

## **Skeletal Muscle Contraction**

All Skeletal muscles are made of numerous fibers. Each muscle fiber contains several hundred to several thousand myofibrils.

Each myofibril, in turn, has myosin and actin filaments, which are large polymerized protein molecules that are responsible for muscle contraction.

The Contraction of skeletal muscles can be evoked by stimulating the nerve (indirect stimulation) or the muscle (direct stimulation).

There are two major types of muscle contraction isometric and isotonic.

## **Experimental Procedure**

In these series of experiments we use frog gastrocnemius muscle or nerve – muscle preparation.

### **Animal pithing**

For this purpose at first hold the legs of the frog hand, then hit the head of the animal to the edge of the sink strongly and immediately destroy its brain and spinal cord by a needle respectively (the needle has to be inserted as shown in Fig 1).

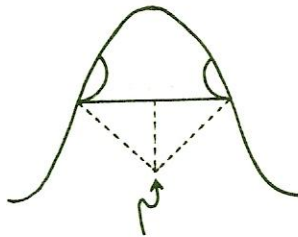
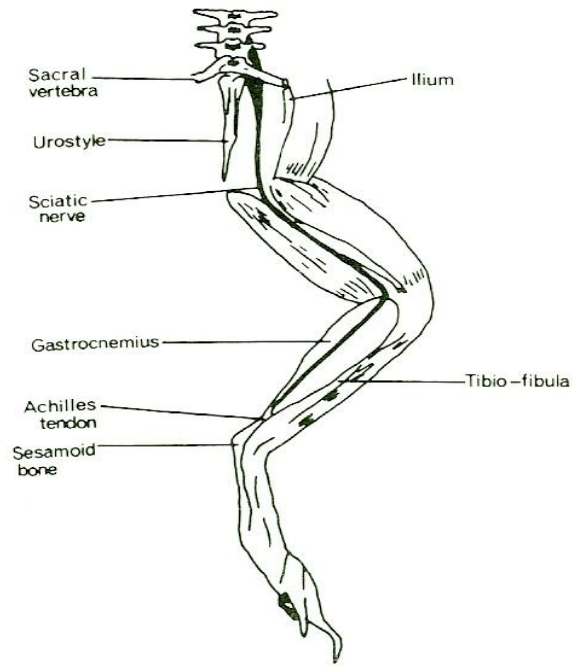


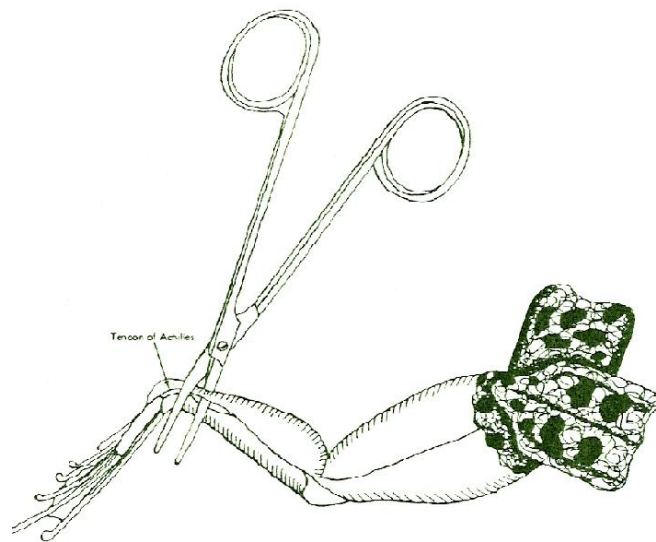
Fig 1- The site of the needle insertion

### **Animal dissection**

Place the pithed frog on the tray. Cut the skin around the waist of the pithed frog and gently pull it from the legs. Tie a thread around the Achilles tendon and cut the tendon distal to the knot and lift the muscle by the thread away from the leg. Cut through the thigh bone (femur) immediately above the knee then cut through the tibia and fibula immediately below the knee. Lift the muscle preparation attached to the knee, by means of the thread, try not to handle the muscle itself (fig 2a, b).



a



b

Fig 2- a. The hind limb of the frog to show the sciatic nerve. b. Cutting the tendon of Achilles

## Mounting the preparation

Place the preparation on a cork board, fix the knee joint on the board by a pin, attach the other end of the muscle by means of the thread, which was tied around the achill tendon, the recording lever.

Apply the stimulating electrodes to the Upper surface of the muscle (fig 3). Keep the muscle moist with frog Ringer from now on.

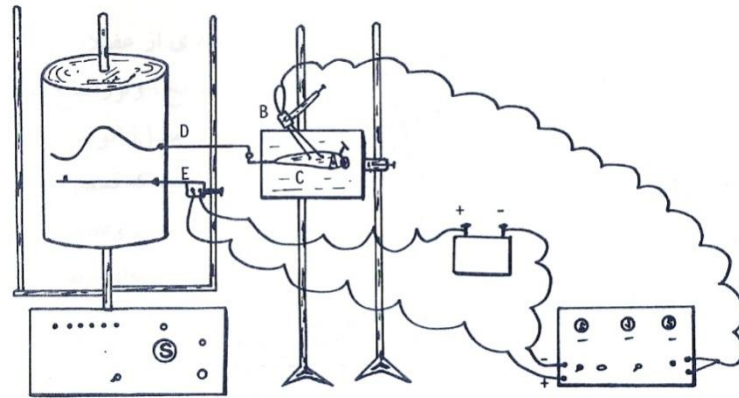


Fig 3- The Apparatus connections

### 1- Multi – fiber summation

This experiment aim to show the variation of muscle contraction amplitude induced by increasing the voltage.

- a- Set the duration of the stimulator to 2 ms.
- b- Switch the mode of the stimulator to single pulse.
- c- Set the speed of the kymograph to 12 (the slow speed).

d- By gradual increase of voltage determine the threshold and maximal stimulus.

## 2-Single muscle contraction (Twitch)

Recording a twitch and calculating the different phases of the twitch.

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

b - Set the speed of the kymograph to 20 (the highest speed).

c - Set the voltage to maximum (as obtained in experiment 1) in order to record the maximal twitch response.

d - Switch the mode of the stimulator to single pulse and record a single muscle contraction.

The twitch has three phases, which are called latent period (LP), contraction phase (CP) and relaxation phase (RP) (fig 4).

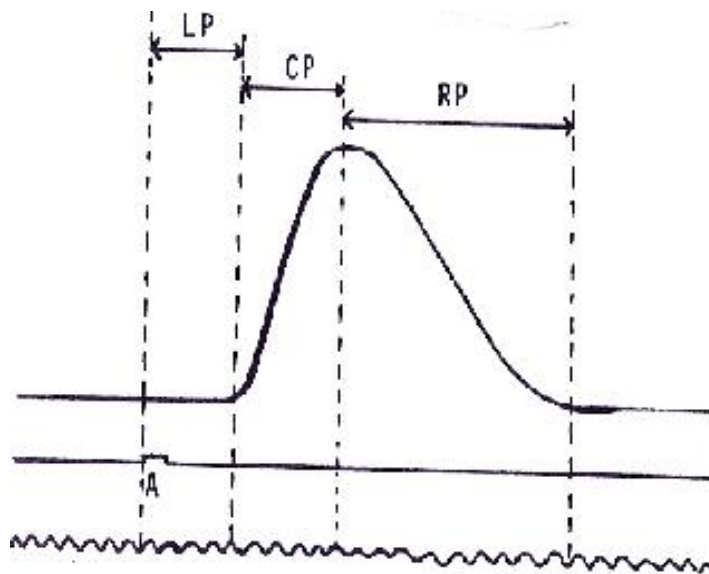


Fig 4- Muscle Twitch

### 3- Summation of twitch responses

Recording a double contraction.

- a- Set the duration of the stimulator to 2 ms.
- b- Set the speed of the kymograph to 14.
- c- Set the voltage to maximum (as obtained in experiment 1).
- d- Switch the mode of the stimulator to single pulse. Apply two consecutive stimuli and record a double contraction (Fig.5).



Fig 5- Double contraction

### 4-Tetanus

Effect of Frequency of Stimuli

- a- Set the duration of the stimulator to 2 ms.
- b- Set the speed of the kymograph to 14.
- c- Set the voltage to maximum (as obtained in experiment 1).

d- Switch the mode of the stimulator to continuous. Start with a frequency of 2 per second, followed by 5, 10, 15, 20, 30, 40 per second. Allow a 10 Second rest period between each stimulation.

Questions:

- 1- Which voltage do you have to use for summation of twitch responses?
- 2- Explain temporal and spatial summations and mention that the summations in experiments 3 and 4 belong to which group?
- 3- Is all-or-non law correct for skeletal muscle? Why?
- 4- Is there any increase in skeletal muscle contraction amplitude if you increase the maximal voltage?
- 5- Explain complete and incomplete tetanus. By which frequencies you can record that tetanus?

