

# MEMBRANE POTENTIAL OF CARDIAC MUSCLE

## PART2.

**\*The regulation of the pacemaker by autonomic nervous system:-**

-The pacemaker potential is not controlling like other muscles, it is regulated.

-Regulating and modulating the potential of the pacemaker control the frequency.

**1-** In the sympathetic case it increases the heart rate.

- a. decreasing the duration :- increasing the heart rate.
- b. increase the number of twitches (amplitude , frequencies) per a second :- increasing the heart rate.

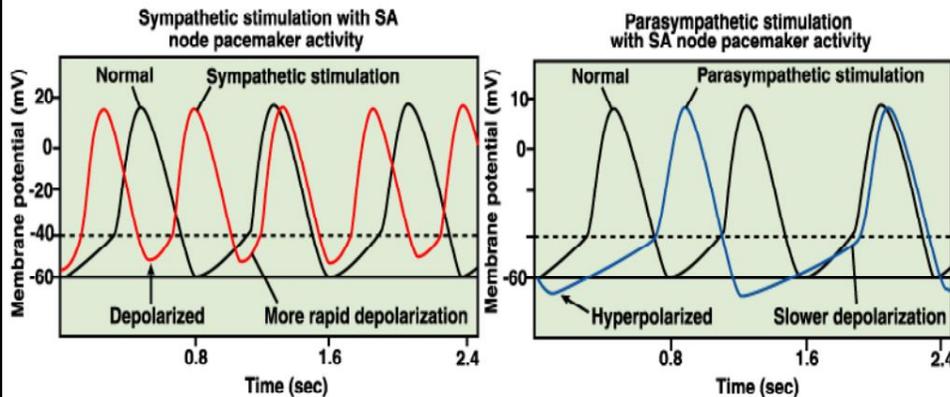
**2-** parasympathetic :- exactly the opposite function of the sympathetic "controlling the heart rate" (decrease the heart rate) by:

- a. Increasing the duration.
- b. Decreasing the number of twitch(amplitude , frequencies).

\*The influence of the sympathetic and parasympathetic occur on the SA node .

\*When we compare the black color with the red one , we notice the increasing in the number of amplitude (frequency) and the twitches per a second (the number in the red more than in the black (In sympathetic).

--(the opposite in parasympathetic)



\*The regulation of the sympathetic and parasympathetic :-

- When the sympathetic increase the heart rate it act on the (B1) receptors ----> secrete neurotransmitters (epinephrine, adrenaline, naphrine , noradrenaline) which secreted from the adrenaline medulla.

\*Increase the heart rate by sympathetic nervous system acting on (B1) receptors by adrenaline neurotransmitters.

\*the parasympathetic decreases the heart rate it acts on the muscarinic receptor (M2) and the neurotransmitter that works on here is the acetylcholine.

\*If I want to decrease the heart rate , what kind of drug should be given to the patient ?

It is the agonist to (B1).

- This kind of drug is called positive chronotropic drugs which increase the HR.

\*The negative chronotropic drugs leads to decrease the heart rate. If I want to decrease heart rate I will give (B1) antagonist and (M2) agonist.

-When I want to make a direct effect to increase the heart rate → I supply the receptor that is responsible of the decreasing of the heart rate by (M2) agonist.

- If I gave (B1) antagonist it's ok. But it will not give the same results the (M2) agonist because(B1) antagonist blocks the increasing of heart rate.

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## CONDUCTING SYSTEM IN THE CARDIAC CYCLE

\*pacemaker potential :- don't give generation and slow response not true action potential

\*why we did not mention the AV potential which is the another pacemaker that exit on the heart muscle?

\*the SA node is not only the pacemaker like AV but why the initiation start from the SA ?

the speed of SA is very fast in comparison with AV potential speed .

\*If there is a problem in the SA node regulation of the heart go to the AV node ,but it doesn't have the same effect of SA node because of the difference in speed .

AV node: gives the rhythm of the contraction of the AV.

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**\*We have two kind of action potential to the cardiac muscle :**

**1-** False response of pacemaker (negative) .

**2-**Myocardium contraction

\*The skeletal contraction:- Inflow of  $\text{Na}^+$  and outflow of  $\text{K}^+$

\*The myocardium contraction:- Fast response "the point 1 and 2" see figure 4 in the slide.

-The point 2 have to key difference between cardiac muscle contraction and skeletal muscle contraction.

-When reaching to point 1:- The outflow of  $\text{K}^+$  slowing the repolarization due to inflow of  $\text{Ca}^{+2}$  influx from the long channel.

\*The duration number 2:-

**a-** Staring from 0 phase until the midway though (absolute refractory period)

-the change of repolarization because of entering of  $\text{Ca}^{+2}$  inside the cell , this cause increasing the positivity of the membrane.

--increase intracellularly to the  $\text{Na}^+$  inside the cell membrane the positivity increase...

In certain time :- closing the inactivation gate, so no more flow to Na<sup>+</sup> inside the cell membrane.

b- after the midway of phase3 (late of phase3) –(relative refractory period).

-in this case the membrane potential positivity is increased gradually  
→ negative → causing opening in the inactivation gate → it allow Na<sup>+</sup> to enter.

\*the refractory period is very short in the skeletal muscle , but in the cardiac potential is very long.

\*the refractory period contain the absolute and the relative.

\*two properties to the skeletal muscle contraction:-

1- increase the frequency of AP within the period of time summation happen.

2- tetanus when the frequency increase more than the summation .

\*There is no summation and tetanus in the cardiac muscle.

\*From the phase 0 (opening the last Na<sup>+</sup> channels) dramatically influx of the Na<sup>+</sup> intracellular causing the membrane potential from the resting to the repolarization.

(PQR) are exist the cardiac pattern in the phase0 so the action potential reach the apex here, and the contraction of the ventricle muscle will happen, and there is closing to the AV valve , ant the pressure still not enough to open the semilunar valve.

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**\*phase 1** :- transient influx to the  $K^+$  and this phase is immediately followed by the phase 2 which include the opening of  $Ca^{+2}$  channel increasing the positivity , (QRS) exist on the cardiac pattern and the aortic valve is opened ( isovolumic contraction).

### MCQ:-

- 1- All of the following regarding (QRS) is correct except?
- a. Isovolumic contraction.
  - b. Closing the AV and opening the semilunar valve.
  - c. at the beginning of the phase1 and immediately start to the phase2.

**d. closing AV and closing semilunar valve.**

- 2- In QRS I can hear S1 of the heart, it's true or false?

**TRUE**

- 3- In QRS I can hear S2 of the heart, it's true or false?

**FALSE**

\*Between the S and T → there is delay the absolute refractory period which start from the phase 0 to the midway of phase 3.

\*From S to the midway of T in cardiac pattern it's the refractory period.

\*After the midway of phase 3 → the end of the absolute immediately followed by the refractory period called (relative refractory period)

\*On the ECG pattern relative refractory period end with the ending of T wave.

\*The midway of T wave is absolute and relative refractory period . If there is any problem in T wave it will be related to the relative and absolute refractory period.

### MCQ:-

- 1- What of the following is wrong according to the T wave?
- a) representing the absolute and relative refractory period.
  - b) **Aortic and semilunar valve open.**
  - c) AV valve open.
  - d) Represent the isovolumic relaxation.

2-In the T wave period we can hear S2 of the heart , it's true or false?

TRUE

3- In the T wave period we can hear S3 of the heart , it's true or false?

FALSE

4- In the T wave period we can hear S4 of the heart , it's true or false?

FALSE

#لجنة التبييض

جود الشوابكة , اروى العجالين , رند بومدين

بالتوفيق...

