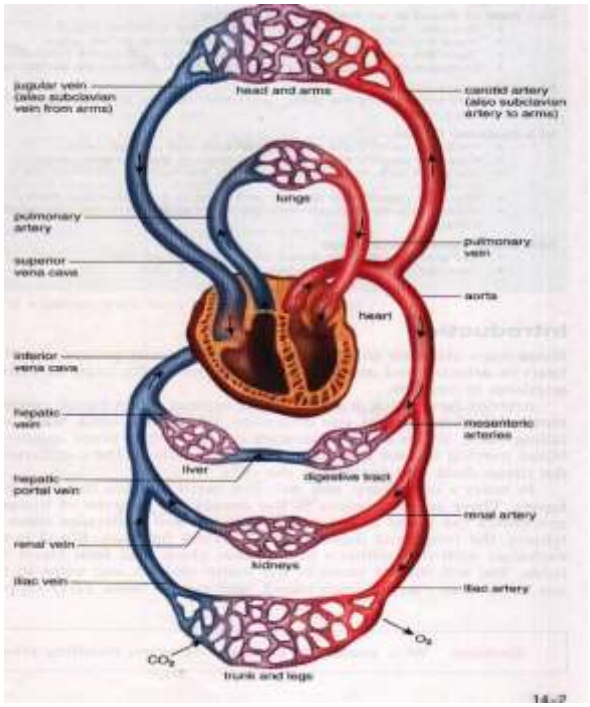
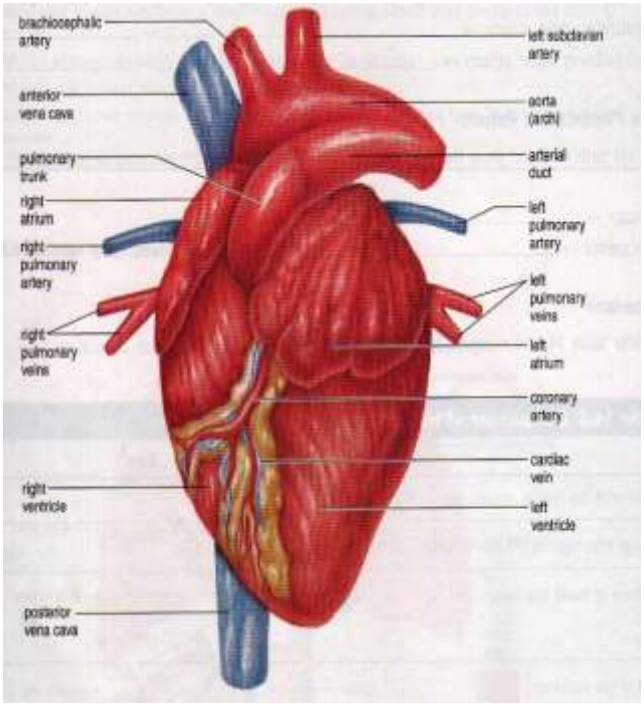
# Cardiovascular system

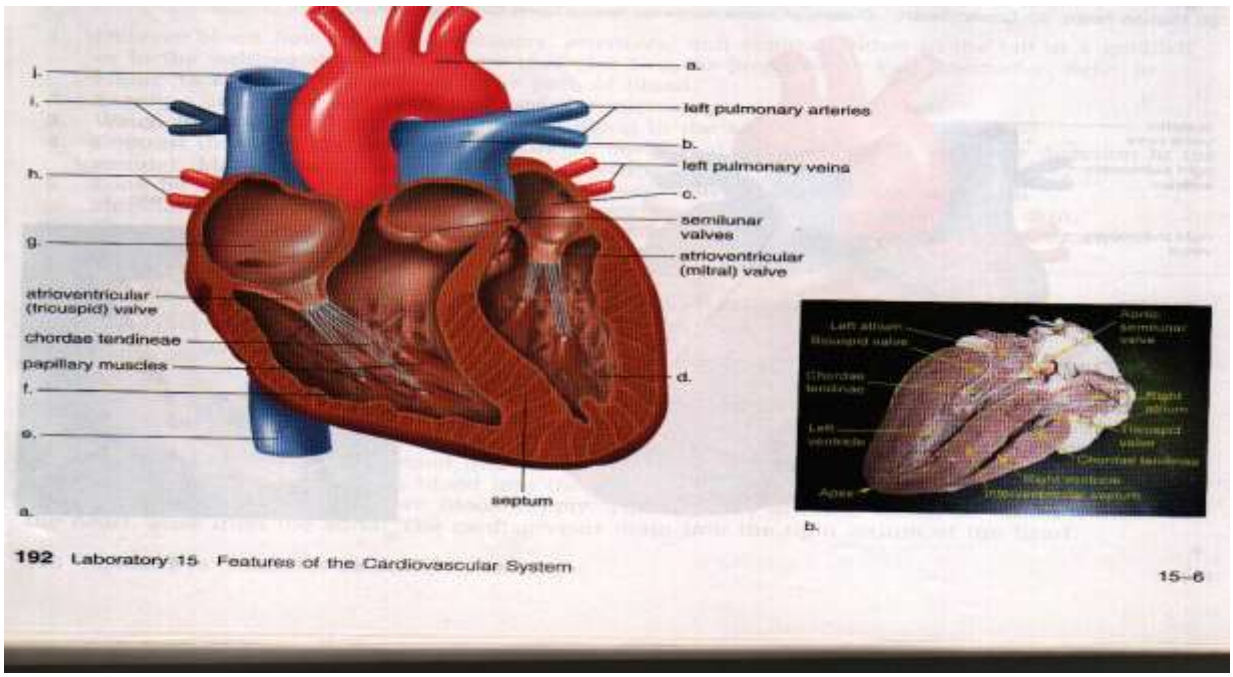
**CVS composed from :**

**1.Heart.**

**2.Vessels which include arteries, veins and capillaries.**



**Heart :**

**in mammals heart contain four chamber (2atria and 2ventricle). The inter atrial septum located between right and left atria. The inter ventricular septum located between right and left ventricle.**

**The atrio-venticular septum separated two atria (right and left )from two ventricles(right and left).**

**All these septa allow the diffusion of electricity except the last one(atrio-venticular) because it is fiber in nature and act as insulator.**

**Cardiac valves: 1.mitral valves: bicuspid valve that located between left atria and left ventricle, act very hard work because the left side of the heart is exposed to higher pressure and have must be strong stress to direct the blood to several part in the body.**

**2.tricuspid valve:located between right atria and right ventricle.**

**Special 2 structures in the ventricle; a.corodae tendon. b.papillary muscles.**

**3.aortic valve:in the beginning of aortic artery. 4.pulmonary valve: in beginning of pulmonary artery.**

**Conductive system: special structures in the heart which formed and transmit action potential of the heart to all cardiac muscle.**

**Composition of conductive system:**

**1.SAN or sino-atrial node( pace maker):group of small crescents nerve cell, 1cm in length which start action potential because it has no resting state. Located in the upper right side of right atria.**

**2.AVN atrio-venticular node: contain less number of cells( therefore less frequency of action potential in absence of SAN). It function receive impulses from SAN transmit it to bundle of His.**

**3.bundle of His: group of short fibers located in the atrio-venticular septa, transmit impulses to purkunje fiber.**

**4.purkunje fiber: group of long fiber extend from his bundle into right and left ventricles.**

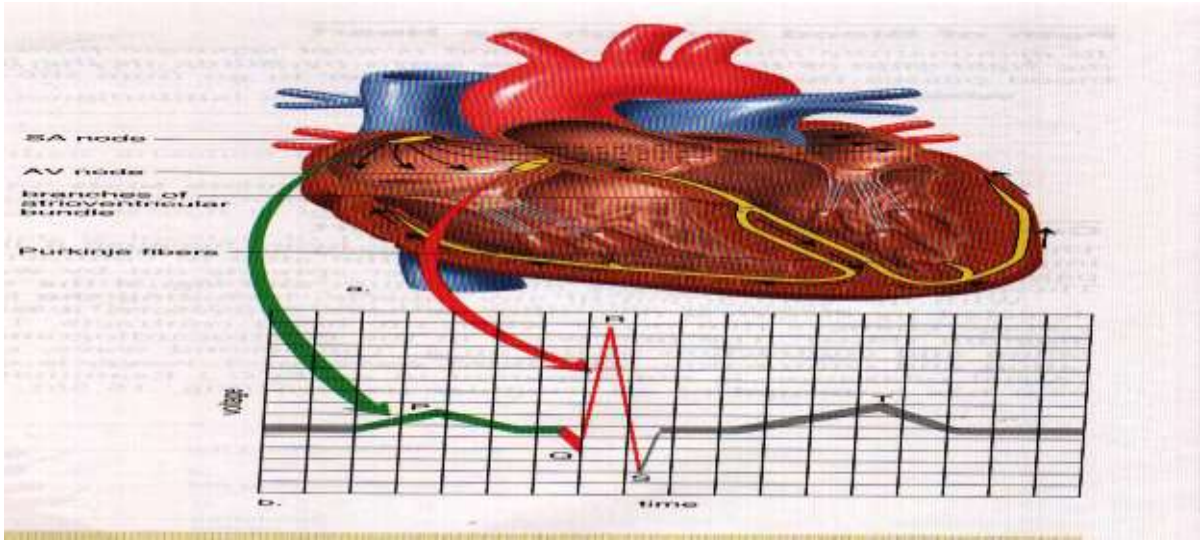
**Transmit impulses to all ventricle muscles.**

**Electrocardiogram ECG**

**ECG composed from waves and periods.**

**Waves:**

**1.P_wave: mean depolarization of both atria. This wave is small because the muscle of atria is small. i.e number of cell is little.**




**2.Q_wave :depolarization of atrio-venticular septum.**

**3.R_wave depolarization of ventricular muscle. This wave is great because ventricle muscle is large.**

**4.S_wave depolarization of last part of ventricles located below the atrio-venticular septum.**

**5.T_wave repolarization of both ventricles.**

**Periods: measured horizontally . 1.P- period. 2.P-R period. 3.QRS complex period. 4.Q-T period.**

**Cardiac disorder:**

**1.ventricular hypertrophy: increase of heart muscle size lead to increase cardiac muscle contraction, this condition occur in marathon sportage, heavy weight handing.**

**The ECG read prolong R-wave and bizard QRS complex period.**

**2.Right and left purkunje fiber branches block. The ECG read very prolong bizard QRS complex.**

**3.pericardial inflammation: lead to increase of pericardial fluid amount this isolate the electricity from recording. The ECG read decrease in ECG voltage.**

**4.Pulmonary emphysema: Occur in asthma and smoker in these case the act as balloon envelope the heart. The ECG also read decrease in ECG voltage.**

**5.angina pectoris: Pain in chest region and extended to neck. decrease blood flow to cardiac muscle.**

**Cardiac cycle:**

**Rhythmic contraction and relaxation of cardiac muscle or systolic and diastolic of cardiac muscle.**

**This process combined with physiological changes include: 1.pressure changes in atria and ventricular chamber. 2.changes in atria and ventricular chamber size.**

**3.electrical changes in addition to continuous sound or rhythmic sound. *the period of systole is shorter than diastole period this important to maintain heart activity (rest of heart muscle).**

**Stages of cardiac cycle:**

**1.late diastole: events in this stage are: a. the cardiac muscle diastole or relax. b. the atrio-venticular valve opened. c.the semi lunar valve closed(in the beginning of aorta and pulmonary artery).**

**d. the blood flow in caudal and cranial vena cava and pulmonary veins) to fill70% the two atria and pass to two ventricles.**

**2.atrial systole: the atria muscle contract to push addition30% blood to ventricle.**

**3.isometric ventricular contraction. the fill of ventricles lead to close of atrio-venticular valve this lead to increase pressure inside the ventricle because all4 valves are closed.**

**4.venticular ejection: The contentious increase in pressure inside the ventricle lead to opened semi lunar valve and eject blood to aorta and pulmonary artery.**

***volume of blood ejected from left side to aorta=volume of blood ejected from right side to pulmonary artery. *the ventricle don't eject all blood but always there is residual volume 50 ml.**

**5.iso metric ventricular relaxation: -The ventricle muscle relax or diastole. -all the valve are closed therefore the relaxation don't combined by changes in length. -this stage is end due to decrease pressure inside ventricle more than atria this lead to open atrioventicular valve and flow the blood and begin another cycle and so on.**

**Heart sounds:**

**The heart sound resulted from the closure of valves. The function of valve is prevent return of blood reverse direction. The sound of heart are lub…dup.**

**Lub(first sound) resulted from closure of atrioventicular valve**

**Dup(second sound)resulted from closure of semi lunar valves of aorta and pulmonary artery.**

**The third sound heard only in human cardiac cycle due to passages of blood from atria to ventricle during the last period of relaxation or diastole.**

**Fourth sound resulted from atria systole this sound is difficult to hear due to combined this sound with the first one.**

**The sound recorded by sensitive microphones and phonocardiography.**

**Cardiac out put: Volume of blood ejected from each ventricle per one minute.**

**Factor affected the cardiac out put(CO):**

**1.volume of blood ejected from each ventricle(stroke volumeSV)per beat.**

**2. heart rate HR in one minute: number of heart beat in one minute. CO=SV×HR**

**The volume of blood which inter and leave the heart in the right side=volume of blood which inter and leave the heart in left side. If difference occur the cardiac cycle will disturbance and stop blood flow.**

**Heart rate:**

**The heart rate is faster in small animal than large animal due to 1.metabolism:which need large amount of o2 to organ and remove the metabolic waste product.2. the limit effect of vagus nerve.**

**Other factors affected the heart rate are: Size, age, environment, nutrition, rumination, pregnancy, lactation, during inspection, position stand or lay, stand increase 5-7 beat than lay.**

**Also HR increase during exercise or running and excitation this increase lead to irregular of cardiac muscle activity because of shortening of diastole period.**

| Animal | Heart rate |
|---|---|
| Elephant | 20-30 |
| Camel | 25-30 |
| Horse | 32-60 |
| Cow | 60-70 |
| Sheep and goat | 70-80 |
| Dog | 70-160 |
| Cat<br>Chiken<br>Mouse | 110-130<br>200-400<br>500-1000 |

**Neural control of heart rate: The heart systole and diastole spontaneously(absence of nerve supply, this due to presence of conducting system. Even after death the heart still pulse for several time.**

**Normally the heart rate increase or decrease under certain condition due to the effect of autonomic nervous system (sympathetic and parasympathetic).**

**Also there is central control on heart rate from central nervous system present in medulla oblongata:**

**1.cardiac inhibitory center: this center release inhibitory impulses through the vagus nerve to sino-atriol node (SAN) and atrio ventricular node (AVN).**

**2.cardiac accelerator center: this center associated with sympathetic branches which activate SAN and AVN.**

**In rest the heart under the effect of inhibitory center in order to make the heart act with normal limit rate.(the vagus nerve act as brake to limit the HR.**

**Vagus activity lead to HR and visa versa.**

**While not only increase in accelerator center activity in exercise and excitation lead to HR but also due to effect of norepinephrine and epinepherine from adrenal medulla.**

**In addition to temperature, thyroxine hormone and pain lead to increase HR.**

**Blood vessel and blood flow:**

**1.arteries: transport blood from heart to all body tissues.**

**2.capillary:for exchange nutrition between body tissues and blood.**

**3.vein: act as reservoir of blood in addition to return blood to from body organs to heart.**

***60-80% of blood present in vein. *the diameter of vein is larger than arteries.**

***it thickness less than arteries. *the veins contain valves which prevent return of blood.**

***the veins are nearest to skin than artery. *histology the smooth muscle of vein less than artery.**

***the large artery aortic arch and carotid sinus contain nerve receptor sensitive to pressure change in artery. *the wall of large blood vessel contain vasovasorum(small blood vessel supply the blood vessel it selves). *also large artery differ from small artery in there contains of connective tissue and smooth muscle; connective tissue in large artery is more than small artery while smooth muscle in small artery is more than large artery , therefore the resistance in small artery is great in arteriole and the large artery more elasticity than arteriole.**

$$\text{Blood flow} = \frac{\text{pressure}}{\text{Resistance}}$$

**This mean increase pressure lead to increase blood flow while increase resistance lead to decrease blood flow. The blood flow inside the blood vessel is laminar (the middle faster than peripheral).**

**the precise cause of blood flow is the activity of the heart and pressure differences between artery and veins. The pressure of artery more than veins either in systolic or diastolic of the heart.**

**The variant in pressure is important for filtration and re absorption.**

**Factor affecting blood pressure:**

**1.peripherial resistance: It is a force against blood flow in the different part of the body away from the heart and large artery specially in arterioles.**

**2.cardiac out put: increase CO lead to increase arterial blood pressure.**

**The blood pressure decrease in bleeding due to decrease blood volume.**

**3.viscosity of blood:is 3times more than distilled water.**

**Polycythemia(increase number of RBC above normal) lead to increase viscosity.**

**Anemia lead to decrease viscosity . Protein concentration also increase viscosity. Increase viscosity of blood for any resin lead to increase blood pressure.**

**Factors affected the diameter of arterioles:**

**1.The arterioles composed from smooth muscle, this smooth muscle always in partial contraction in order to produce partial resistance to blood flow and maintains normal blood pressure.**

**This contraction due to continuous stimulation from sympathetic nervous system called sympathetic tone which controlled by vasomotor center V.M.C. in medulla oblongata.**

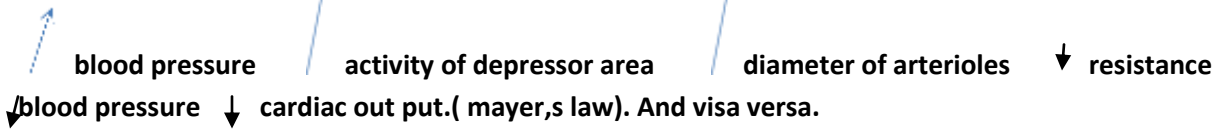
**Stimulation of certain part of V.M.C lead to increase blood pressure and heart rate (tachycardia).**

**This V.M.C. center contain 1.pressor area 2.depressor area.**

**2.baroreceptor: a. aortic body in aortic arch b.carotid body and sinus in common carotid artery .**

**These two receptors are play important role in regulation of blood pressure.**

**a. aortic body in aortic arch b.carotid body and sinus in common carotid artery .**



**blood pressure activity of depressor area diameter of arterioles resistance blood pressure cardiac out put.( mayer,s law). And visa versa.**

**3.increase co2 and decrease o2 lead to stimulation of V.M.C. either directly or indirectly through chemreceptor present in carotid and aortic body.**

*** increase co2 direct effect on center while decrease o2 effect in chemoreceptor.**

***the V.M.C activated by inspiration.**

***the baroreceptor stimulated by manual pressure on neck dilate artery blood pressure disturbance in balance and comma.**

**4.metabolism: running lead to increase o2 consumption co2 production K release from skeletal muscle and body temperature.**

**5.certain hormones and factors: stenosis of the artery due to the effect of epinephrine, norepinephrine, serotonin, angiotensinogen and acetylcholine.**

**Methods of measuring blood pressure: 1.direct method. 2.indirect method.**

**Circulation of venous blood:**

**The blood flow inside vessels depend generally on systolic and diastolic. The pressure inside veins less than artery and reach to zero; therefore the factors that lead to flow of blood inside veins are:**

**1.Negative pressure inside thoracic cavity: the disturbance of pressure inside thoracic cavity during each inspiration pull the blood from veins toward the heart.**

**2.increase pressure inside abdominal cavity due to diaphragm contraction during inspiration lead to squeeze of blood and pull it toward the heart.**

**3.the negative pressure inside pleural cavity (less atmospheric pressure also pull the blood toward the heart.**

**4.Skeletal muscle also squeeze the blood inside veins and push it toward the heart.**

**5.valves inside veins prevent return of blood.**

**Circulation of blood inside certain organs:**

**1.brain: the brain differ from other organs that it is not receive blood from one artery but there are four main arteries supply the brain.**

**a. two vertebral arteries; which combine to form basilar artery.**

**b. two internal carotid arteries; which combine with basilar artery to form circle of willis located beneath the brain. The supply of brain by O2 and nutrient are important because any disturbance in blood supply lead to degeneration of brain tissue which is difficult to regenerate.**

**Blood Brain Barrier: BBB Composed from brain blood capillaries and tissue which surrounding it.**

**The precise function of BBB is maintains of internal environment of neuron in the central nervous system.**

**The entrance of substances to**

**lipid soluble**

**brain =**

**size of molecule.**

**Polar substances pass slowly. $H_2O$ and $CO_2$and $O_2$ pass easily. Glucose passes slowly (the nutrient of brain). Protein pass within certain limits.**

**2.coronary circulation: The blood supply of the heart are: by the right coronary artery and left coronary artery which they branches from aorta. these arteries are always opened during cardiac cycle.**

***The blood flow increase during diastolic and decrease but not stopped during systolic.**

***The sympathetic and parasympathetic dilate coronary artery, also increase $co_2$ and decrease $o_2$ lead to dilate coronary arteries which are important for facilitate blood flow to the heart muscle in exercise and excitation.**

**3.pulmonary circulation: the pulmonary circulation is the movement of blood from right ventricle of the heart to the lungs and return to the left atria through 4 pulmonary veins.**

**The pulmonary artery is differ from aorta that is shorter than aorta, wide diameter, less thickness, and its capability to dilate is high than aorta, the pulmonary capillaries is wide,**

**therefore the pressure inside the right side less than left side, this is important because it make the hydrostatic pressure in pulmonary artery less than oncotic pressure in plasma (to prevent fluid accumulation inside the lungs).**

**4.hepatic circulation: the blood enter the liver through:**

**a.hepatic artery which supply 1/3 the liver tissue.**

**b. portal vein this blood transport the absorptive nutrient from intestine to the liver.**

**5.fetal circulation: the fetal cardiovascular system act as respiratory system, digestive system and renal system, therefore the blood circulation in uterus is high in pregnant.**

**The exchange of substances between fetus and maternal is through placenta(structure between endometriam of uterus and fetal capillaries act as connection between maternal blood and fetus blood).**

**The blood of fetus aorta is non oxygenated and contain metabolites that exchanged with maternal blood through placenta and return to fetus by umbilical veins directly to caudal vena cava of fetus( to the blood of lower part of the body) right atria left atria through oval foramen left ventricle then to aorta.**

**While the blood come from upper part of the body reach to right atria through cranial vena cava(non oxygenated)to right ventricle then pump to pulmonary artery.**

**The blood pressure is high inside pulmonary artery (due to collapse of lungs and give high resistance) more than aorta therefore the blood pass to aorta through *ductus arteriouses(duct between pulmonary artery and aorta)* and mixed with aortic blood which ejected by left ventricle.**

***the fetus live under hypoxic condition therefore the Hb-F compensate by high reaction with o2, and the HR of fetus more than adult.**

**Changes in fetal circulation at birth:**

**The dissipate of umbilical cord at parturition lead to several changes in blood circulation;**

**1.stenosis of umbilical vessel due to local changes in O2 and CO2 concentration.**

**2.closure of portal hepatic cord this need several weeks or months.**

**3.decrease blood in caudal vena cava lead to decrease pressure inside the veins.**

**4.at the same time the respiration process begin.**

**5.the return of blood to the left atria by 4 pulmonary veins lead to increase pressure inside left atria this lead to closure of oval foramen.**

**6.stenosis of ductus arteriosus through minutes after parturition.**

**Congenital cardiac disorder:**

**1.patent ductus arteriouses:**

**The ductus arteriouses still opened during the first weeks after parturition, lead to machinery murmur resulted from passages of blood from aorta (high pressure) to pulmonary (lower pressure) this sound high during systolic and decrease during diastolic. Common in domestic animals, treated by surgery.**

**2.defect in closure of oval foramen (between left and right atria). This case lead to systolic murmur and treated by surgery.**

**3.valuvular disturbance:**

**a.stenosis semilunar valve (in the beginning of aorta and pulmonary) either congenital or acquired lead to decrease blood flow also lead to systolic murmur.**

**While the stenosis of atrioventicular valve lead to diastolic murmur.**

**b.valvular insufficiency or incompetency:**

**atrioventicular valve insufficiency lead to systolic murmur.**

**Semilunar valve insufficiency lead to diastolic murmur.**

**Blood and cardiovascular system in birds or avian:**

**1.erythrocytes are oval and nucleated.**

**2.thrombocyte are large and nucleated.**

**3.neutrophil called hetrophil.**

**4.B-lymphocyte maturated in bursa of fibrecious.**

**5.glucose is double than in mammals.**

**6.low plasma protein.**

**7.avain are homoeothermic organism, the cardiovascular system play important role in conserving and removing of body heat.**

**8.heavior heart relative to a given body, may be due to high aerobic power input needed to sustain flight, bigger stroke volume and cardiac out put.**

**9.the heart slightly to the right of midline.**

**10.left atrioventicular valve are tricuspid.**

**11.right atrioventicular valve is a single spiral flap of myocardium.**