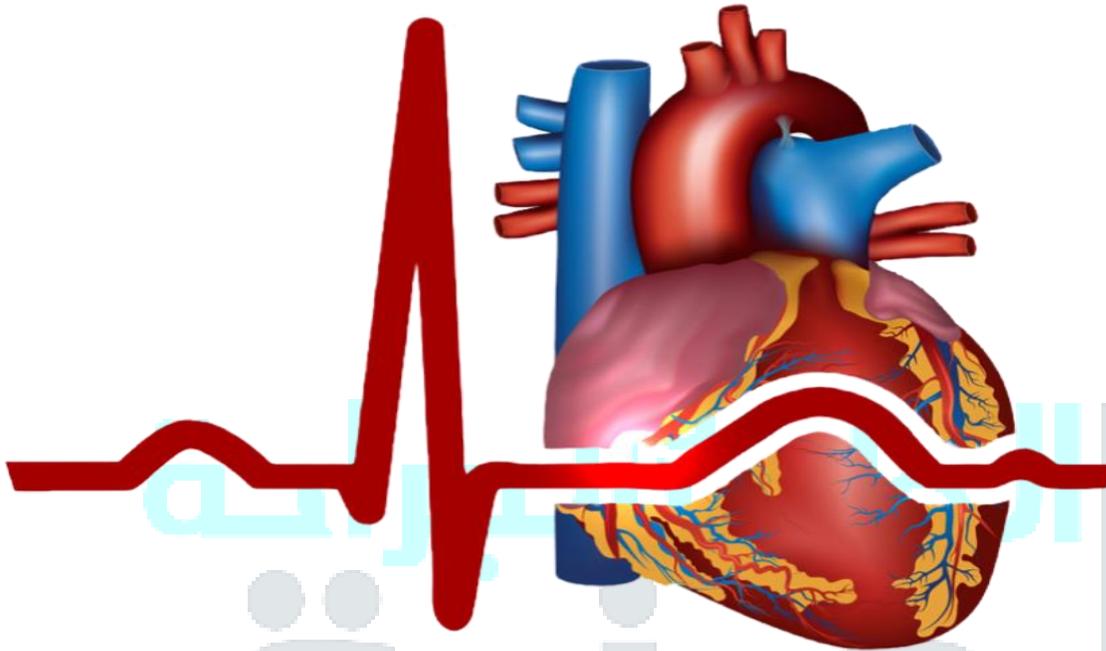


Doctor 2020 - wateen - medicine - MU



physiology sheet

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Physiology of cardiac muscle

objectives

Intrinsic cardiac conduction system

•Types of heart cells

•Conduction or electrophysiology pathway

Clinical topography of the heart

Topography ((موقع القلب بالنسبة للأعضاء الأخرى))

Holotopy

intercostal middle of mediastinum

Sceletopy ((موقع القلب بالنسبة للضلوع والفقرات)):: **right to left**

Upper border

3rd rib horizontal

Right border

1.5cm 3rd to 5th rib parasternal

Lower border

5th rib cartilage to 5th intercostal obliquely

Left border

5th intercostal Apex to 3rd rib

Heart :

in center of the chest ((1/3 to the right << 2/3 to the left))

Syntopy (شكل القلب / pyramid)

القلب يكون في المنتصف و يأخذ المركز الأعلى بالشرايين والأوعية الدموية في منطقة الوسط

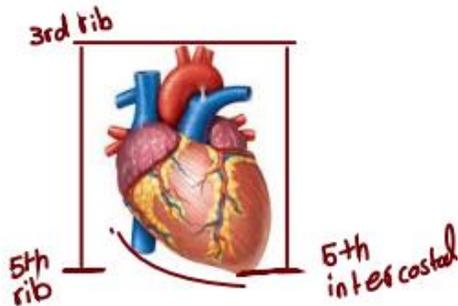
Anteriorly sternum

Inferiorly diaphragm

Laterally pleural of the lung

Posteriorly esophagus and vasculature

Superiorly great blood vessels



Layers of the heart –3 layers))

Endocardium -- direct contact with blood

Myocardium ((true muscle of heart - العضلة القلبية))

-Atrium 2layers((circular ,longitudinal))

-Ventricles 3 layers- ((1 circular ,2 longitudinal))

3 layers due to have pumping action and larger

-Fibrous ring

Pericardium serious and fibrous

Serious : visceral and parietal

Not true layer

****Pericardium (two layers)::**

***fibrous**

***serious ::: visceral and parietal ((between them <pericardial cavity> is important foe lubrication ,, also sliding between two sides of pericardium .**

Pushing against the balloon as pleura , peritoneum this causes tow layers near –visceral- far – parietal- fluid in between – pericardial fluid –

Limiting product is oxygen

Timely manner function properly

Coronary arteries

Myoglobin

Mitochondria

Fuel

Glucose pyruvate

Fatty acids beta oxidation

Lactate pyruvate

Amino acids ketogenic and non-essential one

Ketone bodies fasting state

- **The main function of heart is pumping of blood which is continuous process. and if it stops, death will occur (so pumping the blood which contract the muscles, need a lot of ATP).**
- **The heart rate is:: 1100 beat/ day. (we need very organized, rhythmic, sustained hard work), otherwise death will occur.**

→ How the structure suit the function?

1-coronary artery ::(which is superficial , give adequate amount of O₂ that enough for contraction and so for pumping).

2-myoglobin::

<u>Myoglobin</u>	<u>Hemoglobin</u>
<ul style="list-style-type: none">- Has one heme group.- Higher affinity of O₂ ,, very strong bond between (O₂-Mg)- Not sensitive to Bohr effect- Can't carry CO₂	<ul style="list-style-type: none">-has 4 heme groups-lower affinity to O₂- sensitive to Bohr effect (shift of curves)
<ul style="list-style-type: none">-storage O₂ in muscles-in cells	<ul style="list-style-type: none">-carrier-in RBCs

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3- Mitochondria :: a lot of mitochondria inside the tissue of cardiac cells (oxidative phosphorylation).

- **fuel ::**

- 1- **Glucose :: pyruvate**
- 2- **Fatty acids :: β oxidation=>acetyl CoA (used in fasting phase)= ketone bodies in liver cells.**
- 3- **Lactate – ionized (during intense exercise) =>to pyruvate.**

-without ATP: MORE

-normally: aerobic

-doesn't prevent as lactic acid.

- 4- **Amino acids ((ketogenic and non essential one))**
- 5- **Ketone bodies**

Myocardium clinical disorders

Angina pectoris

**Due to strenuous activity
Tissue becomes ischemia
Pain subsides at rest
Nitroglycerin**

Myocardial infarction (heart attack)

Death of cardiac muscle replaced by scar tissue and could lead to death

**** When there is no enough blood supply::**

(لما يبذل الشخص جهد شديد وعنيف مباشرة يحصل الم في الجهة اليسرى من الصدر)

- strain activity: simple occlusion of coronary arteries => no blood supply => no enough O₂ => ischemia (angina pectoris) => very severe pain (not serious).

**** When rest:: improved**

(لما يرتاح بتحسن أو ممكن يحتاج vasodilator).

****When rest for along time:: no improvement (not severe) => MI (HEART ATTACK): occlusion for along time =>death of cardiac muscles => replaced by fibroblast. (more serious)**

Intrinsic cardiac conduction system ((automatically))

•Electrophysiology of the heart is so special it had the ability to intrinsically depolarize itself it doesn't really depend upon the nervous system.

-this is special for cardiac muscles and mesenteric plexus , myenteric plexus in GIT.

So, nervous system function is regulation of the rate. "No other function "

•The heart exhibits was called automaticity (the heart has its intrinsic ability on its own to spontaneously depolarize itself and then trigger action potentials to send it out to all other parts of the heart)

Types of heart cells

Two different types of myocardium

•Nodal cells ((pacemaker cells))are non contractile cells these are the ones that generates automaticity set a rhythm or the base (SA, AV, AV Bundle(His), Bundle branches (left and right), Purkinje fibers) "" main fun. is generation the action potential – rhythm- ""

•Contractile cells(actin and myosin, troponin and tropomyosin, sarcoplasmic reticulum) those ones that force and pushing the blood out of the heart.

Heart cells : contractile cells:: can generate action potential

(**pacemaker** لكنه بطيء جدا مقارنة بـ)

“Worker bees” of the hear

- **Don't pace the heart**
- **Very slow compared to nodal cells**
- **Premature ventricle or atrium contraction (not serious)**
mischievous
- **Arrhythmia (serious) Ectopic atrial tachycardia or ventricular tachycardia**
- **Cell to cell spread not so fast**
- **The wave of depolarization “ knock out”**

Overdrive suppression the crushing of the worker bee's dream

Pacemaker cells ((generate the action potential))

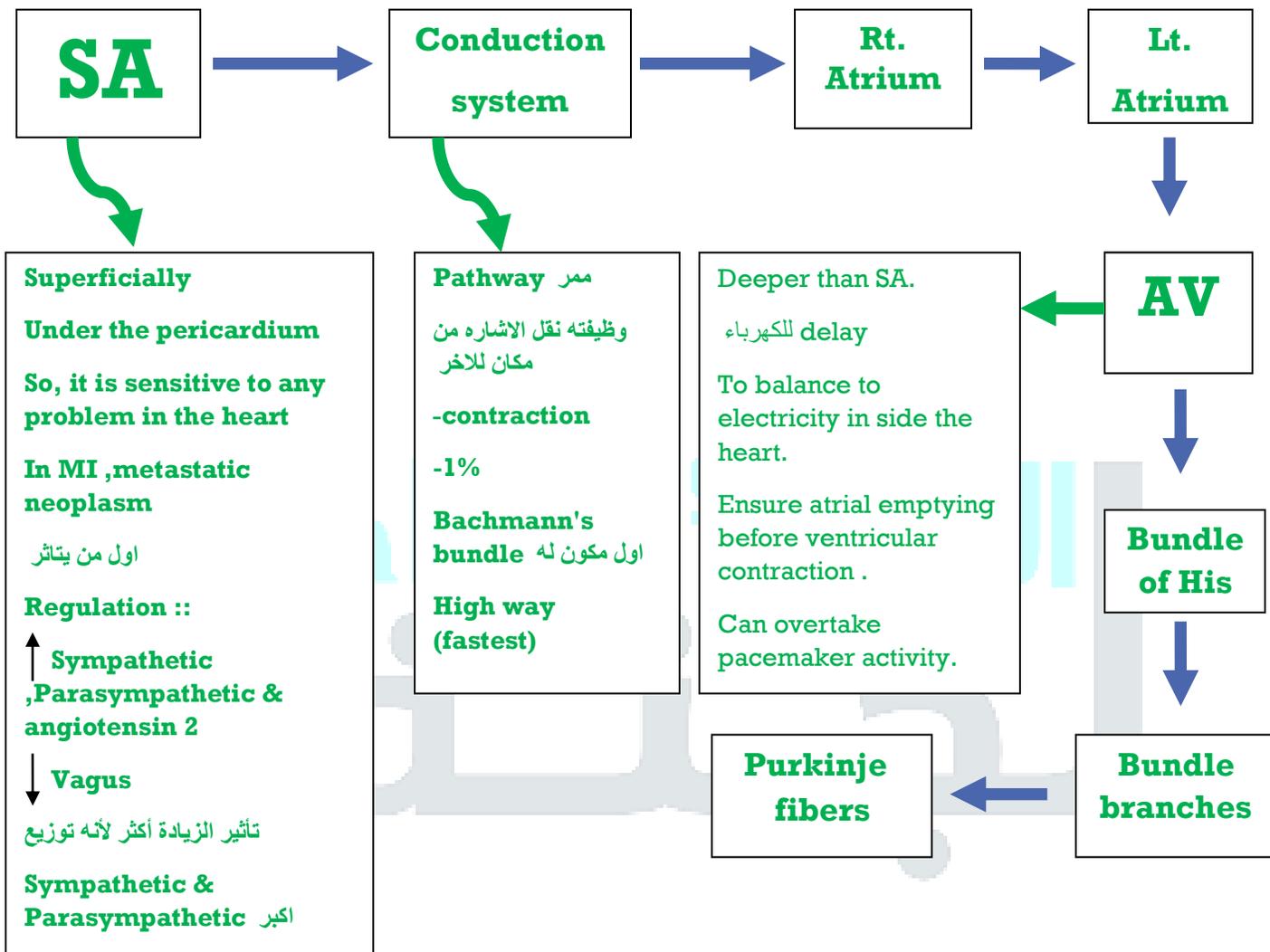
-initiation(very rapid):وظيفتها

• **SA node “ Champion” Sinoatrial node (the fastest)**

• **AV node**

• **Bundle of his**





V) TYPES OF NODAL CELLS

- Listed in order of sequence of conduction pathway

Table 1. Types of nodal cells

Nodal Cells	Location	Function	Intrinsic rate
SA node	Near the entrance of SVC into right atrium / <i>superficially</i>	Pacemaker of the heart • Sets the sinus rate and rhythm	60-80 beats/min
AV node	At the top of the interventricular septum Superior and medial to entrance of coronary sinus into right atrium	Receives impulses from SA node Conducts impulses very slowly (0.1 second delay) • This <i>delay</i> prevents simultaneous atria and ventricular contraction • Fewer gap junctions • Small diameter cells	40-60 beats/min
Bundle of His	Inferior to AV node in the membranous part of interventricular septum	Receives impulses from AV Node Reduces high frequency impulses from traveling into ventricles from atria in conditions like atrial fibrillation	20-40 beats/min
Bundle Branches	Right and left bundle branches span along the length of interventricular septum until the apex.	Receives impulses from bundle of his Right Bundle sends impulses to right ventricle Left Bundle sends impulses left ventricle	16-40 beats/min
Purkinje Fibers	Terminal conducting fibers located in the sub endocardial layer of myocardium in the right and left ventricles	Receives impulses from bundle branches Makes sure the entire ventricular myocardium contracts as a unit (syncytium) Contains tons of gap junctions transmits impulses <u>very fast</u>	15-40 beats/min

Conduction system

- 1%
- Bachmann's bundle
- Atrial internodal conduction pathways
- Bundle branches
- Purkinje

If we have problem in SA , AV can overtake activity of SA.

If we have problem in AV , Bundle of His take activity but very slow (patient does not need transplant of pacemaker)

Problem in Bundle of His lead to shutdown of all nodes.

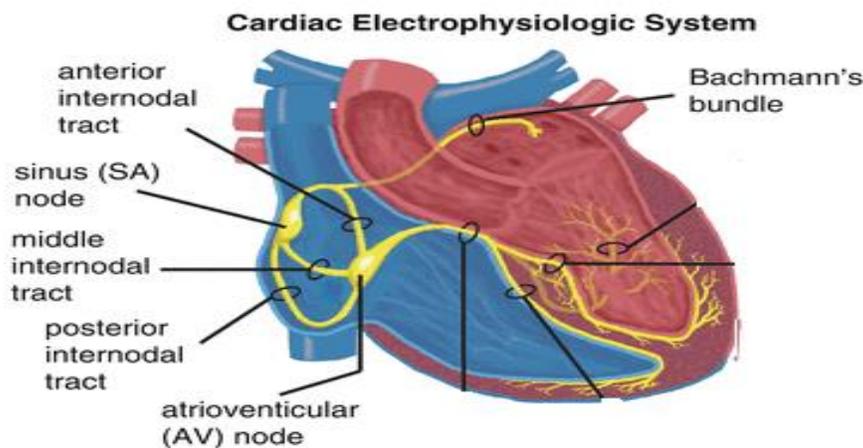
In this case The rhythmicity from conduction sys.

bundle branches & purkinje fibers can not take activity due to bundle branches & purkinje fibers not a pacemaker.

(اذاتم توليد كهرباء لا تكون منتظمة لان القلب فقد rhythmicity)

**Pacemaker potential::patient need transplant of pacemaker.
If problem in bundle branches, atrium& ventricle cells take the activity.**

Electrophysiological system



SA node ((fastest))

Superficial under visceral epicardium

Crescent shape structure Superior component of the right atrium just beneath the large vessel here called superior vena cava;

Easily damaged by :

- **Atrial myocardial infarction**
- **Metastatic neoplasm**
- **Pericarditis**

Sets the pace((**action potential**))at around **60 to about 80 beats per minute** (normal heartbeat) on its own without any extrinsic innervation and this is called sinus rhythm

↑ Speed up: Sympathetic and angiotensin II

↓ Slow down: vagus

- **Bachman's bundle (superfast conduction highway) Saves the day**

The electrical potential conducted from the right atrium by SA node to the left atrium through Bachman's bundle Make sure the right and left atrium contract simultaneously

- **Internodal pathway**

This will supply all the other parts of the right atrium but eventually all this internodal pathways converge on this second important structure to the AV node

- **AV node**

Runs from the actual right atrium to the interventricular septum so it is acting as a connection, the gateway between the atria and the ventricles because what happened is some potentials of Bachman's bundle can make their way over here to the AV node also

So, all the action potentials that are coming from the SA node that are being spread out to the internodal pathway or the Bachman's bundle are converging to the AV node 40-60b/m

Can permanently takeover

- **Bundel of his**
20-40b/m
Starting dizzy

- **Bundles branches and distal purkinje fibers**

15-40b/m

Pacemaker potential not enough to sustain life very long

•Atrial myocardial cells (45-65b/m)

Rebels' missy and driving crazy don't permanently takeover the dutie..

