PASSION ACADEMIC TEAM

YU - MEDICINE

Cardiovascular System

Sheet# 10

Lec. Date :

Lec. Title : Coronary Circulation

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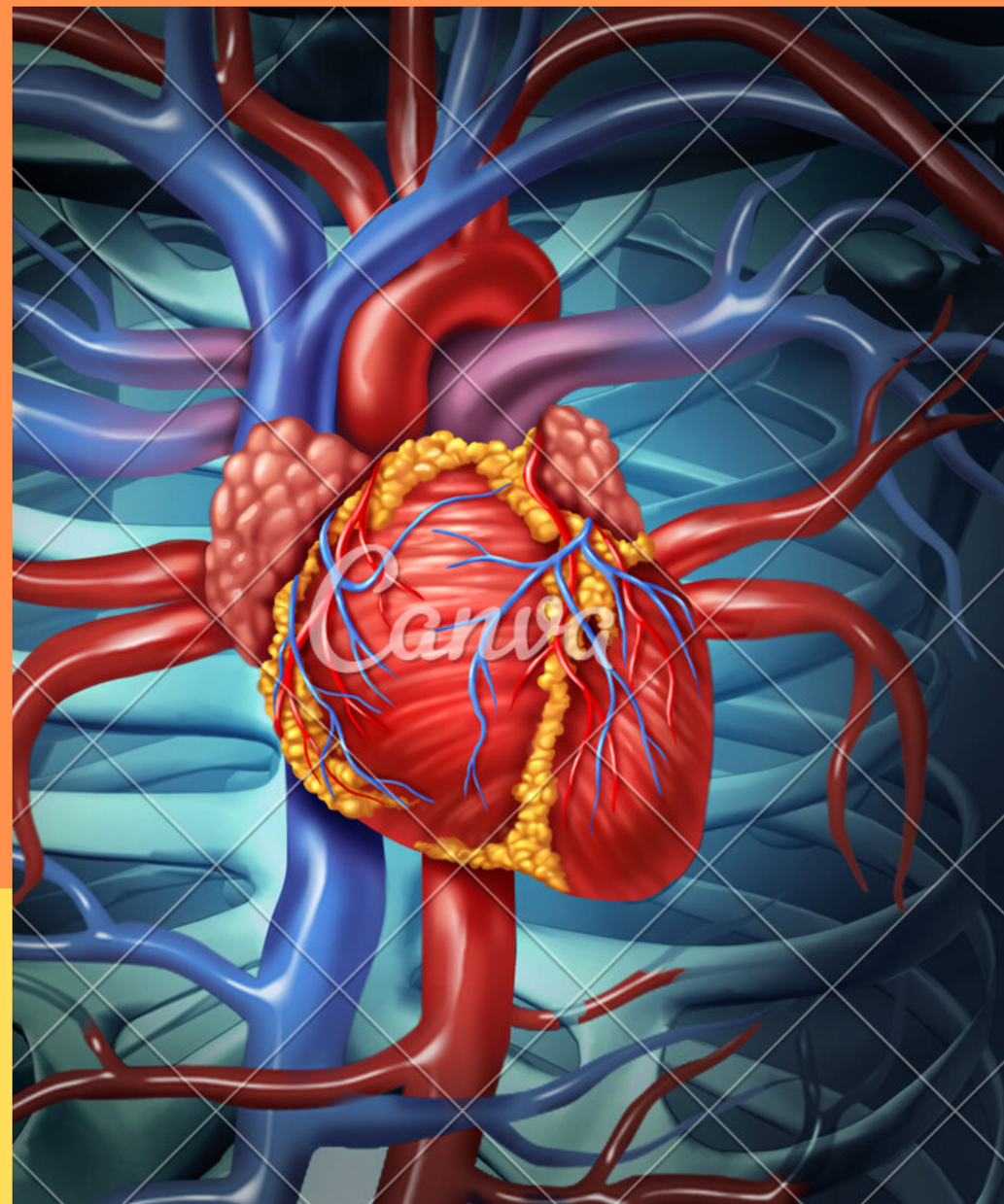

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lec 10

CORONARY CIRCULATION

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Objectives

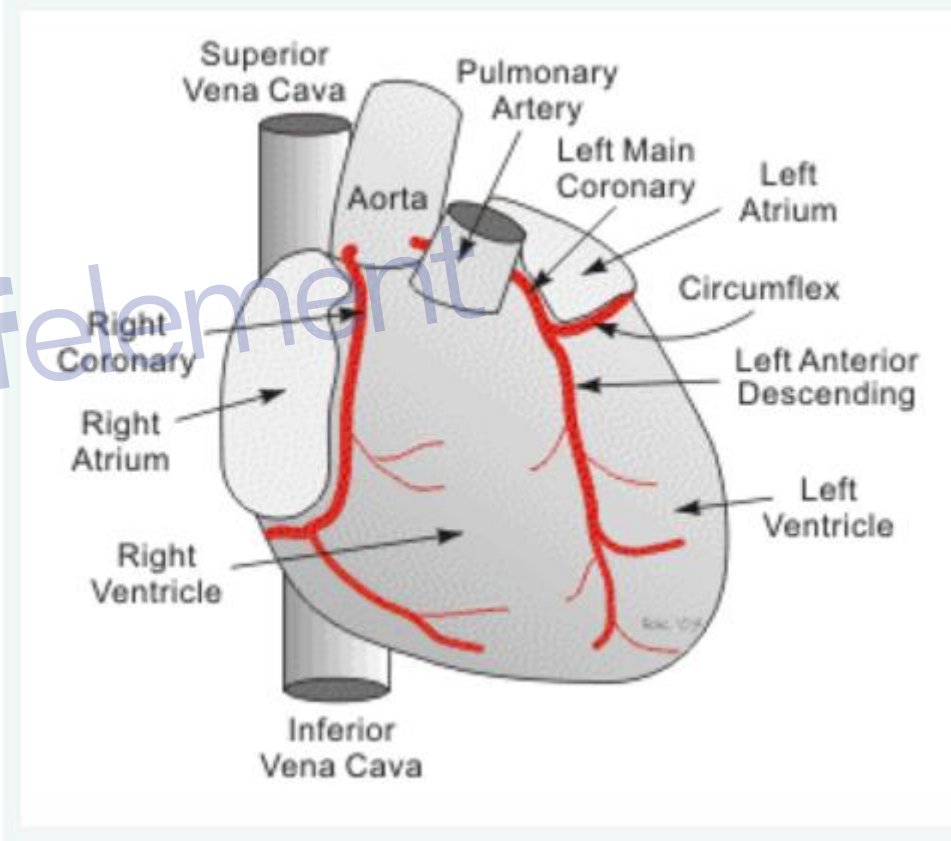
- Review the functional anatomy of coronary circulation
- Recognize the importance of phasic changes in coronary blood flow
- Describe the factors affecting the coronary blood flow
- Recognize the clinical significance (CAD)

DISTRIBUTION OF CORONARY BLOOD VESSELS

- **CORONARY ARTERIES:**

1- Right coronary artery: supplies blood to the right ventricle, the right atrium, the posterior part of left ventricle, the posterior part of interventricular septum and major portion of the conducting system of heart including SA node

2- Left coronary artery: supplies blood mainly to the anterior part of left ventricle, left atrium, anterior part of the interventricular septum and a part of the left branch of bundle of His



SLIDE 3

#Coronary arteries * originated at the base of aorta from opening called coronary ostea.

*coronary ostea located behined the leaflet of aortic valve: Coronary arteries devide into right and left CA.:

#Left coronary arteries devided into 2 branches:

This 2 branches: 1) Left anterior descending branch 2) Circumflex branch

#At right coronary arteries* As we see > It supply blood to the right porthion of the heart, while the left coronary arteries supply blood to the left Portion (But we have varieties)

#Aproximatly 50% of population the right coronary artery→gives branch Posterior descendine vessels that supply blood to the heart posterior aspects

#20% of population left coronary artery is **dominant** in supplying blood to the ventricles . While in 30% of population the right and left coranary arteries delivered a same amount of blood and neither is dominant

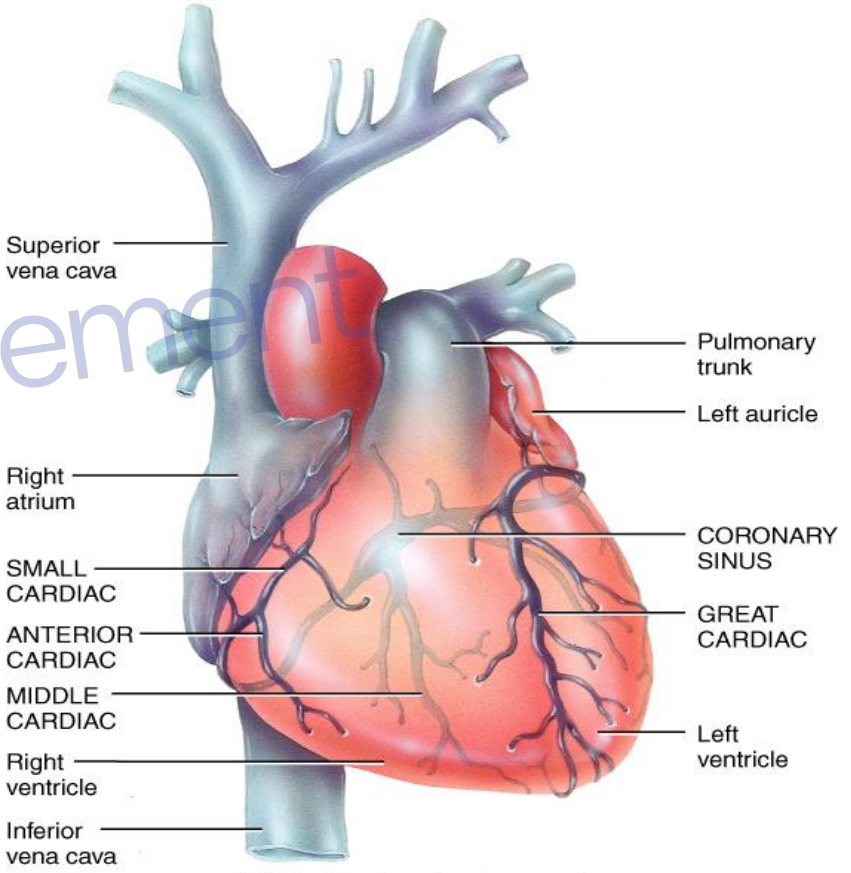
DISTRIBUTION OF CORONARY BLOOD VESSELS

- Coronary venous drainage occurs through three systems:

- Most of the venous blood flow from the left ventricle muscle returns to right atrium by the way of the coronary sinus, which is about 75% of the total coronary blood flow.

- Most of the venous blood flow from the right ventricle to right atrium occurs through the small anterior cardiac veins.

- Thebesian Veins
  - Thebesian veins drain deoxygenated blood from myocardium, directly into the concerned chamber of the heart.
  - PHYSIOLOGICAL SHUNT?



(b) Anterior view of coronary veins

20.08b

#Coronary venous drainage occurs through **3** systems :

1)Coronary sinus 2) Anterior cardiac vein 3) Thebesian vein

1 is a wide vein and this vein drains most of the venous blood from the myocardium of the heart

But mostly from the left ventricle and flows into the right atrium

2 drains venous blood Mainly from R. Ventricle and drain in R. Atrium

3 constitunt the deep venous system> this vessel drains only about 10 % of the venous blood from the myocardium directly into various cardiac chambers.

it is not necessary only to the right atrium, possible to the left ventricle and thus this 3 system contributes to the **anatomical shunt**

* This venous drinage system contribute to an anatomical shunt effect تم الحديث عن هذا في rs

*75% venous return to right atrium happen by coronary sinus + less than 10% by the besian + The rest by anterior cardac vein

CHARACTERISTICS OF THE CORONARY CIRCULATION

The sixth and seventh points were not mentioned by the doctor in the record

1) It is very short and very rapid (so it is essential to the heart).
2) The blood flow in this circulation occurs mainly during cardiac diastole
3) There is no efficient anastomoses between the coronary vessels.
4) It is a rich circulation, under resting conditions coronary blood flow is about 225 ml/ minute (5% of the CO while the heart weight is 300gm).
5) Its regulation is mainly by metabolites and not neural
6) At rest, the heart extracts 60-70% of oxygen from each unit of blood delivered to heart [other tissue extract only 25% of O_2].
7) In severe muscular exercise, the coronary blood flow may be increased threefold to fourfold to supply heart with the extra nutrients needed.

1)It is very **short** and very **rapid** (so it is essential to the heart).

*Thus it works to supply the heart wall(myocardial cells) very quickly

*and this system is very short (no friction and no resistance)

2) The blood flow in this circulation occurs mainly **during cardiac diastole**.

3)This circutatory system **doesn't have effeciant anastomoses** between the coronary vessels or there is no anastomosis never.(So coronary arteries appear to function as end arteries)

arterial occlusion > fomation anastomosis >allow to anastomosis between vessels to be functional

#we have 2 type of anastomosis:

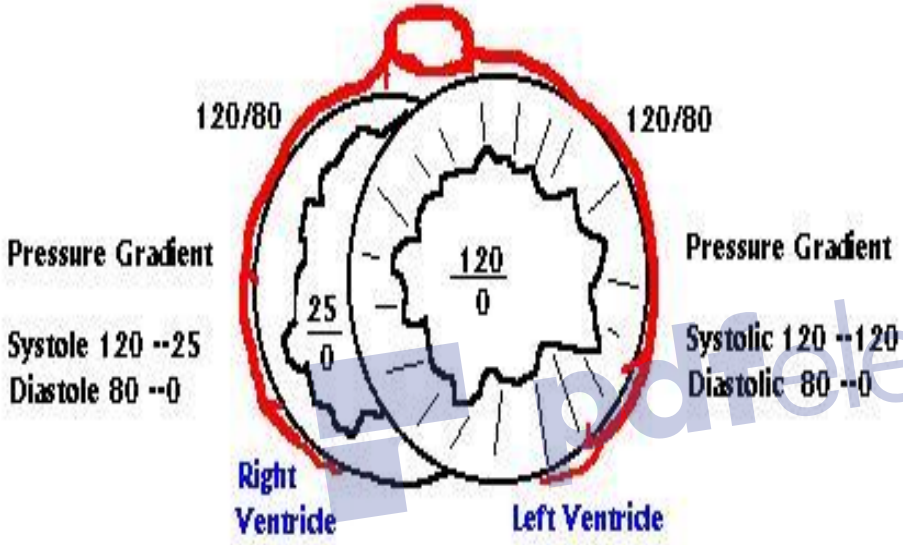
1) Cardiac anastomosis (anastomosis between branches of coronary arteries and deep venaus system. 2)Extracardiac anastomosis (between cardiac vessels and Vessels line near the heart but it is not part of heart). Like Vasa vasora of pulmonary arteries

5)**Regulation** of coronary blood flow is mainly occures **by metabolites** by local changes,And not by neural mechanism .

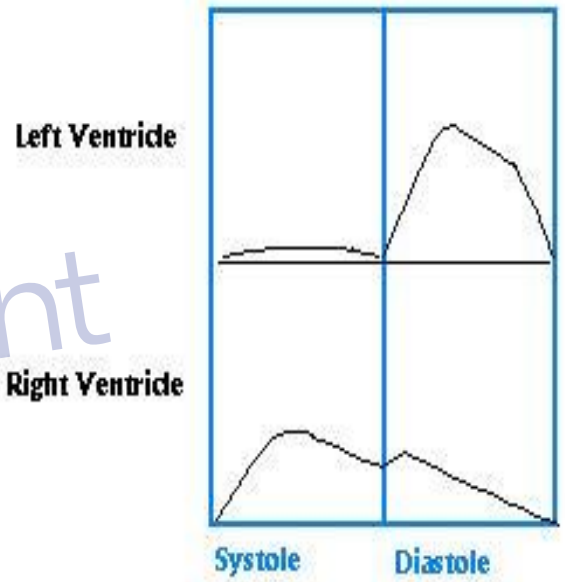
6) 60-70% of O2 extracted by the heart tissue ? (heart is highly oxidated tissues) many more of mitochondria up to 40% of cardiac cell occupid by mitochondria.

In the opposite side the other tissues they extract only 25% of O2 * the heart extracts 60-70% of O2 from each unit of blood

PHASIC CHANGES IN CORONARY BLOOD FLOW



Pressure gradients between the ventricular lumen and the coronary arteries



Coronary Blood Flow during the cardiac cycle

- The coronary blood flow is determined by the balance between
  - pressure a head (i.e. aortic pressure) and
  - the resistance (i.e. extravascular pressure exerted by the myocardium on the coronary vessels) offered to the blood flow during various phases of cardiac cycle

Phasic changes in coronary blood flow:

a. Left ventricle - phasic or intermittent flow - flow during diastole

b. Right ventricle – continuous flow - flow during both diastole and systole

Phasic changes in coronary blood flow. Blood flow in systemic vascular bed be high at systole and low in diastole. so it parallel with pressure profile in aorta.

*However in coronary circulation blood flow is some what paradoxical???. Perfusion pressure. responsible for coronary ciraulation(it's Pressure resulted from constriction of the heart) *So the heart is the source of its own perfusion pressure

*But I have in the opposite > myocardial contraction>generate perfusion pressure > and at the same time compression the vascular tissues of the heart > they compress its own vascular supply.

*So the heart. Yes, give me its own perfusion pressure but at the same time because of the myocardial muscle contraction also the heart compresses the vascular supply > also collapse compreses the blood vessels(coronary) that nourish the heart muscle

*So profile of blood flow through the coronary arteries dependent on 2 thing : 1)Perfusion pressure in the aorta.
2) Extravascular campression (resulting from myocardium cotraction).

When we look at the image on the left, which is a clip of left and right ventricles and aorta.

#We notice that during the contracting of the heart, the pressure generated in the left ventricle is equal, or just a little over than 120, and in the aorta is equal to 120

#During diastole, the pressure of the left ventricle is equal to zero, but due to the wandkassel effect , the pressure in the aorta is 80

in the image you can see pressure gradiant

L.V

*During systole >> no blood flow >>> delta p=0

*During diastole >>blood flow >>> delta p =80

R.V

*During systole >> significant blood flow >>> delta p =95

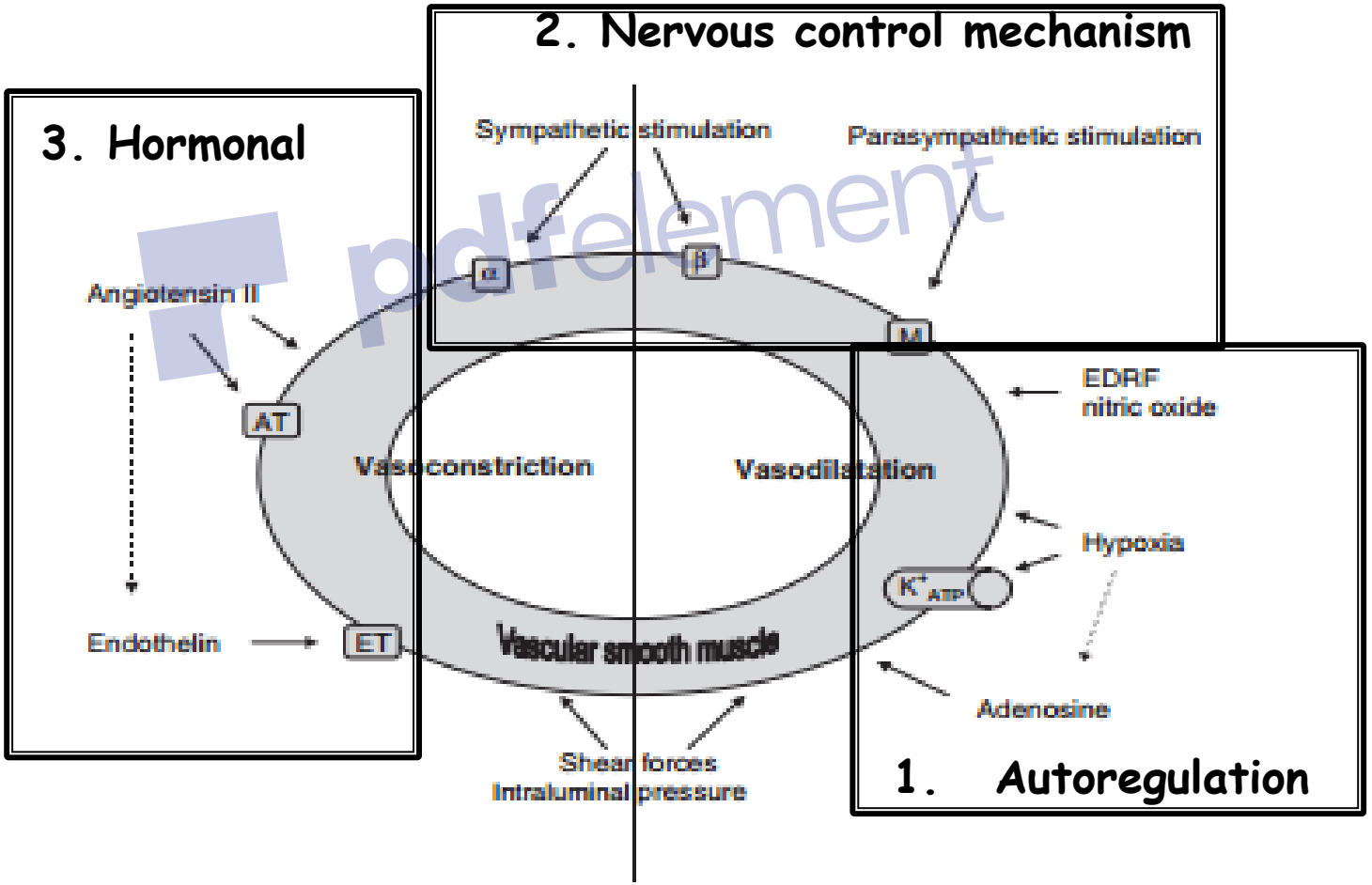
*During diastole >> gretest blood flow>>> delta p=80>>> His time period is longer

##L.ventricel can cause sever mechanical compresion of subendocardial vessels . not subebicardial vessel . both filling but endo cardial more compression.

R.ventricle can cause modest mechanical compression of myocardial vessel (less muscle than L.V)

subebicardial vessels filling during systole flow #subendocardial vessels filling during diastole flow

REGULATION OF CORONARY BLOOD FLOW



Requlation of coronary blood flow through coronary vessels is determine by the same phisical factor that manage systemic flow

$$Q = \text{Delta } P / R$$

Systemic blood flow is affected by factors(delta p & R) that influence coronary vascular flow

1) delta p >> driving pressure determined by aortic blood pressure and right atrial pressure. as we mentioned in previous lecture > (main arterial blood pressure in aorta - Aortic pressure) ((upstream P - downstream P)

##increase aortic P >> enhancing coronary blood flow but increase arterial blood P >>> opposes coronary blood flow

2)R (coronary vascular resistance) has two main determinant 1)Coronary artery diameter (continuously adjustment by many mechanism to keep blood flow within abtimum values. 2)External compression attributable to myocardial contraction (vary degree)

To maintain the adequait circulation of blood, there are three mechanisms:

1-Autoregulation

2-nervous control mechanism

3-hormonal regulation

$1 The mechanism control in **autoregulation** it can be explained in more than one theory:

1-metabolic hypothesis

*increase metabolism & decrease [o2]>> building up of vasodilator chemical substances (K+ / H+ / CO2 / others) >>> vasodilation of smooth muscle

2-Endothelial cells line release relaxing substances such as (NO)

3-ATPase K+ channels > proposis when ATP level is high result more coronary blood flow so K+ channels close >>> no K+ Efflux

#In this case it is easy to reach depolarization>>> inter Ca+2>>> contraction vascular smooth muscle>>> reduction in diameterof coronary arteries>> reduction blood flow **(And vice versa when ATP level is low)**

$2 Autonomic nervous system (little effect)(generaly weak influince)

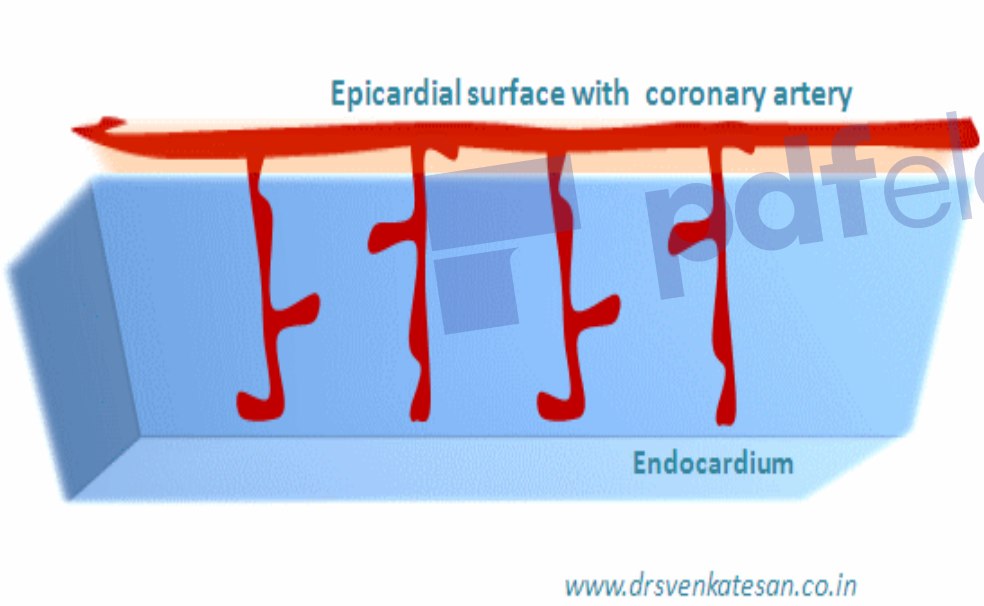
Diameter controlling mainly in sympathetic nerve & some area by parasympathetic fibers (by increasing NO releasing by coronary endothelial cells.

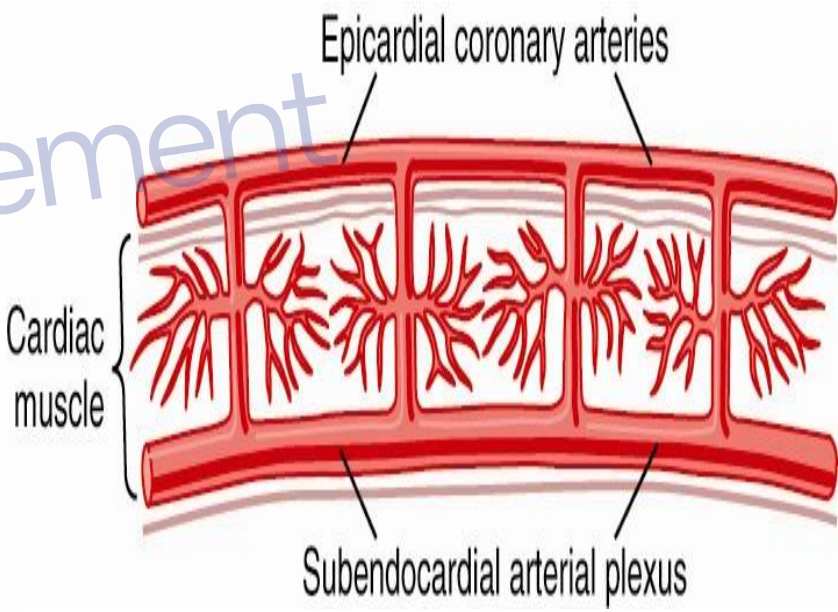
Alpa 1 >>> responsible vasoconstriction

#beta 2 >>>responsible vasodilation

$3 Hormonal regulation by Angiotensine 2 and Endothelin cause vasoconstriction

EPICARDIAL VESUS SUBENDOCARDIAL CORONARY BLOOD FLOW





endo >>> 1200 cappilaries/mm2

epi >>> 750 cappilaries /mm2

*Blood flow of cardiac myocites usual epicardial regions toward the endocardial region.
* In systole (ebi > endo).
*Total blood flow in(Epi/ Endo) region are almost equal?
#the subendocardium has provided by many protictive or compinsatory mechanism.
#this mechanism made the flow in epi and endo cardial region almost the same

#1#Capillary dinsity in Subendocardial region is much higher than the epicardial region therfore during diastole flow the subendocardial regon of the L.ventricle is considraply higher >> severe myocardial infarction make the opposite thing when systole (epicardial) (Blood flow less) >> No complete comprision
#2# Myoglobine content (in endo> epi)
#3#Menimal diffusion distance between cappilary and Myocardial cells in subendocardial region