Mechanical activity of the frog's heart

The heart is a good example of a spontaneously active muscle, i.e. it will continue to beat when taken out of the animal.

In these series of experiments the frog's heart muscle is used.

Experimental procedure

The frog's heart is composed of a sinus venosus, two atria and a common ventricle.

In these series of experiments the frog's heart muscle is used.

Animal dissection

Expose the heart of a pithed frog by cutting through the skin on the chest and through the Pectoral girdle on both sides. Cut away the pericardium carefully.

Connecting up the frog

Place the frog on a cork board mounted on a stand and pass a hook through the apex of the ventricle (1-2mm). Connect the heart to the recording lever by the thread tied to the hook. Keep the heart muscle moist with frog ringer from now on.

1- Recording the normal heart beat

Set the speed of the kymograph to 14. Recode the normal pattern of the heart beat. Identify the components of the mechanical records with the aid of Fig 6.

Fig 6- Frog normal heart beats

2- Extra systole Absolute and relative refractory periods.

a- Set the speed of the kymograph to 14.

b- Apply the stimulating electrodes to the surface of the ventricle.

c- Set the voltage at 4-5 volts.

d- Set the duration of the stimulator to 2 ms.

e- Switch the mode of the stimulator to single pulse.

Stimulate the heart muscle on the systolic curve (contraction period) and on the diastolic curve (relaxation period). Stimulation on the diastolic curve (relaxation period) leads to an extra systole and subsequent compensatory pause (Fig 7).

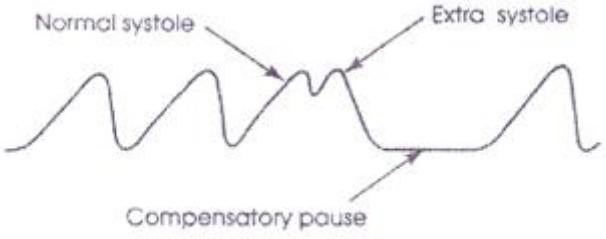

Fig 7- Extra systole and Compensatory pause curve

3 – The response of the heart to drugs.

– Acetylcholine and atropine

a- Set the speed of the kymograph to 12.

b- Expose the heart to acetylcholine.

After recoding the effect of the drug on heart rate and amplitude of contraction, wash the heart thoroughly with ringer solution. Then irrigate the heart with atropine and after 30 seconds repeat the exposure to acetylcholine.

4- Effects of local heating and cooling on the heart beat and contraction.

Wash the heart with ringer solution to remove the drug's effects.

Irrigate the heart with warm (35^0C) and the with cold (10^0C) ringer. Record the changes of the heart beat and contraction.

5- Effects of different ions on the heart beat and contraction.

Irrigate the heart with calcium chloride (5%) record the effect of this ion then wash the heart thoroughly with ringer solution.

Then irrigate the heart with potassium chloride (5%) and record the effect of the ion.

Questions:

1- What is the extra systole and how can it be obtained in the lab.?

2- Explain the absolute and relative refractory periods.

3- Explain the compensatory pause and its causation.

3- What's the effect of acetylcholine on the heart rate and contraction?

4- How does atropine antagonize the effect of acetylcholine

5- Explain the effects of the following items on the heart rate and contraction:

I – Warm Ringer

II – Cold Ringer

III – Calcium chloride

IV – Potassium chloride

The stannius Ligatures

These experiments aim to investigate the heart the effects of first (I) and second (II) stannius ligatures on the heart beat and some other properties of the heart.

1- The first stannius ligature experimental procedure

Dissect and connect up a pithed frog according to the previous experiment, then record the normal heart beat.

In order to fasten the first stannius ligature, pass a thread under the heart between truncus ateriosus and sinus venosus.

Tie a knot tightly at the connection between sinus venosus and atria to disconnect them (fig 8).

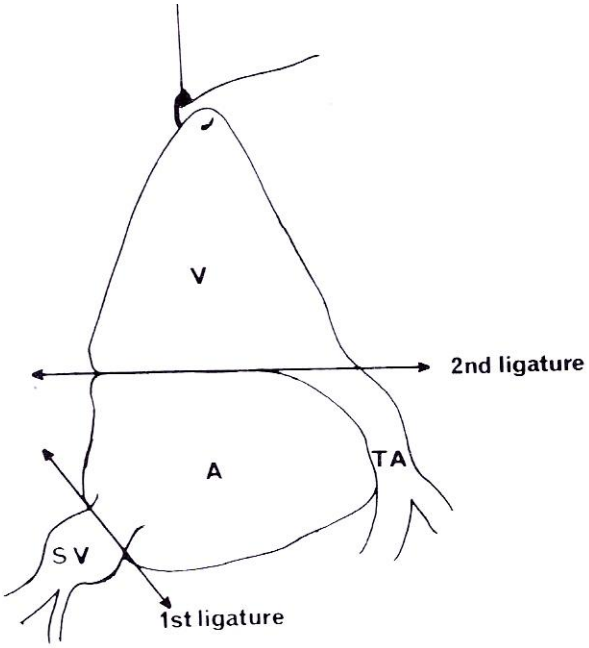

Fig 8- The first and second stannius ligatures

As a result the sinus venosus continues to beat but the atria and ventricle stop beating. As a result, you will record a smooth line.

Now apply the electrodes to the ventricle, set the duration of the stimulator to 2 ms, and do the following experiments.

1-1- All – or – non – law

Stimulate the heart from sub – threshold voltage to threshold and higher voltages to see if the heart obeys from all – or- non – law.

1-2-Tetanus

Set the voltage to threshold and stimulate the heart with the frequency of 20-30 Hz to see if the heart shows tetanus.

1-3-Absolute and relative refractory periods

Set the voltage to threshold and stimulate the heart by single pulse in contraction and relaxation phases.

1- Second stannius ligature

Tie a second ligature between the atria and the ventricle (fig. 8) and observe that sinus venosus continues to beat, atria are still not beating but after a short period of time the ventricle starts beating with slower rhythm than sinus venosus.

Questions:

1- Compare the all – or – non law between skeletal and heart muscles.

2- Why doesn't the heart muscle show tetanus?

3- Why does the sinus venosus continue to beat after the first stannous ligature?

4- Why does the ventricle stop beating after the first stannous ligature but start to beat after the second stannius ligature?