11.2. Movement

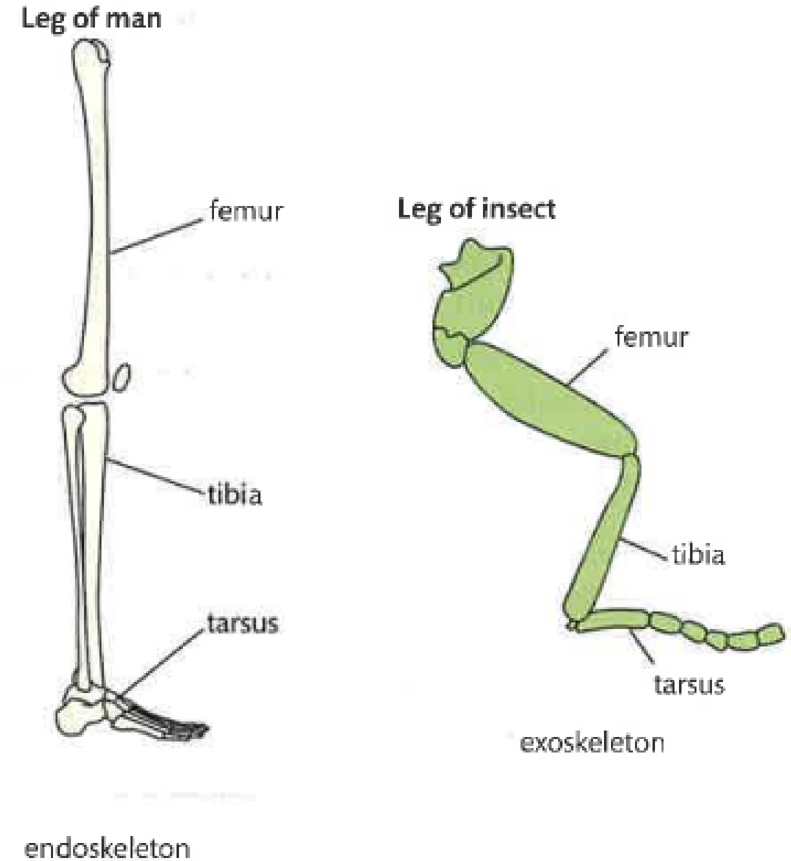
Some animals have exoskeleton and some have endoskeleton

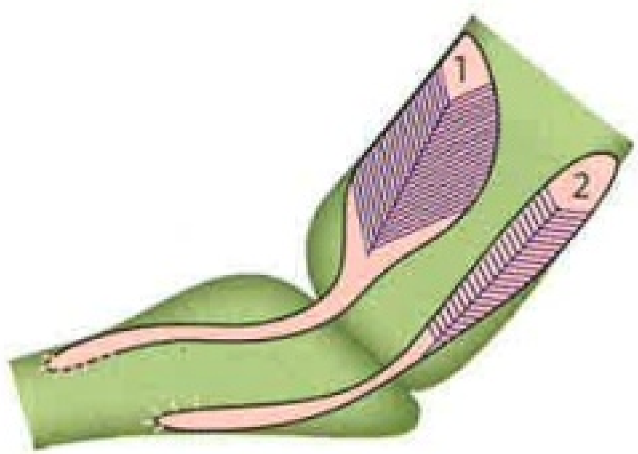
Some, however, have absolutely no skeleton.

11.2. Movement

The extremities of animals with endoskeleton and exoskeleton may look alike, but there are major differences in functionality.

The muscles of an insect are attached to the inner side of the exoskeleton, and go through the joint.

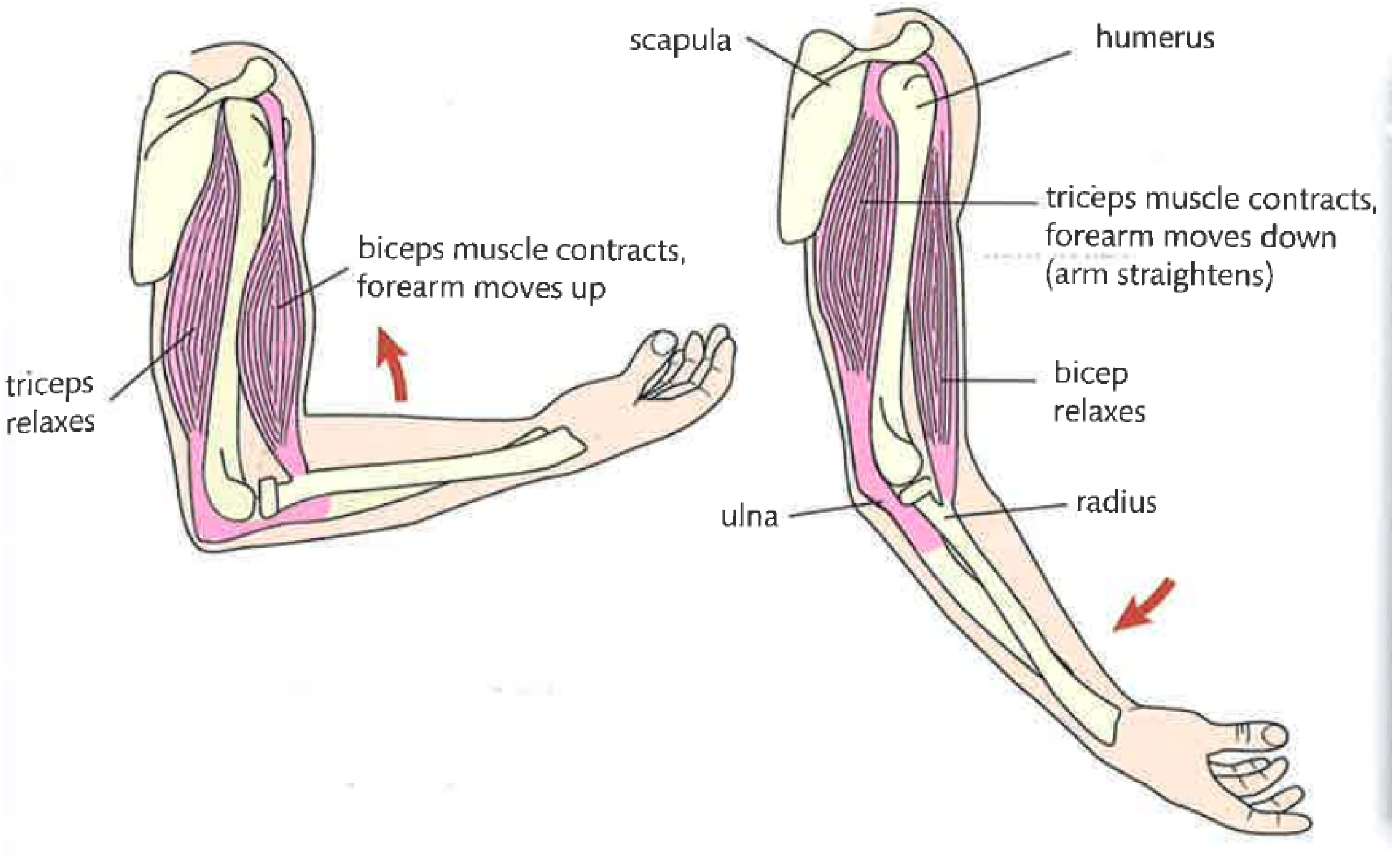




In both cases the skeleton provides anchorage for muscles and act as levers*

11.2. Movement

Muscles can't push, only pull, so they work in pairs*. For every movement there is at least one muscle "pro movement" and another "against movement". The former is called agonist, and the latter is called antagonist.



11.2. Movement

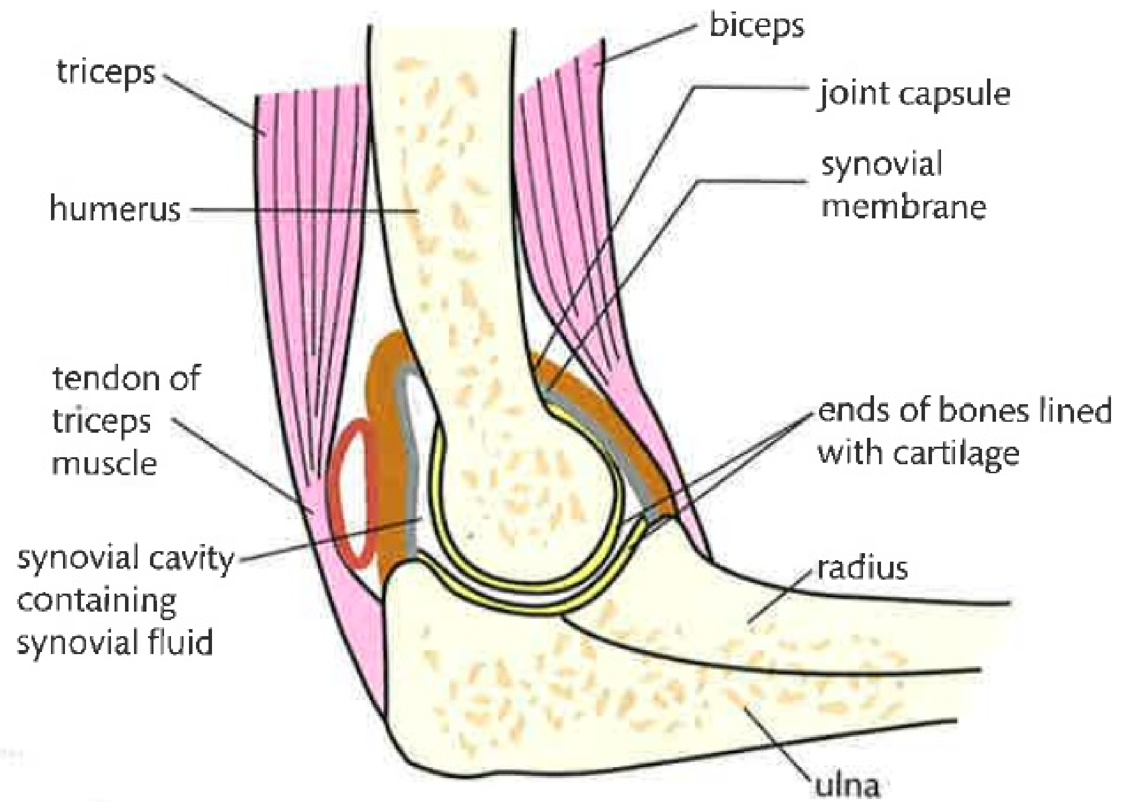
The elbow is a good example to illustrate the parts of a joint*

The joint ends of the bone are covered in cartilage, which has less friction.

The joint is encapsulated in two concentric membranes: the joint capsule and the synovial membrane

The synovial membrane is filled with synovial liquid, which lubricates the joint.

The muscles don’t insert in the bone directly: the end of the muscle is a tendon and said tendon goes into the bone



The bones are also tied together with ligaments, which prevent the joint from moving apart but allows movement. Neither ligaments nor tendons are very elastic, and stretching them causes a lesion.

Parts of the muscle fibre.

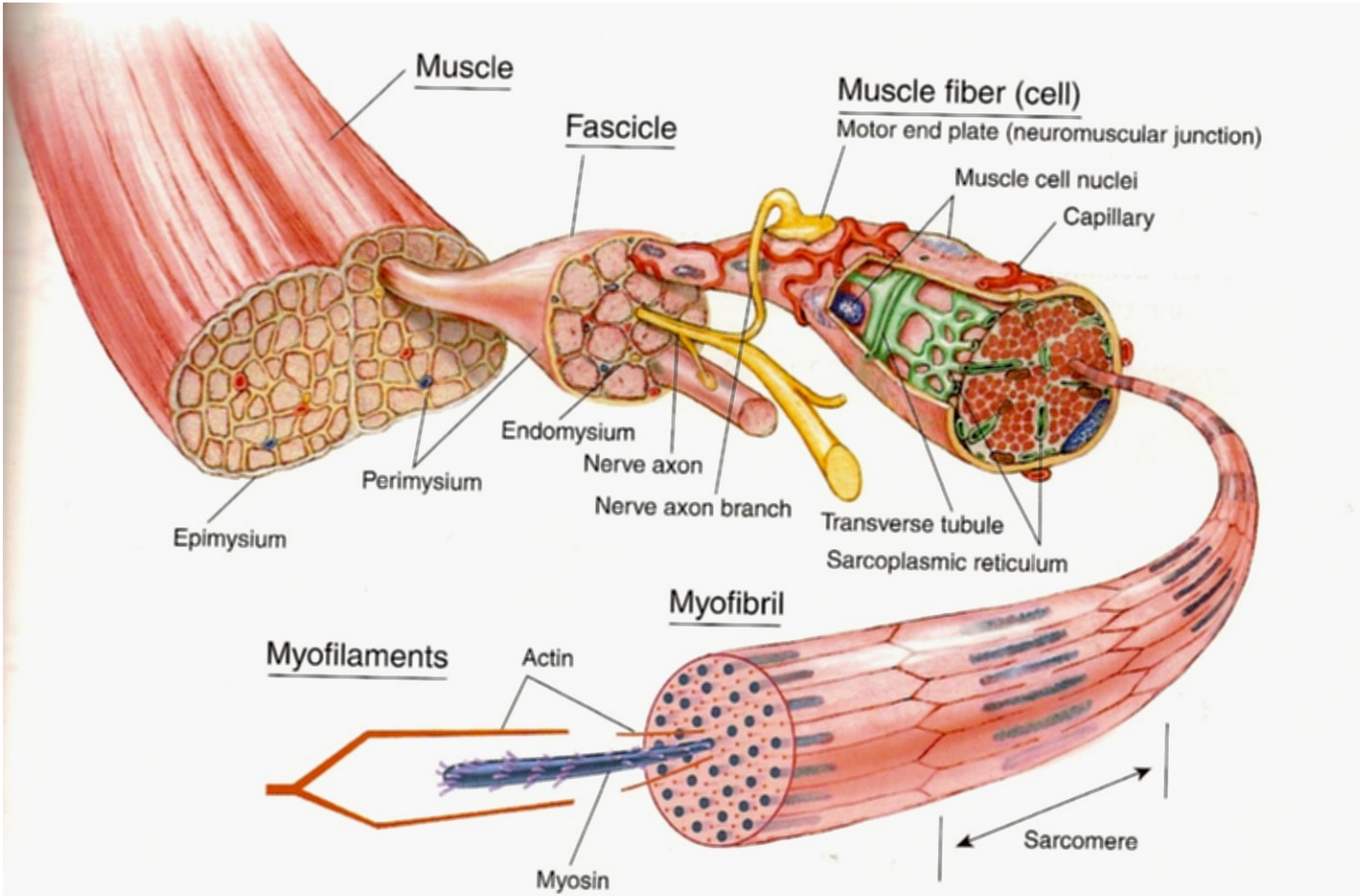
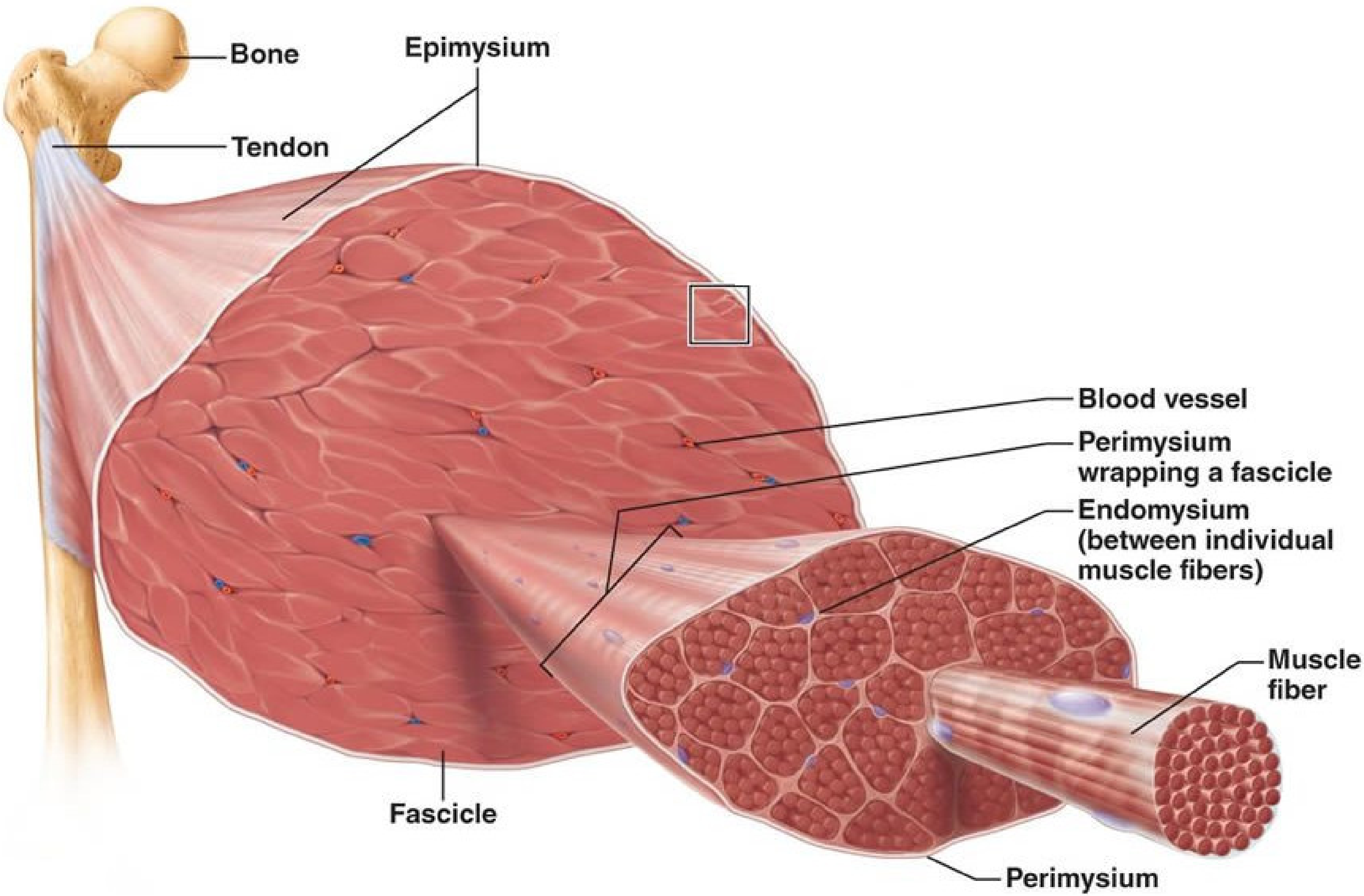


Figure 1-1 Muscle structure

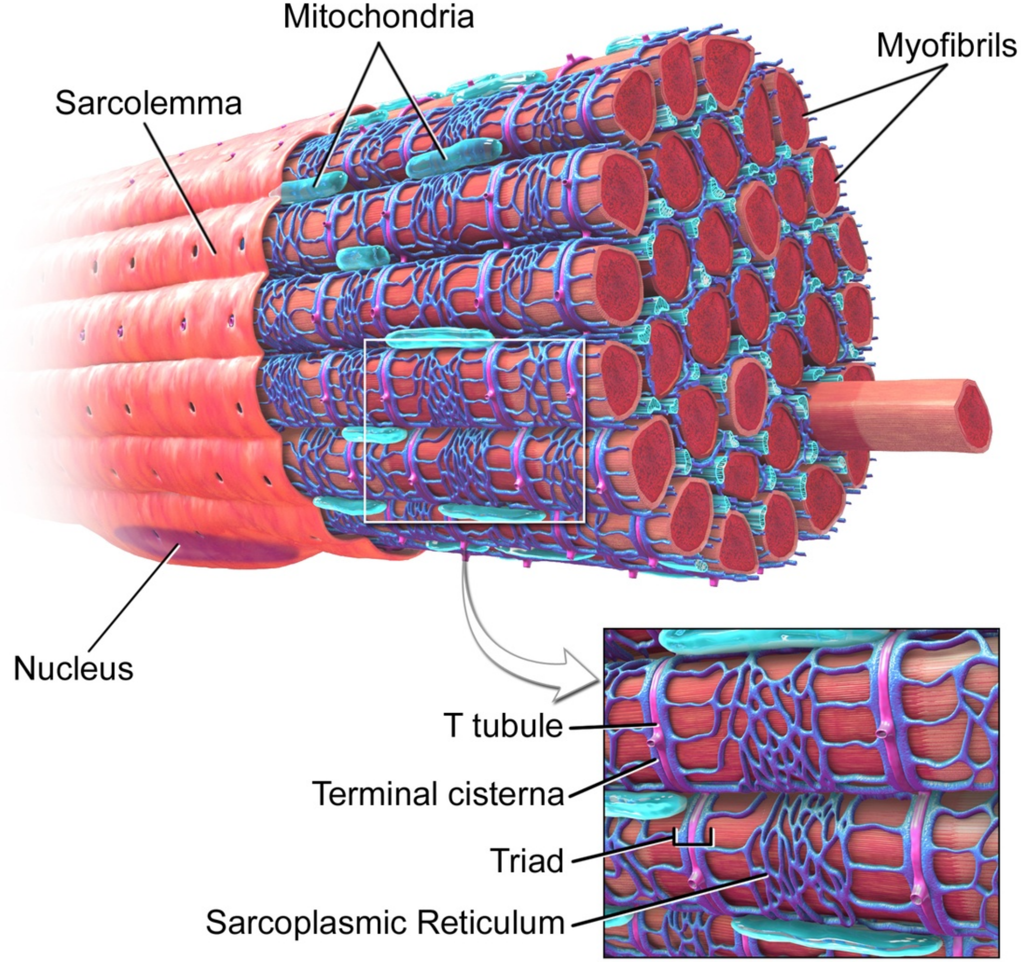
The muscle is divided into fascicles

The fascicles are made of very elongated cells called muscle fibres



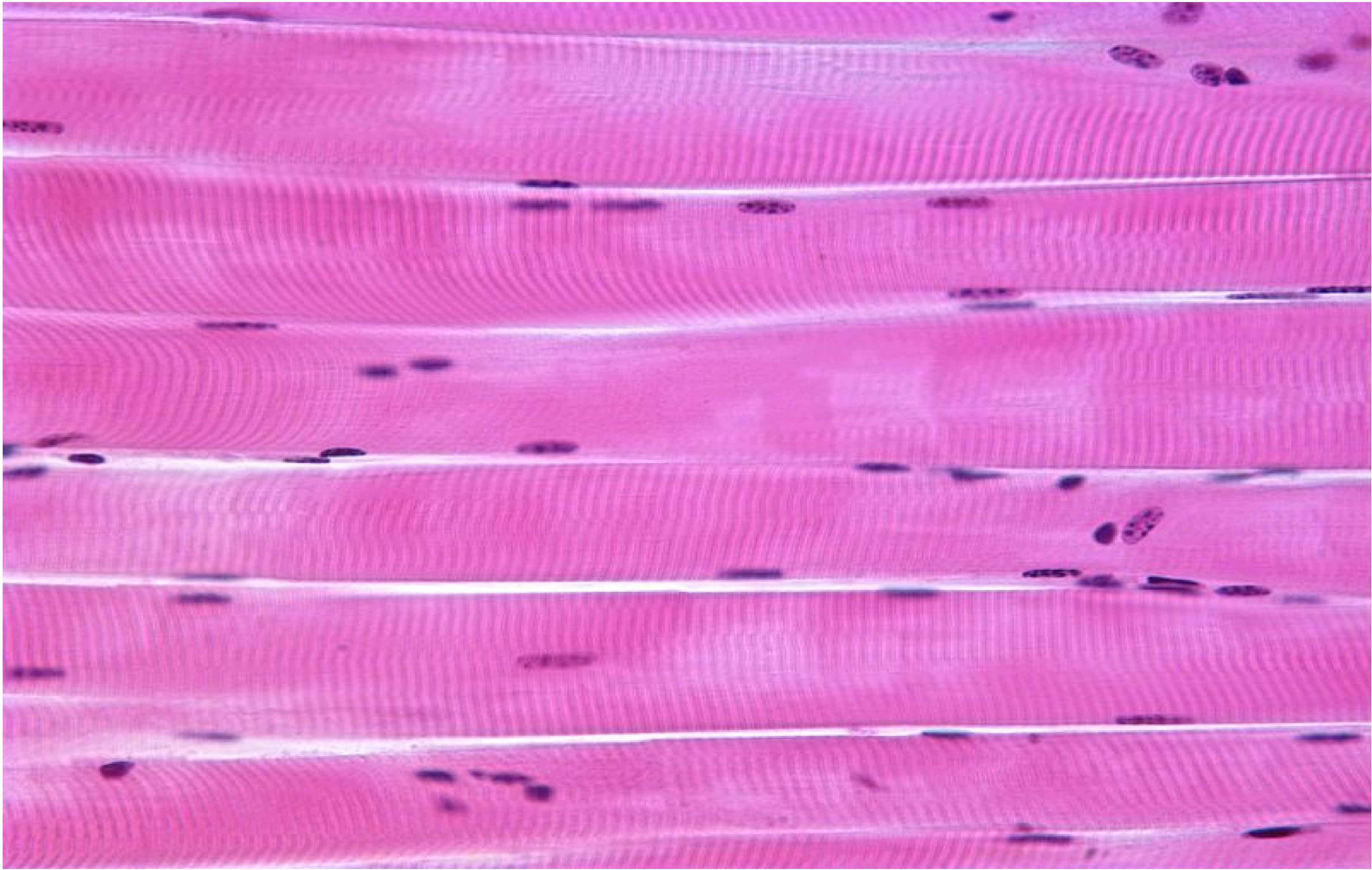
The cells themselves are highly modified for their function:

- They contain many contractile fibres called myofibrils.
- Each cell has many nucleuses alongside the numerous myofibrils*.
- The smooth endoplasmic reticulum is extremely developed, and is a network that reaches all the parts of the cell.

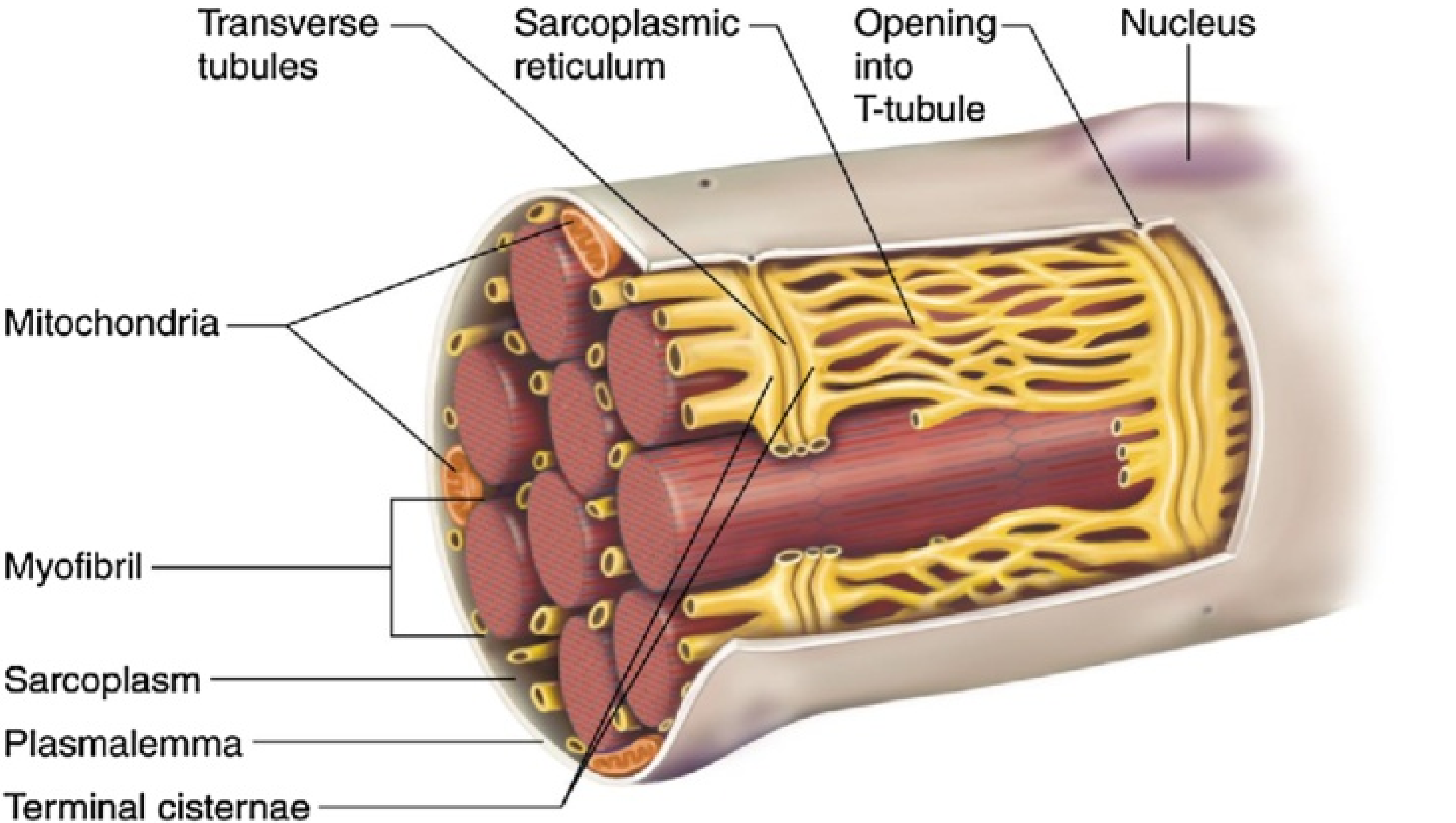


- The membrane has very deep invaginations that also reach every part of the cell in a root-like pattern. They are called T-tubules and are in close proximity with parts of the smooth endoplasmic reticulum.

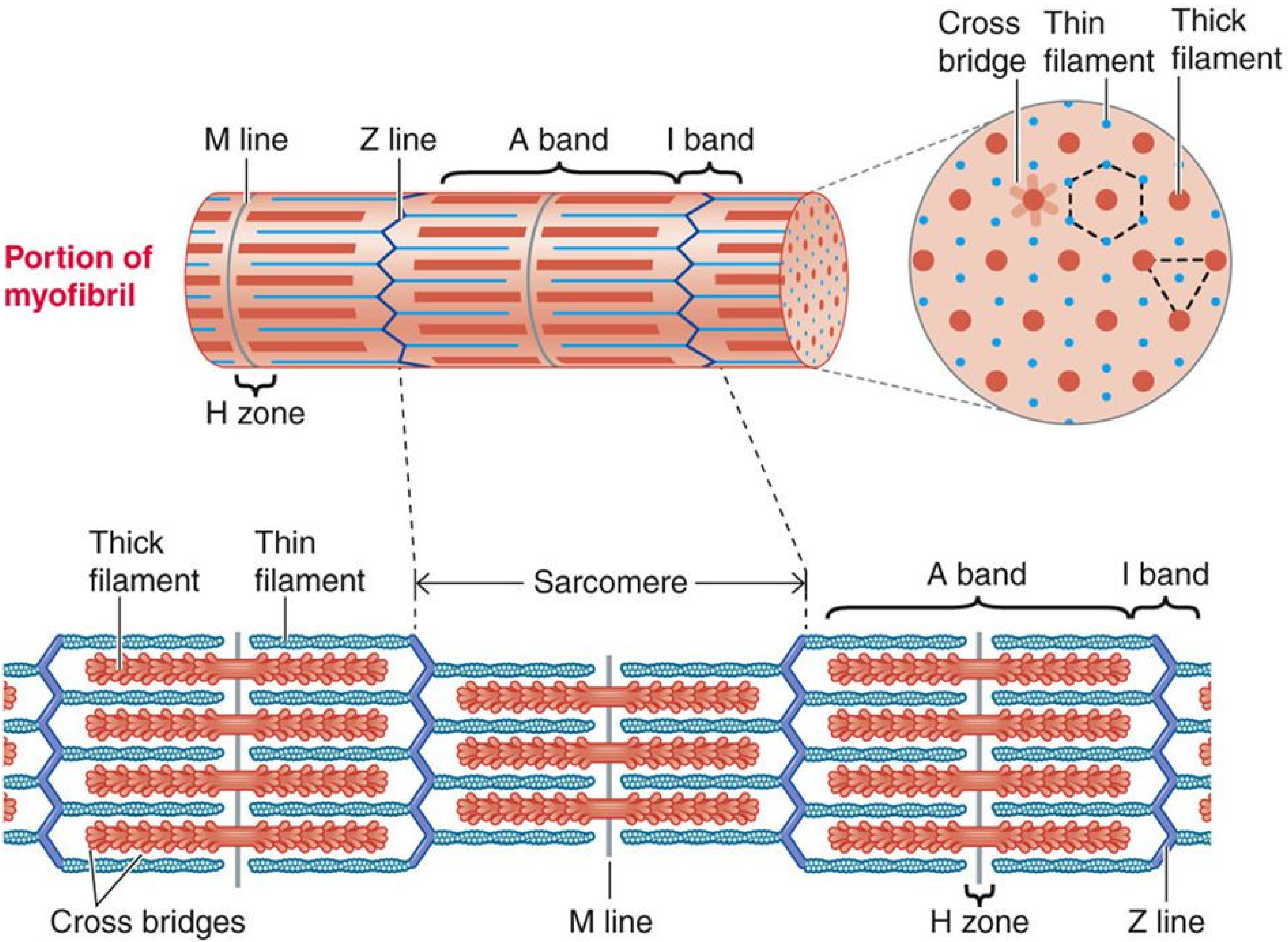
One single cell can have many myofibrils and many nucleuses*.

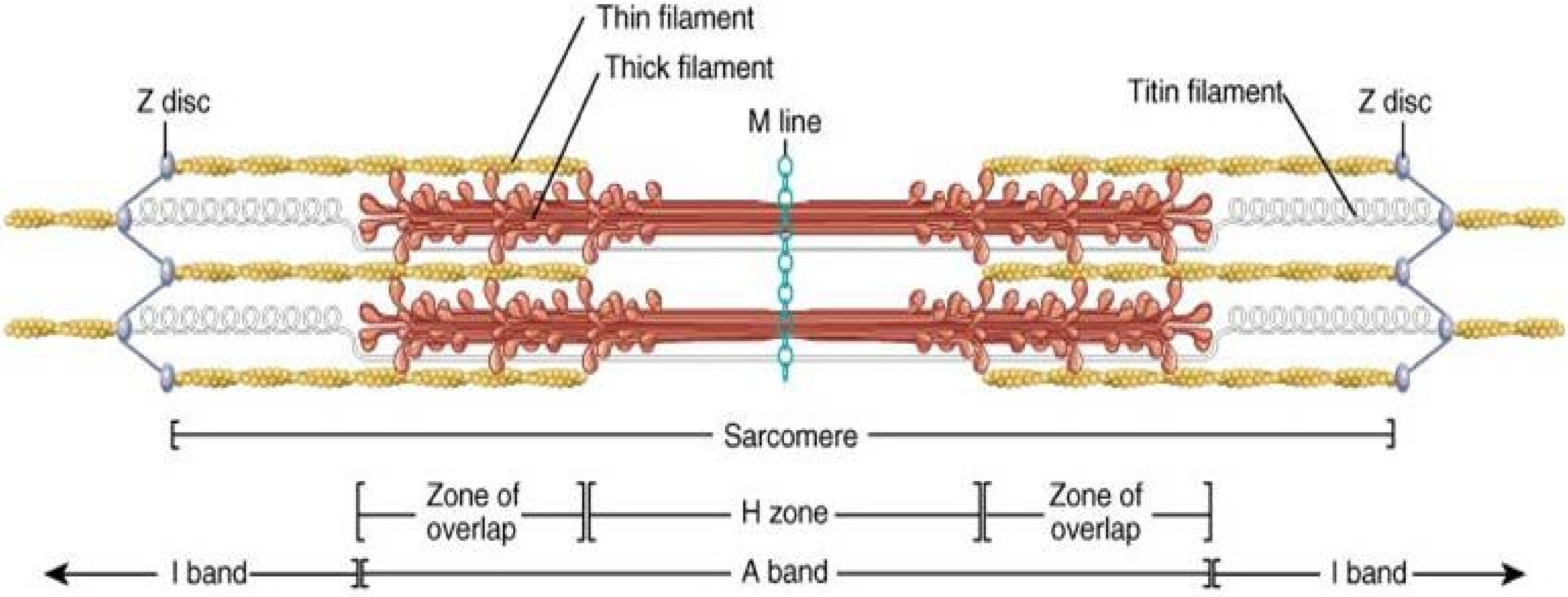


The cytoplasm of these cells is not as fluid as in other cells, it’s a bit crammed with solid elements, and it has a special name: sarcoplasm

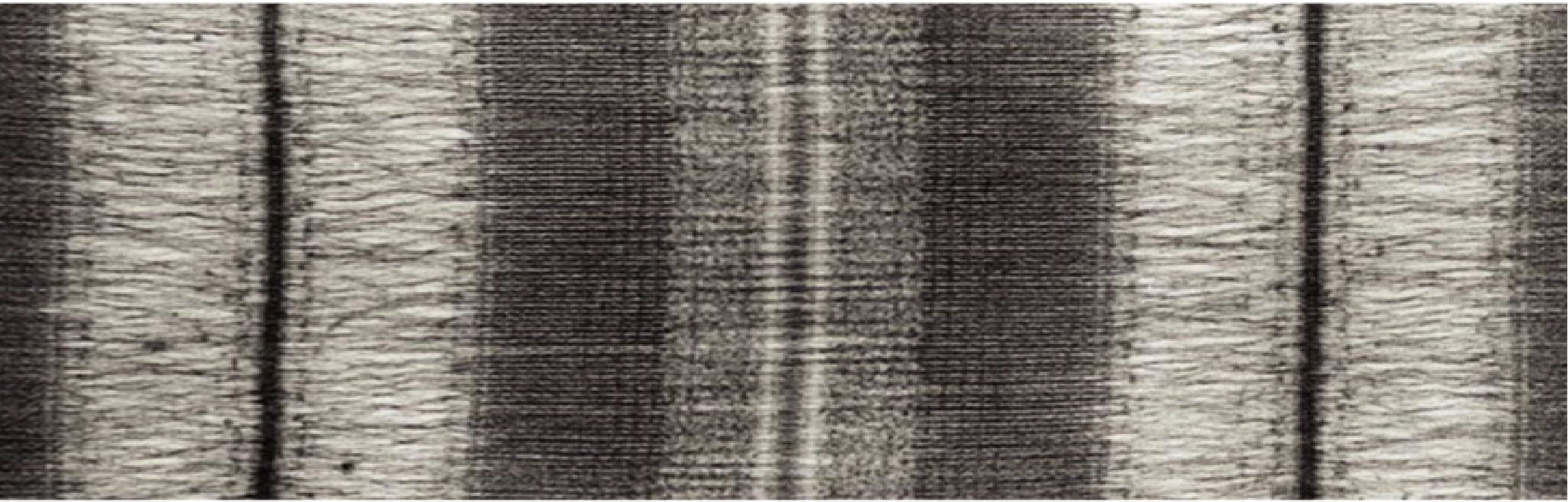


The fibrils have a structure in units called sarcomeres*



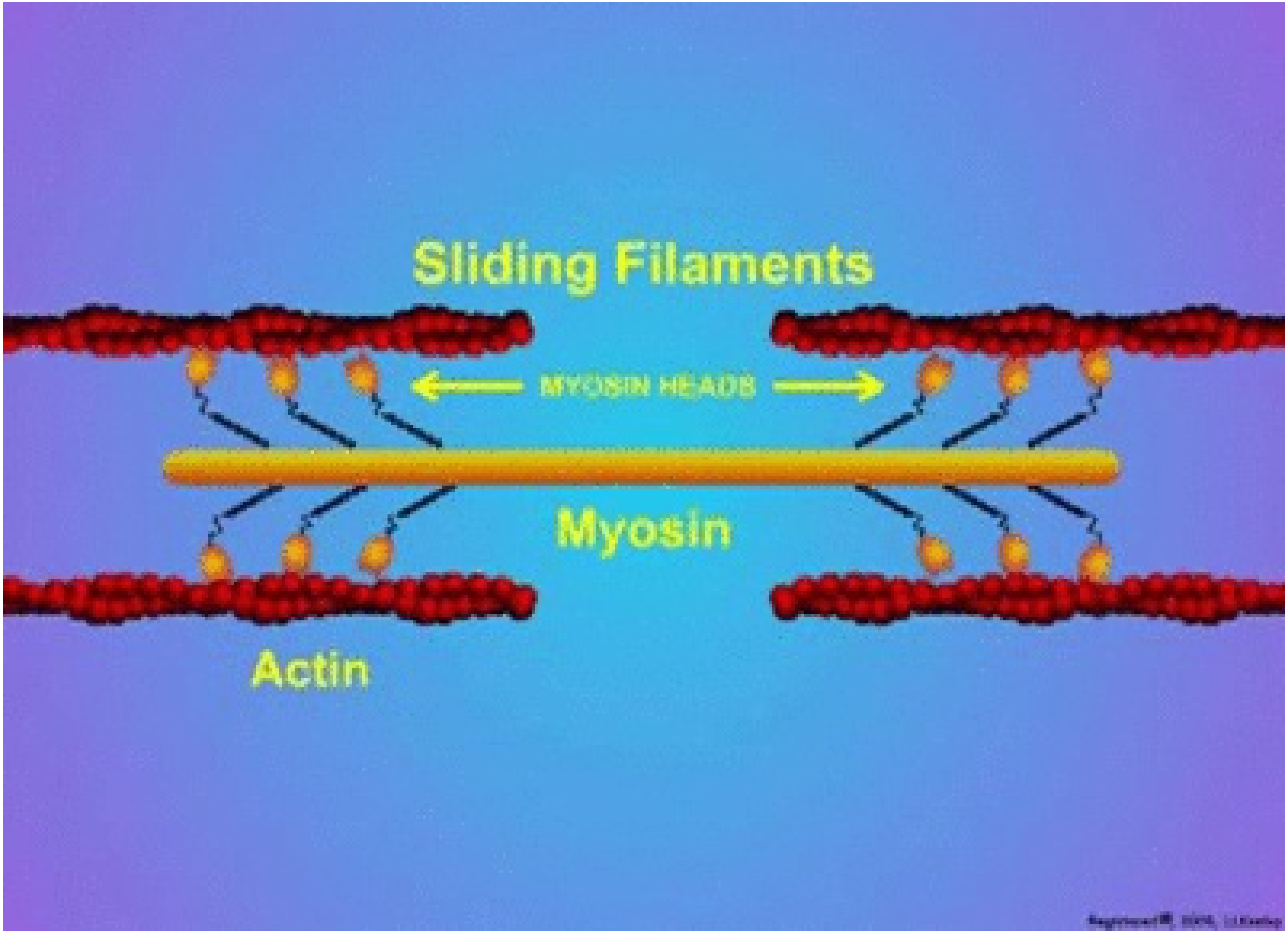


Z discs are quite opaque to ETM, so they look quite dark:



11.2. Movement

The protein myosin has heads that bind to the actin filaments and pull them from both sides*.

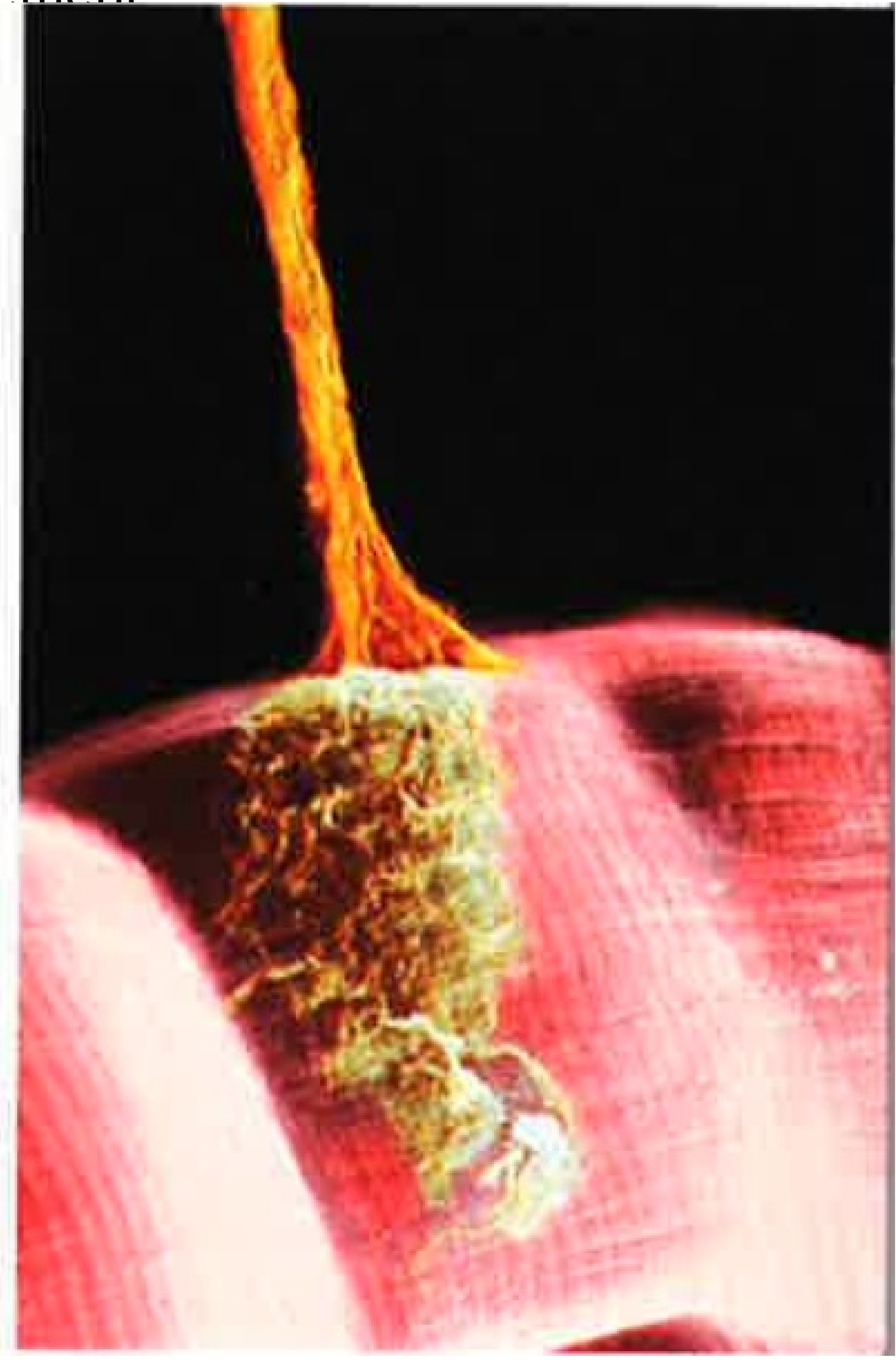


Steps of muscular contraction*.

1. A motor neuron carries an impulse to the muscle cell (fibre). At the end of the neuron, a neurotransmitter is, of course, released (acetylcholine) and binds to the receptors in the sarcolemma.

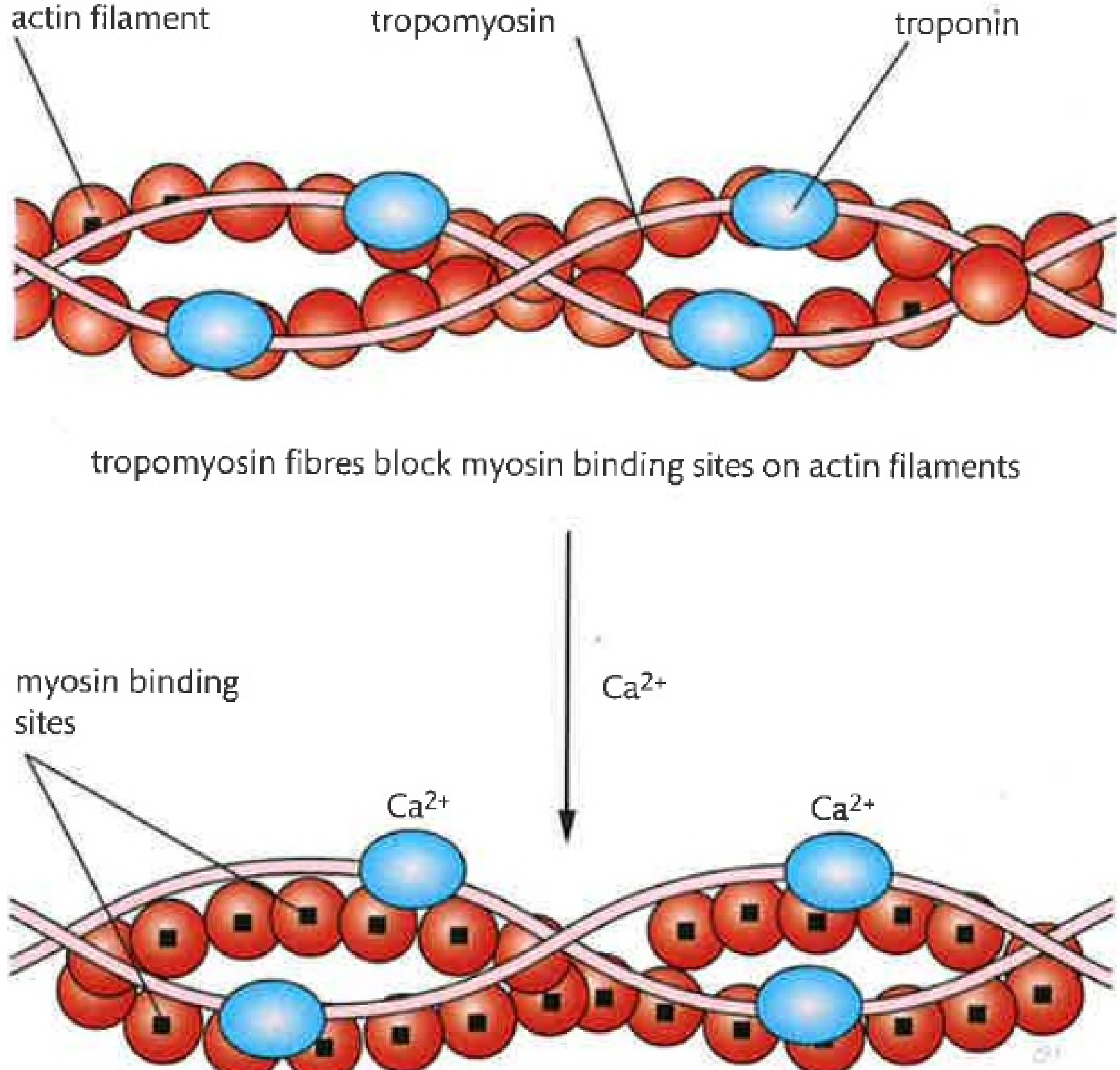
2. The sarcolemma receptors trigger a sodium discharge from the T tubules quite resembling the action potential in the neuron.

3. The sodium discharge spreads to the cells and reaches the endoplasmic reticulum, which reacts by releasing calcium everywhere into the sarcoplasm.



4. Normally, actin filaments are blocked by a protein called tropomyosin, so myosyn can’t grab them and pull

But when calcium appears, it attaches to the troponin protein and moves tropomyosin out of the way. Myosin starts binding and pulling immediately after.

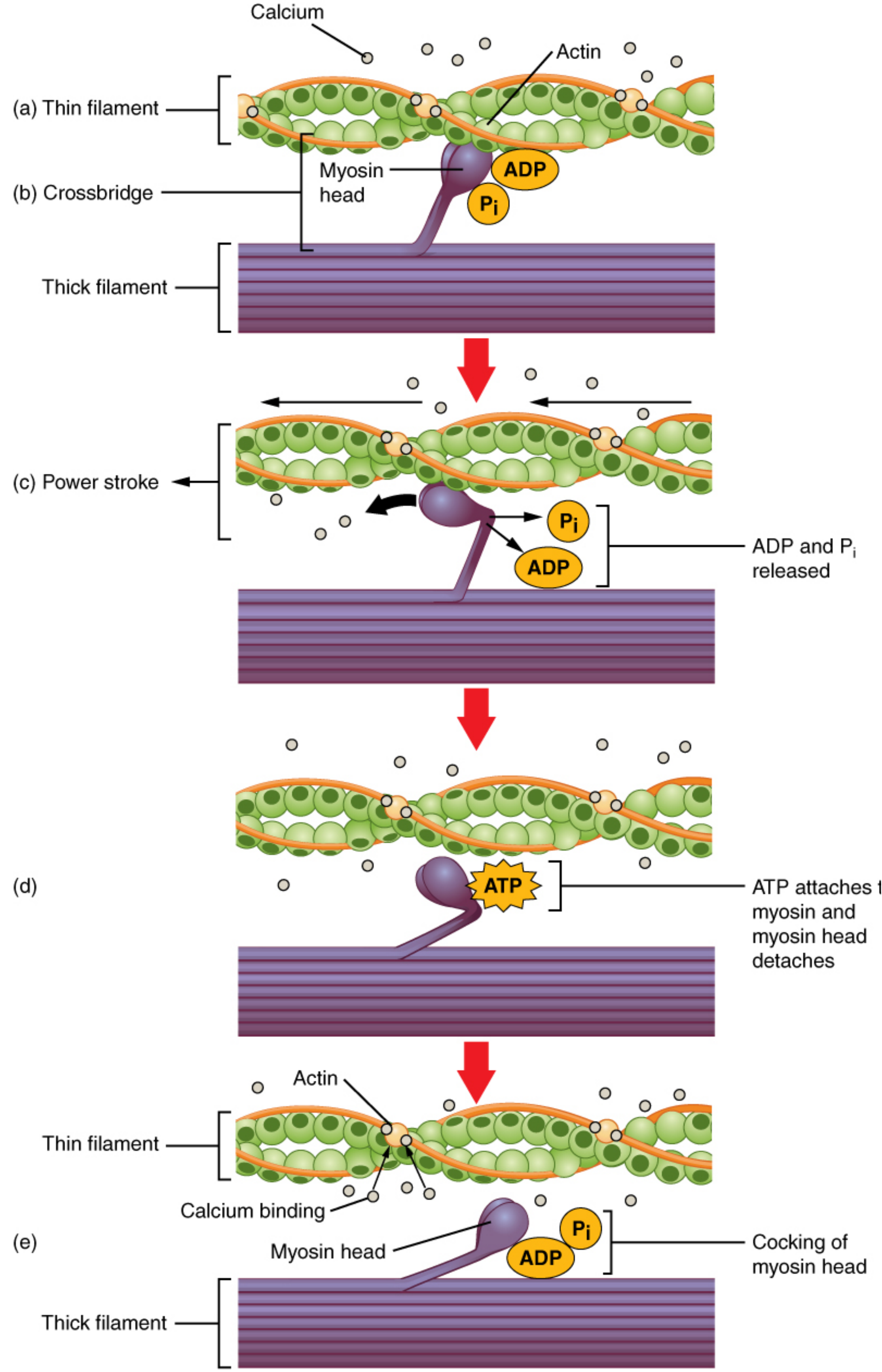


11.2. Movement

The process of myosin repeatedly pulling the actin filament is called “cross-bridge cycle”, and there are basically two things to remember:

1. It obviously requires ATP*

2. Less obvious: the actual pulling doesn’t consume the ATP, the ATP molecule is broken when the head “stretches” (usually called cocking). The myosin head pulls by a spontaneous return to the most stable conformation.



Any Questions?