney is

It I regal control systems are rapidly adapting, what are the mechanisms that are re-Specials for the long-term regulation of blood pressure?

86 the primary long-term committee of blood pressure in the body. The regulation of blood no. the primary long-term committee of blood no. the primary rang-term communes or many pressure in the bad by the kidney is referred to as the **pressure diurests** theory,

112. What is the pressure diurests theory? What is the pressure discretis intenWhat is the pressure discretis addition and water depends directly on the amount of the kidney to exercise sadium and volume output increases (see figure less assessment rises, urinary sadium and volume output increases (see figure less assessment). 112. What is to be a control of the kinney to exercise and volume output increases (see figure) the abolity of the kinney to extract and volume output increases (see figure) the about volume causes a realization of the control of t The ability of the resourcities, urmany assumed the decrease in blood volume causes a reducing sure. As arterial pressure is blood volume. This decrease in blood volume causes a reducing sure. As about pressure is reducing a security as a steady state. The sure. As arrenary method volunte, inhald pressure. As blood pressure is reduced a reducible to results in a decrease in blood volunte. This of pressure is reduced to the discontinua and therefore a reducition in blood pressure is culturally state. The consequence of this discontinua and therefore is also reduced, restoring a steady state. The consequence of this results in a decrease a reduction in a reducing a steady state. The consequence of the reduced the reduced in a steady state. The consequence of the reduced in the control and therefore the reduced in tory abulty to the state of the sure duties to some different resistance or centuring and the rotal peripheral resistance or renul filtration and ready in and the rotal peripheral resistance or renul filtration and ready, this theory says that changes in renal vascular resistance or renul filtration and ready, and the source of the resistance of the resistance of the renal vascular resistance or renul filtration and ready. tantty, tim meery any to after blood pressure in the long term, tion are the only ways to after blood pressure in the long term,



The relationship of renal perfusion pressure and sodium or water excretion. Dotted lines show normal wa evated sedium intake. Dashed lines show the resulting arterial blood pressure. The slope of this cure cale modified by angiotensin, aldosterone, and other factors.

113. What is the autoregulatory multiplier effect of total peripheral resistance? Small increases in blood volume and cardiac output can have large effects on systems up cular resistance (i.e., arterial or vasoconstriction) because increases in extracellular fluid tolars and blood volume increase MCFP, which increases both venous return and cardiac outps. creases in cardiac output, acting through autoregulatory mechanisms, increase total peripherit sistance. Because arterial pressure equals cardiac output times total peripheral resistance, asile cause both cardiac output and total peripheral resistance are increased by increasing blad volume, the resulting increase in arterial pressure is referred to as a multiplied effect.

MICROCIRCIII ATION

114. What is the microcirculation?

The microcirculation?
The microcirculation is made up of the smallest blood vessels. It is generally defined big fing the vessels with a small state of the smallest blood vessels. cluding the vessels with diameters less than 200 \(\mu\). These are the vessels that penetric in \(\mu\)
parenchymal lives and parenchymal tissue and are responsible for the primary control of blood pressure and field change in the circulation. change in the circulation. The smallest vessels in the microcirculation are referred to a set minal microcirculation. minal microcirculation. The smallest vessels in the microcirculation are referred to F and a meters between 4 and 9 ... capillane with diameters less than 100 µ, capillane ameters between 4 and 8 μ , and venules with diameters less than 150 μ -

What is the primary function of the microcirculation?

What is the primary function of the microcirculation?

The microcirculation is responsible for exchange and the microcirculation is responsible for exchange and the microcirculation? what is the primary function to the control of the primary infection of his was a considered to the contract of the co The normal best. The exempts we missessums serveen the circulatory system and the CO, of the second of the capital section of the capita For a series place manny on the capitalness. These vessels are so the body lakes place manny on the capitalness. The average capitalness is approximately $500~\mu$ in length, appeared. The average capitalness is approximately $500~\mu$ in length.

116. How do substances move across the capillary wall? i flow do substances more acrus the capillary was provided in the

 Transcellular—pass way for ripopnilic substances
 Clefts—pathway for hydrophilic substances Cero pathway for large proteins Froestate – psanway co ange processes – psanway for large hydrophilic molecules - psocytotic vessels – psahway for large hydrophilic molecules

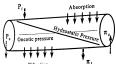
Il. Nume the ferest involved in the movement of water across the capillary wall. It is not be forest.

In Summe.

Hydrostatic pressure inside the capillary Hydrostatic pressure of the interstitial fluid

 Colloid osmotic pressure of the plasma Interstitial fluid colloid osmotic pressure

L Explain how the Startung was a sound to the startung to the 18. Explain how the Starling forces work. The biling between Pytrosomes (Pressorte), and someone forces determines the net movement make the pressure of the interstitial space. Colloid osmotic pressure is the pressure that the pressure of innormality or the interstitial space. greate from the capitality to use interestinal against continuous osmotic pressure is the pressure that send begins of the pressure of impermeable proteins in the plasma and interstitial fluid. The send to interest to interest the protein when the protein continuous information in order to interest the plant to interest the protein of the protein continuous transfer and transfe each beause of the presence of imperimensors proteins in the plasma and intensitial fluid. The each beause is nearly impermeable to protein. When the protein concentration is high on applies membranes and low on the other opins membrane is nearly impermeature to protein. When the protein concentration is high on one six of the repellary membrane and low on the other, water moves in an attempt to equalize the six of the repellary membrane and low on the other, water moves in an attempt to equalize ne six of the capitary memoriane and town or une outset, water moves in an attempt to equalize the executions. This pulling force on the water is colloid osmotic pressure. Most ions do not the constitutions. This putting to use on the water is control to stitute pressure. Most ions do not capillary membrane because the membrane is freely permeable on the forces across the capillary membrane because the membrane is freely permeable. outside to the 10000 across are separately abstracted to the inclinations to the property of the separate to the inclinations, the balance of forces favors a net, as the next favor to the interestition. Manufacture to the interestition. when ad they are in equinorman. Others increment contained to, are contained on forces favors a net, increment of water from the capillary to the interstitium. Nearly all of the fluid that enters the innegrets to what the state of th head vessels, where it is finally returned for blood circulation. Thus, interstitial fluid volume is the balance between capillary fluid filtration and lymphatic drainage,



Filtration Showing representation of the Starling forces acting on the capillary, $P_e = capillary$ hydrostatic pressure; $E = \frac{1}{1000} \frac{1}$ ** incrementation of the Starling forces acting on the capillary, $P_c = \text{capitlary nyelectors}$ *** incrementation of the Starling forces acting on the capillary, $P_c = \text{capitlary nyelectors}$ *** interesting their pressure; $\pi_c = \text{capitlary colloid osmotic pressure; } \pi_c = \text{interestitial fluid colloid osmotic}$ **Physic Dec. 1. page Daked grows show direction in which force acts. Solid arrows show direction of fluid movement.

^{10.} Row are endsthelial cells in a microcirculation involved in regulation of blood pressure?

Endstellar and the endocratical cells in a microcirculation involved in regulation of blood pressure. Entries a cells line a microcirculation involved in regulation or observed of the veloc-libod firm and cells lining blood vessels experience deformational forces because of the velocis a should clis liming blood vessels experience deformational forces occause or a significant forces occause or a significant force of the signif

88

88
from large muscular arteries to microvascular capillaries of specific organ systems, the form large muscular arteries to microvascular adjacent cell types. Responses of the specific organ systems, the mediators, which activate adjacent cell types. The specific organ systems are mediators, which activate adjacent cell types. from large moscular arteries to microvascular capitation of appearance organ prison, the form large moscular arteries to microvascular capitation of the mediator signals and the functions coupled to a bio-feeling mediator, which capitation of the mediator signals are sufficiently controlled to a bio-feeling mediator, only signal forces, hormones, cytokines, and completely controlled to the controlled to t from large muscular afterios which activate adjacent ceu types, respusaes or these colls, set of releasing mediancs, which activate adjacent ceu types, respusaes or these colls, set of releasing mediancs, which activate adjacent forces, hormones, cytokines, and compared differential recognition of the mediant forces, hormones, cytokines, and compared the mediant ceutific mediant. For example, polyteriol colls, and considerable mediants are cause relaxation, contraction, proliteriol colls, and contraction of the collection of the from High mediators, winnorderlessing mediators, winnorderlessing mediators, winnorderlessing mediators, winnorderlessing mediators, bromones, cytokines, and compared a
differential recognition for example, physical forces, hormones, cytokines, and compared to the control of the compared to th of tereas—ecognition to will differential recognition to the control of the contr different system. For Exempts, and cause relaxation, continuous, prouteration, or the decirion system for endothelial cells, can cause relaxation, continuous, prouteration, or the decirion system for endothelial cells. Smooth muscle cells are not the only responder cells affected which act cells can respond to mediators affected to the cells can respond to mediators. which act on endotherias which act on endotherias can enot use unity responder cells are most muscle cells. Smooth muscle cells can respond to mediators adjacent smooth muscle cells of the cells can respond to mediators adjacent smooth muscle cells can respond to mediators adjacent smooth muscle cells.

128. What type of vasoactive substances are released from endothelial cells?

Proteins Thrombin

Peptides Substance P

Vasopressin Angiotensin

Kinins

Bradykinin Amines

Serotonin

Nucleotides

Adenosine triphosphate (ATP) Adenosine diphosphate (ADP) Metabolites of arachidonic acid

Leukotrienes

Prostaglandins Hydroxy-eicosaetraenoic acids (HETEs)

FTFs

Nitric oxide

121. Describe the action of nitric oxide.

Nitric oxide is released from endothelial cells and causes a potent relaxation of vacue smooth muscle. When blood flow in the microcirculatory vessels is increased, their force aim but the endothelial cells cause the release of nitric oxide, which dilates the blood wester to flow-dependent dilation is an important regulator of shear stress and may be part of the nets nism by which flow is regulated during functional hyperemia.

SPECIAL CIRCUITATIONS

122. What is the splanchnic circulation?

The splanchnic circulation is the blood supply to the liver, spleen, pancreas, stomet, atte testines. It is here that nutrients are absorbed from the gastrointestinal tract and enter the blob stream. Major hemodynamic characteristics of this circulation are its large volume and high are pliance

123. What proportion of the cardiac output does the liver receive?

The liver receives about 25% of the cardiac output, or about 1250 mL/min. Of this mark proximately three-fourths comes from the portal vein, and about one-fourth comes from the patic artery. Portal venous blood reaches the liver from the intestinal circulation, when the sorbed nutrients from the intestinal villi. Hepatic arterial blood is rich in oxygen and supplet nutritive needs of the hepatic cells. A constant oxygen consumption in the liver is midsigned a variable and efficient.

a variable and efficient extraction of oxygen by the hepatocytes.

What are the pressure in the hepatic circulation?

124 What are the pressure is about 10 mmH2 out. what are the pressure is about 10 mmHg, whereas the hepatic arterial pressure is about 90 potal venous pressure is about 90 potal venous presistance of the upstream vessels is much higher than the potal venous pressure is about 90 potal venous pressure in a potal venous pressure is about 90 potal venous pressure in a potal venous pressure in a potal venous pressure is about 90 potal venous pressure in a potal venous pressure in a potal venous pressure is about 90 potal venous pressure in a potal venous 184. When

portal venous pressure is about 90

portal venous pressure is about 90

portal venous pressure is about 90

Because the resistance of the upstream vessels is much higher than the downstream ves
months Because in the sinusoids is quite low, only about 2-3 mmHg. The portal venous -
portal venous -
and -
portal venous -
and -
an PORBACTERISE the resistance of the sinusoids is quite low, only about 2–3 mmHg. The portal venous circula-te the pressure in the sinusoids is quite low, only about 2–3 mmHg. The portal venous circula-te the pressure in the sinusoids is quite low, only about 2–3 mmHg. The portal venous circula-te the pressure in the sinusoids is quite low, only about 2–3 mmHg. The portal venous circula-te the pressure in the sinusoids is quite low, only about 2–3 mmHg. The portal venous circula-

ger is not autoregulated. ion D.

How does the liver contribute to the overall hemodynamics of the body?

Like How does the liver contribute to the overall hemodynamics of the body?

Like How does the liver contribute to the overall hemodynamics of the body?

How does the liver count is highly compliant. Because of this compliance and the large size of the highlic circulation is highly compliant. Because of this compliance and the large size of the highlighten carries as an important storage reservoir for blood. The limited is the limited of the limited is the limited of the

The hepatic circulations are important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves are increased in the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. The liver normally contains at office the liver serves as an important storage reservoir for blood. the liver serves as a subject to the local blood volume, which can be mobilized by increased sympathetic sympathet www.memory.contains.

An observativity in situations such as hemorrhage. In situations in which venous pressures are in
server situations of blood may be translocated to the liver, causing it to become a little volumes of blood may be translocated to the liver, causing it to become spre-scivity in situations of blood may be translocated to the liver, causing it to become enlarged What are the major characteristics of the intestinal circulation?

What are the major characteristics of the intestinal circulation are responsive to a second control of the intestinal circulation are responsive to a second control of the intestinal circulation are responsive to a second control of the intestinal circulation are responsive to a second control of the intestinal circulation?

What are the major circulation are responsive to changes in sympathetic nerve ac-the wssels of the intestinal circulation are responsive to changes in sympathetic nerve ac-The vessels of the intestinal control as to circulating hormones. Both the resistance and the compliance of the intestinal time will be well as to circulating hormoneant sympathetic control. The intestinal circulations are interestinal circulations. girly is well as to circulating the sympathetic control. The intestinal circulation is highly compli-diculation are under important sympathetic control. The intestinal circulation is highly compli-diculation are subject flow and volume in this vascular bed may cause reduce. distance are under impostment of the interest and a cause reductions of blood flow and volume in this vascular bed may cause reductions of blood flow at so increase Because of the anatomic arrangement of the circulation in the line of the cause of the anatomic arrangement of the circulation in the line of the cause of the anatomic arrangement of the circulation in the line of the cause of the anatomic arrangement of the circulation in the line of the circulation in the line of the cause of the at 9 increased 60000 nonat 9 increased 60000 nonat 9 increased 60000 nonat 9 increased 60000 nonat 90 increased 60000 non nother organs. Because of the property of the control of the contr become ischemic during periods of low blood flow.

127. What is the blood flow to skeletal muscle?

What is the properties with the state of the Siebal muscle DRAM Have to any an analysis and relaxations of small arterioles cause a large per-be issue. At rest, intermittent contractions and relaxations of small arterioles cause a large perto issue. At rest, greenings of the mostle capillary bed to be nonperfused at any given time. As a result, resting muscle regge of the mostle capillary bed to be nonperfused. mage of the muscle capaniary and the muscle baselow blood flow (approximately 2-3 mL/min/100 g). During exercise, arterioles within the muscles within the muscles of the m has also blood flow can increase dramatically (up to 100 mL/min/100 g in some muscles).

128. How is skeletal muscle blood flow controlled?

RING B SECTION AND ACTION AND ACTION AS THE SECTION OF A SECTION AS A Alter, Manual Instability of fects with the sympathetic effects dominating. During active gack contaction, the local release of vasodilator metabolites, thought to include potassium, (0), bein said, or pH, provides the major control, completely overriding the sympathetic neural eless (functional hyperemin). The contraction of the muscle itself also plays a role in blood flow nation is skeletal muscle, with maximal flow occurring during the periods between muscle contractions when the vessels are not being compressed by the muscle fibers.

129. What is unique about the cerebral circulation?

A constant blood supply to the brain is critical because even brief periods of ischemia can take inversible tissue damage. This constant blood flow is supported by an anatomic vascular pates comprising many anastomoses, or alternative pathways for blood flow in the brain and Store local control of resistance. On a moment-to-moment basis, blood flow in the brain is mainand by this local autoregulation and under some extreme conditions by initiating powerful reto so maintain arterial blood pressure. Generally, total cerebral blood flow is maintained con-See with blood being shunted to areas of high metabolic activity. For example, activation of treal oract by a flashing light pattern on the retina increases blood flow only to areas associated with vision and not to other cortical areas.

De. How is cerebral blood flow regulated? Central blood flow regulated?

Central blood flow is regulated almost exclusively by metabolic factors such as CO₂. K⁺. and demonst. Although cerebral blood vessels are innervated by sympathetic nerve fibers, their sk a fib.

the a the control of blood flow is not clear.

an

131. What is the blood-brain barrier? What is the blood-brain barrier?

What is the blood-brain barrier?

The capillaries of the cerebral est of the body. This barrier to the movement of substances in other areas of the body. This barrier to the movement of substances in other areas of the neurons from effects of substances. 131. What is the blood-unit of the carebral circulation are significancy reas permeable to proceed the corebral circulation are significancy reasonable to proceed the core of the body. This barrier to the movement of sec The capillaries of the control of the capillaries of the body, this obtains to the movement of sale. Performed and ions that capillaries in other areas of the body in the capillaries in other areas of the body in the capillaries in other areas of the body in the capillaries in other areas of the body in t the blood and is referred to as the blood with the blood and is referred to as the blood and i

132. What is the main function of the skin circulation?

What is the main function of the skin circulation:

In addition to supplying nutrients to the tissue, the skin circulation aids in the replaying nutrients to the tissue, the skin circulation aids in the replaying when the body temperature is clevated, these vessels dilate to delive the control of the property of the control of the con 132. What is the usual results in the usage, the second in the replaint in addition to supplying nutrients to the usage, these vessels dilate to diffuse the second in the body temperature. where it can be coosed. Classes excusive conditions when been nearly complete constitutions of skin blood to the body surface, where it can be construct, resulting in a nearly complete constitution of skin blood to the body surface.

133. How is the skin blood flow controlled?

How is the skin blood flow controtreu:

Blood flow to the skin is the most variable in the body. Skin blood vessels dilate directly advantated in response to cold. Most of the control occurs by Symmulus... Blood flow to the skin is the most reasons to cold. Most of the control occurs by sympathic response to heat and constrict in response to cold. Most of the control occurs by sympathic response to heat and constrict in response to heat and construct in response to heat and const response to heat and constrict in response to heat and construct in respon activity evolution of including the second of the cardiac output when body temperature is markedly elevated.

134. What are the factors that influence the blood flow to the heart? Physical factors

Neural and neurohumoral factors Metabolic factors

Metabolic factors
The physical factors include maintenance of blood pressure and the squeezing of the blood The physical ractors increase. In contrast with other organs, the heart is responsible for near

vessels during caturate Constitution of this, decreases in cardiac function may be amplified by teat. taining arterias pressure. December of the pressure, which result in reductions in coronary blood first at ing hans in curous y men, permission of the perfusion of heart occurs during diastole because this is the period when the cardiac muscle relaxes, along passage of blood through the vessels. During systole, the contraction of the ventricles cases age travascular compression, which can completely stop blood flow through the coronary vasculane.

135. What is the most important regulator of coronary blood flow?

The coronary circulation supplies the metabolic needs of the cardiac tissue. One of the next striking characteristics of the coronary circulation is the tight coupling between blood flow at metabolic activity. Thus, metabolic autoregulation and functional hyperemia play the motion portant role in the regulation of coronary perfusion. The mechanism for this link between cartax metabolic rate and coronary blood flow is still not completely understood. What is known is that a decrease in the ratio of oxygen supply to oxygen demand causes the release of a point was sodilator substance into the interstitial fluid of the heart, where it can relax coronary blood sels in an attempt to normalize blood flow.

136. How important is the neural regulation of coronary blood flow?

Neural regulation of coronary blood flow is much less important than the metabolic and tion. Activation of cardiac sympathetic nerves, which increase heart rate and contractility cases an increased rate of coronary metabolism and thus acts indirectly to increase blood flow.

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