

A.4.1. The Muscle Cell

Introduction: *(repeat of previous page)*

In this Basic Physiology chapter, we discuss **two** types of cells in the body that demonstrate several basic physiological principles that are very useful to know and understand before starting the study of specific organ systems. These are a) the **nerve** cells and b) the **muscle** cells. In this and the next pages, we will concentrate on the physiology of the muscle cells.

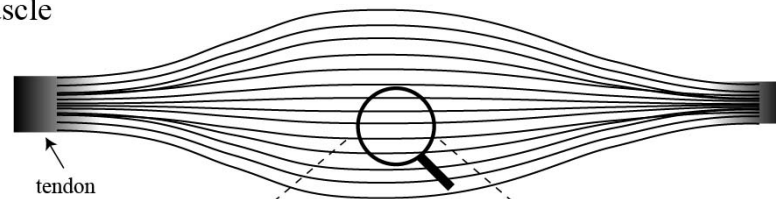
A. What is a muscle cell?

1. A muscle cell is a cell that, when stimulated, contracts .	2. The muscle cell is part of a whole muscle which, when stimulated, contracts. This makes all kind of things happen in the body.
3. There are three types of muscles in the body: a. the skeletal muscle b. the cardiac muscle c. the smooth muscle	4. The skeletal muscles are muscles that are attached to the skeleton (hence its name). Contraction of these skeletal muscles makes the skeleton move (arms, legs, walking, etc.).
5. The cardiac muscle is the heart that contracts (=pumps) to push the blood around our body.	6. The smooth muscles are muscles that are located in many organs in our body like the stomach, the intestines, the blood vessels etc.

B. The skeletal muscle cell

1. A skeletal muscle is typically long and attached to two or more tendons. The tendons, in turn, are attached to the bones of the skeleton.	2. The muscle consists of elongated cells grouped together by layers of connective tissues (called endomysium, perimysium and epimysium depending on the level of the connection from small to large)
3. The tendons and the connective tissues are all connected to each other and surround the working muscle cells.	4. One single muscle fibre (= cell) can be very long (centimetres) and very thin (10-100 microns).

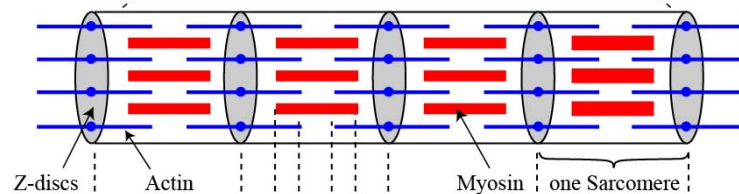
A: Muscle



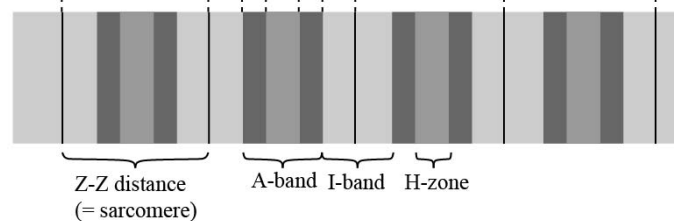
B: Muscle bundle



C: Muscle fiber



D: Anisotropy



5.

One muscle cell contains:

- several nuclei (plural of nucleus)
- one motor-end plate (for connecting the motor nerve to the muscle cell)
- several mitochondria for producing ATP (= energy for the contraction)
- > 1000 sarcomeres arranged along the cell.

6.

The **sarcomere** is essentially the working unit of the muscle:

- A sarcomere runs from one Z-disk to the next Z-disk
- Sarcomeres contain two type of molecules (=myofilaments): **actin** and **myosin**
- The actin molecules are attached to the Z-disks
- The myosin molecules are arranged in a regular pattern between the actin molecules

C. Striation (= Anisotropy)

1. When viewed under the microscope, the skeletal muscle shows a typical striated pattern of light- and dark bands . This striation is caused by the structure of the sarcomere.	2. There are two bands; the dark A-band and the light I-band .
3. The dark A-band corresponds to the length of the myosin molecules (these are thick molecules and therefore less light is transmitted through them; hence the darkness as seen under the microscope).	4. The lighter I-band corresponds to the length of the actin molecules, which are thinner and therefore allow more light to pass through.
5. The Z-disk is hardly visible in the microscope (often called Z-line).	6. Because the Z-line is hardly visible, the I-band stretches from one A-band to the A-band in the next sarcomere.
7. Some people have also noticed and described a somewhat lighter zone in the middle of the A-band; called the H-zone . This is the zone in which the myosin molecules do not overlap with the actin molecules (and hence a little bit more light is transmitted through this small region).	8. All this is not terribly important except for the fact that some teachers like to ask what would happen with these bands when contraction of the sarcomere occurs (see A.4.3. <u>The Sarcomere</u>).

D. The cardiac and the smooth muscle cells

1. The cardiac and smooth muscle cells differ in several important ways from the skeletal muscle cells.	2. The cardiac muscle is also striated whereas the smooth muscle is not. Hence its name; smooth!
3. More pages on the cardiac and smooth muscle cells are available at link: <u>A.4.7. Cardiac Muscle</u> and link: <u>A.4.8. Smooth Muscle</u> .	