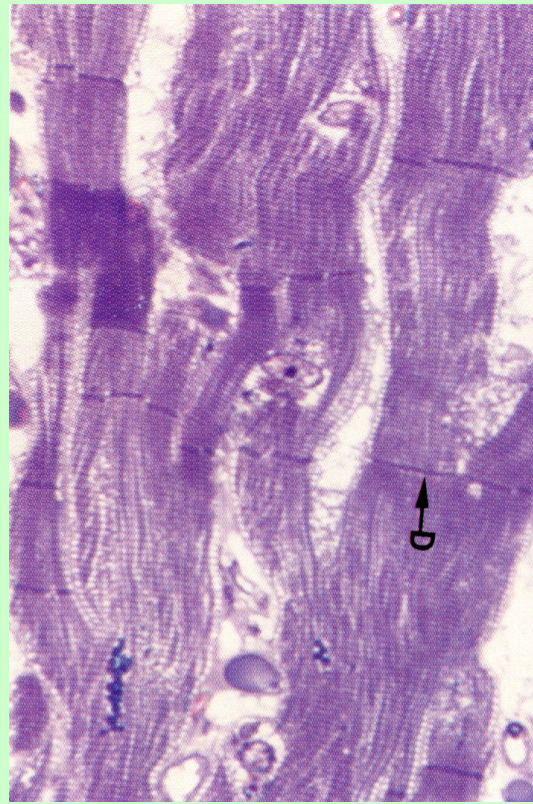
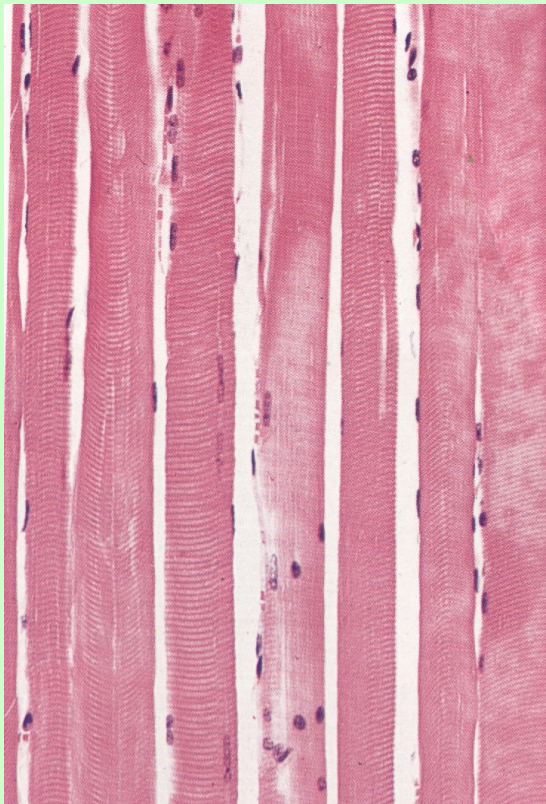


# **Muscle tissues**

**Ass. Professor  
Goriachkina Valeria Lvovna**

**Muscle tissues are classified on the basis of their appearance. Two different types of muscle tissues are recognized: striated and smooth. Striated muscle tissue is subclassified on the basis of its location: skeletal muscle tissue and cardiac muscle tissue**



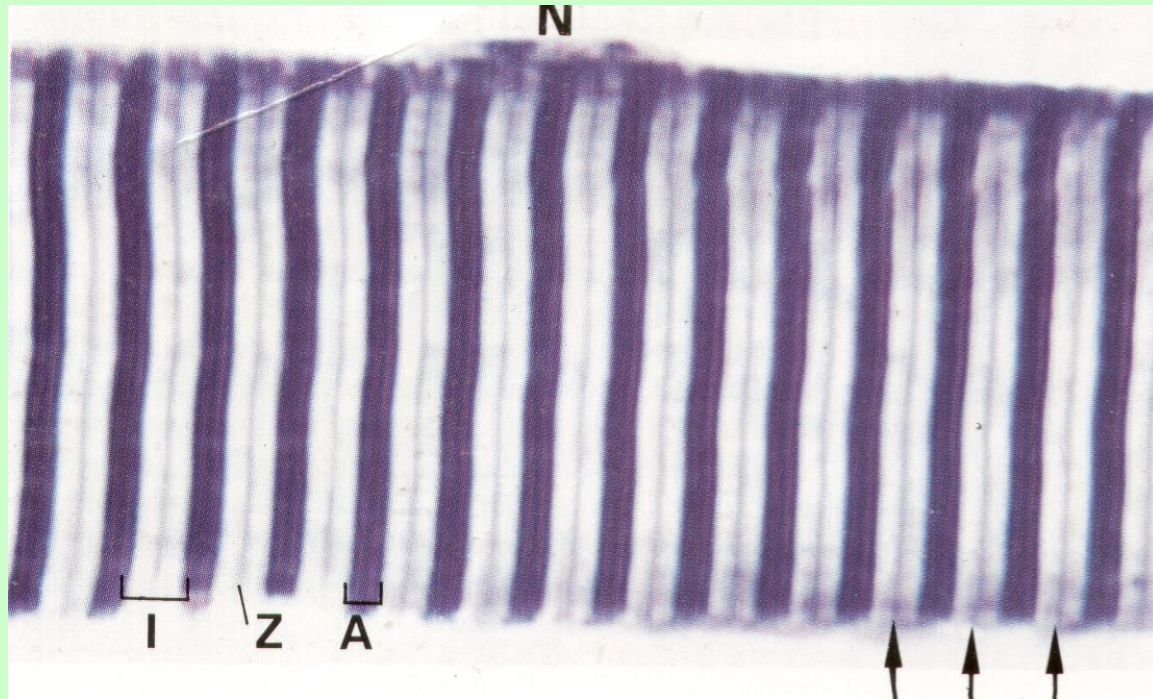
# *General Features of Skeletal Muscle Tissue*

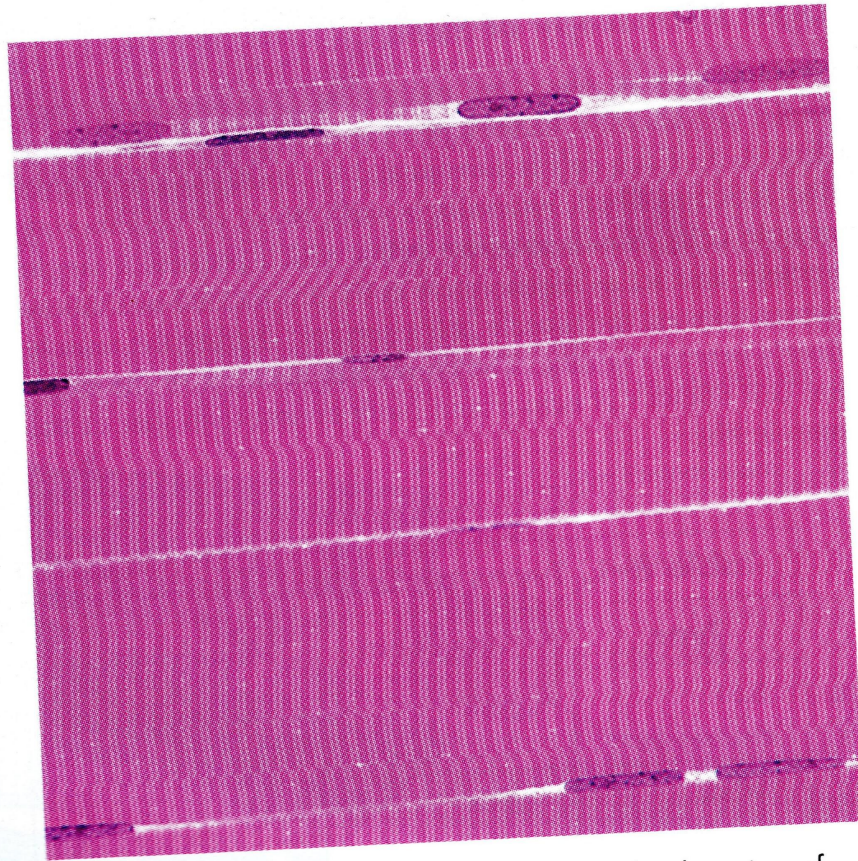
1. It is form of striated muscle fibers.
2. Each muscle fiber contains many nuclei. They are located immediatly under the plasma membrane.
3. Each muscle fiber contains parallel myoffibrils (80% myofibrils in the fibre), which are trasversely striated.
4. The cytoplasm of the muscle fiber is known as Sarcoplasm (Greek **sarkos** - flesch)
5. The sarcoplasm contains glycogen, lipids and myoglobin (pigmental protein; it can take up, store, or give up, oxygen as needed).
6. The function of this tissue is controled voluntarily - it could be contracted or relaxe by will skeletal muscle came to be known also as **voluntary muscle**

# The arrangement of the contractile proteins within skeletal muscle fiber

## Skeletal muscle tissue

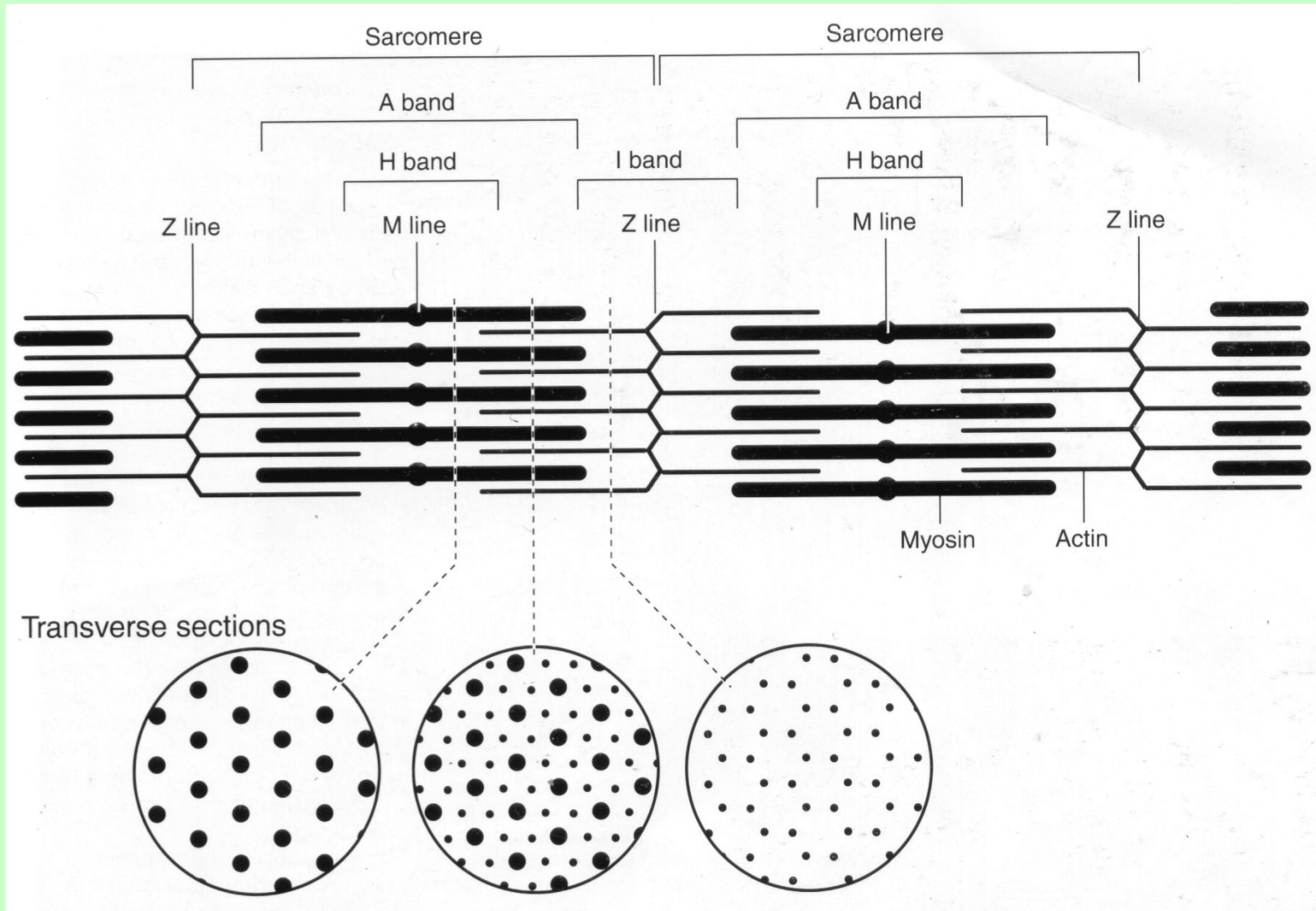
Each myofibril has characteristic banding patterns (dark and light bands). When observed under polarized light, the dark-staining bands are birefringent (**anisotropic**), while the light-staining ones are **isotropic**. Accordingly, the dark bands are called **A bands** (**A** for anisotropic) and the light ones, **I bands** (**I** for isotropic). Owing to these alternations of dark and light bands, transverse striations in a muscle fiber can be seen with light microscope.

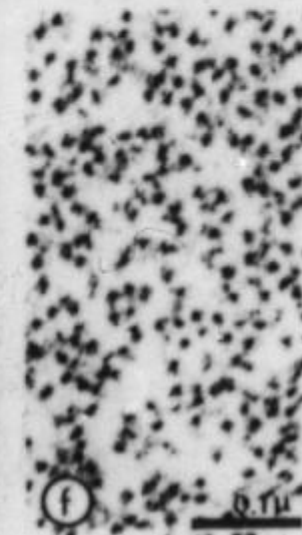
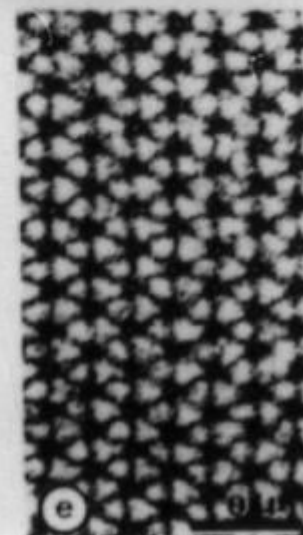
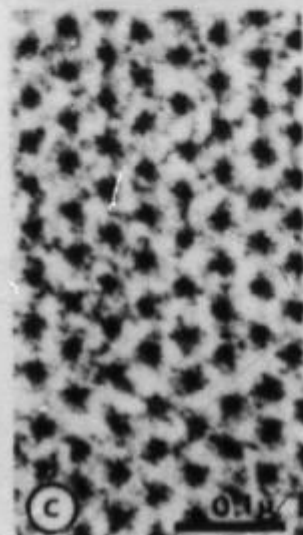
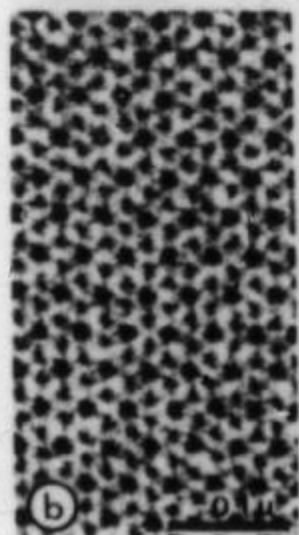
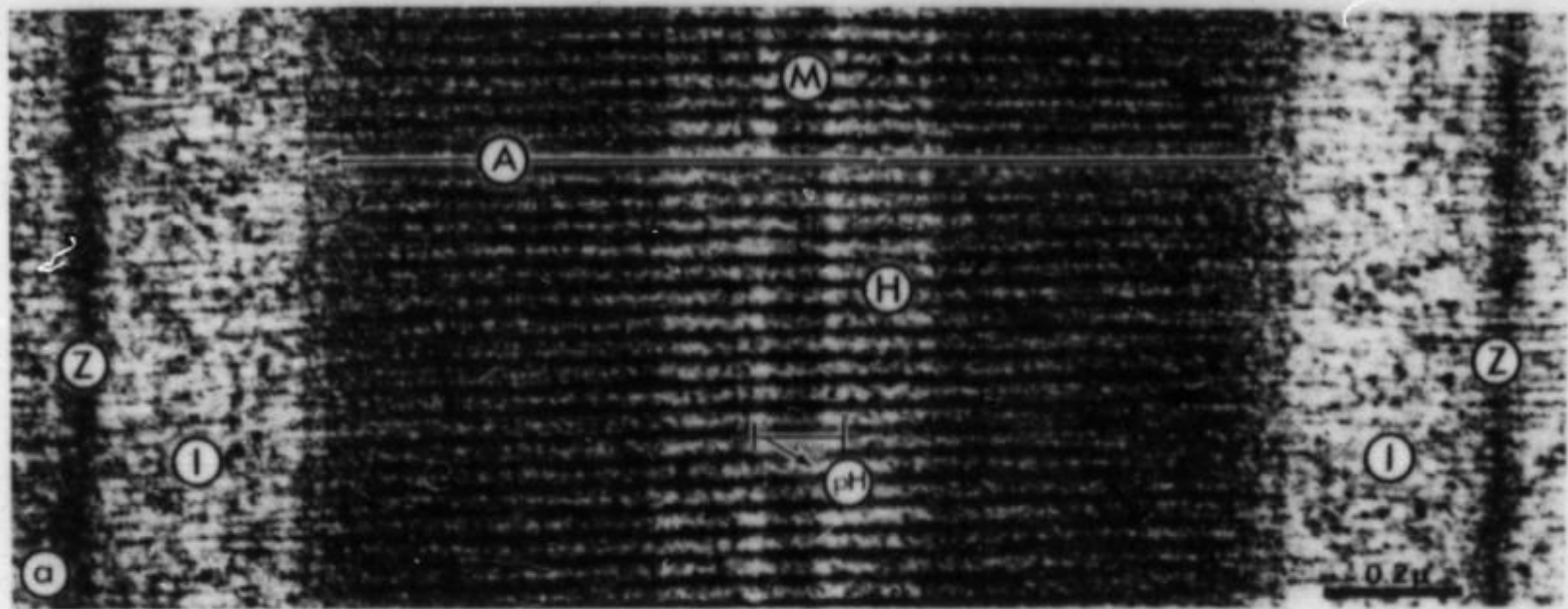




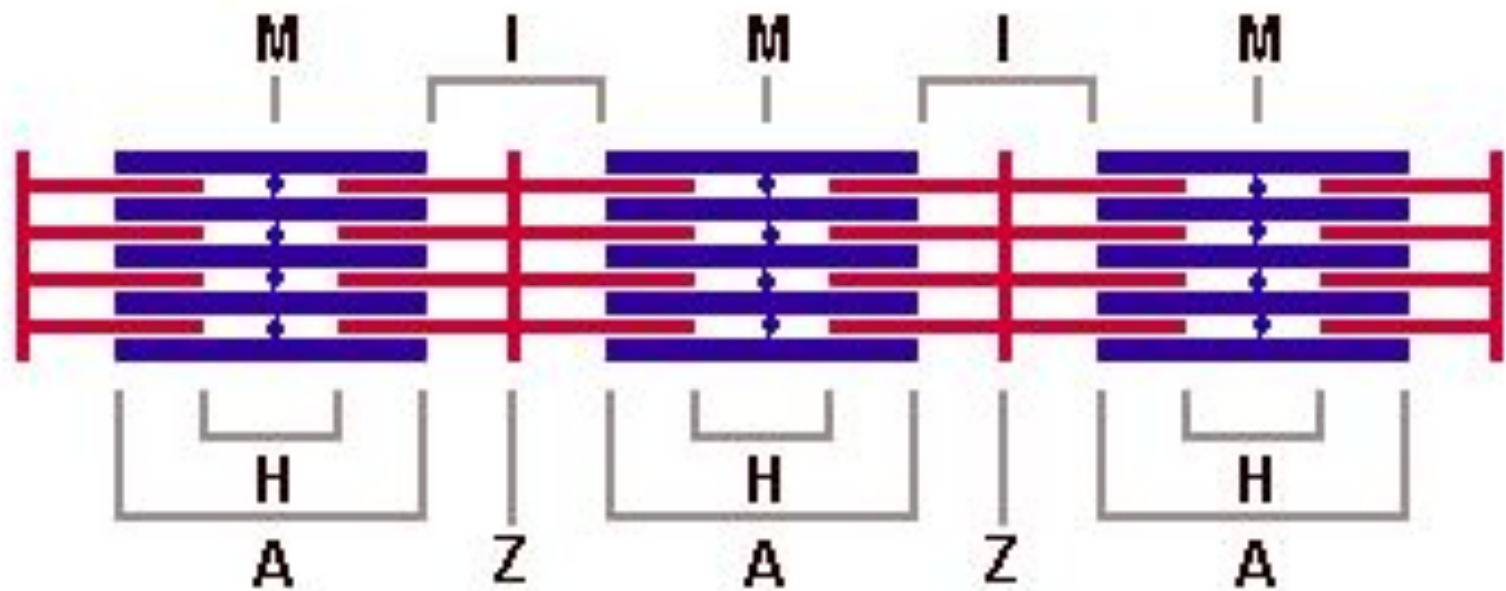
**Figure 8-1.** Photomicrograph of a longitudinal section of skeletal muscle ( $\times 540$ ).

# The structure of thick and thin filaments at the molecular level





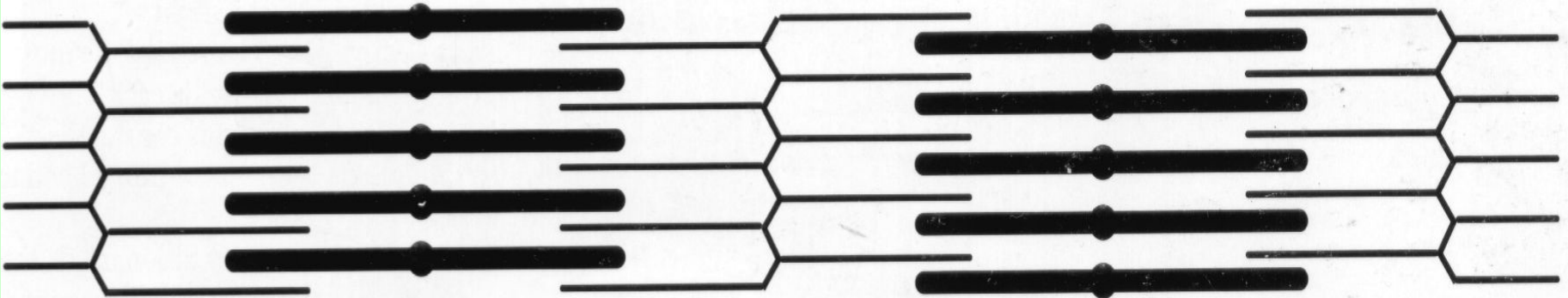
— myosin — actin



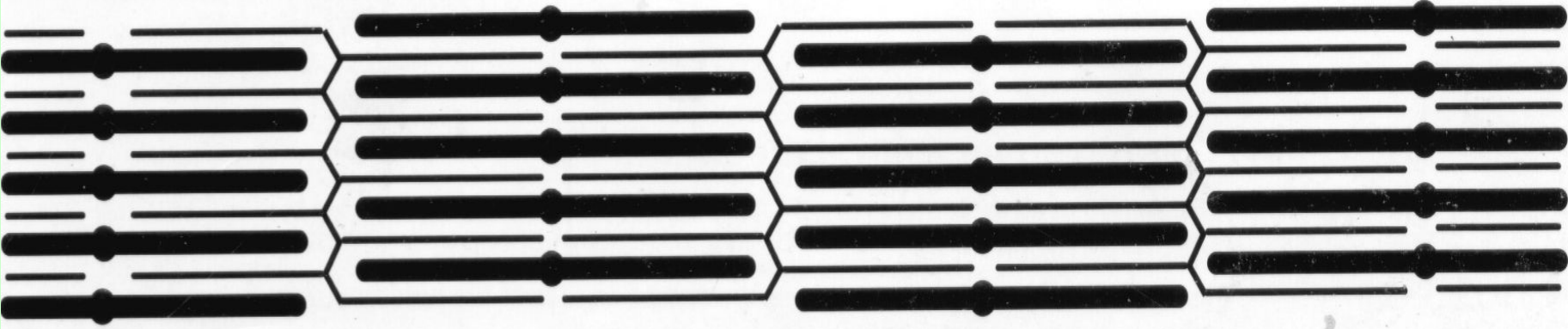
**Bands and lines in the contractile apparatus of skeletal muscle**

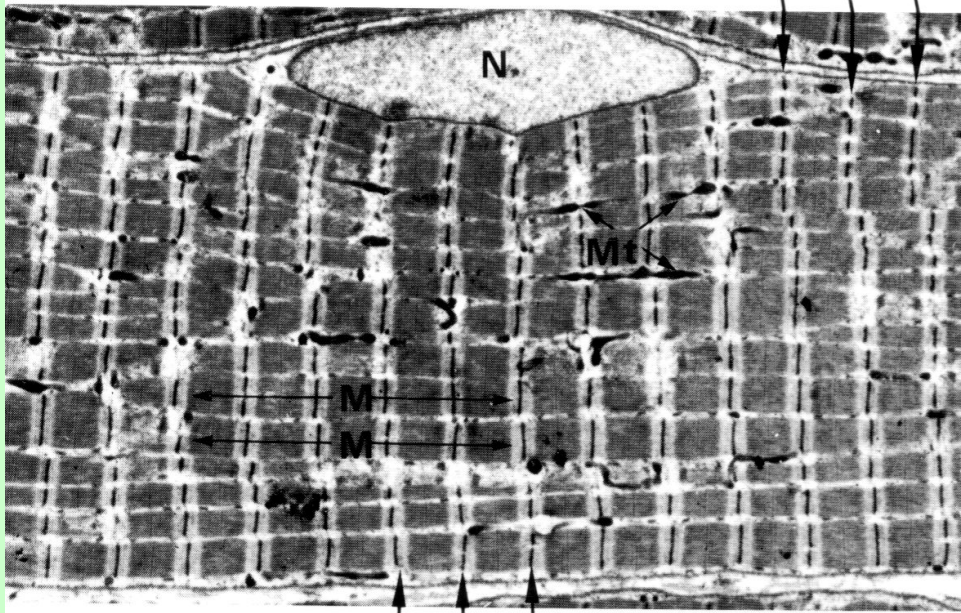


Myofibril in relaxed state

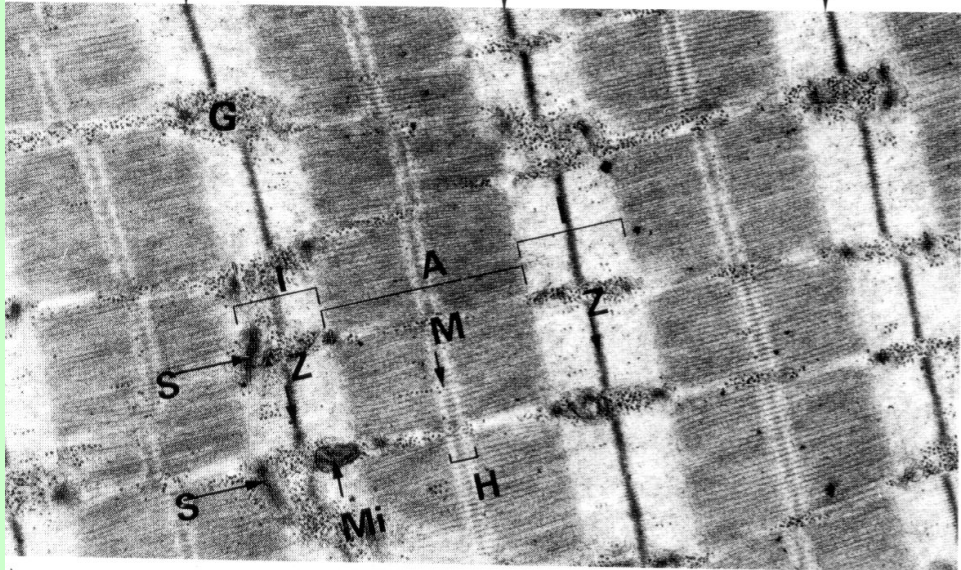


Myofibril in contracted state

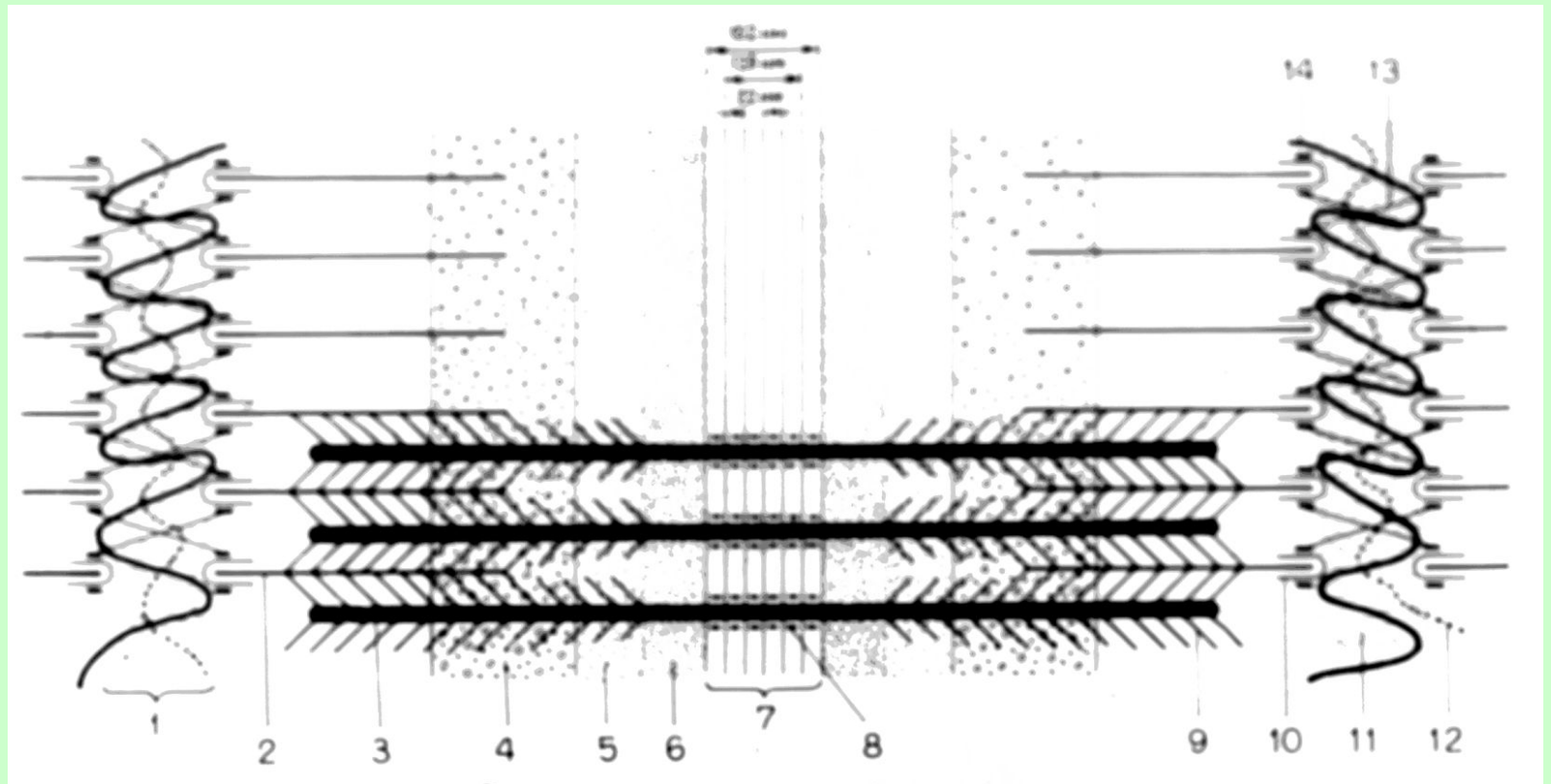




b)

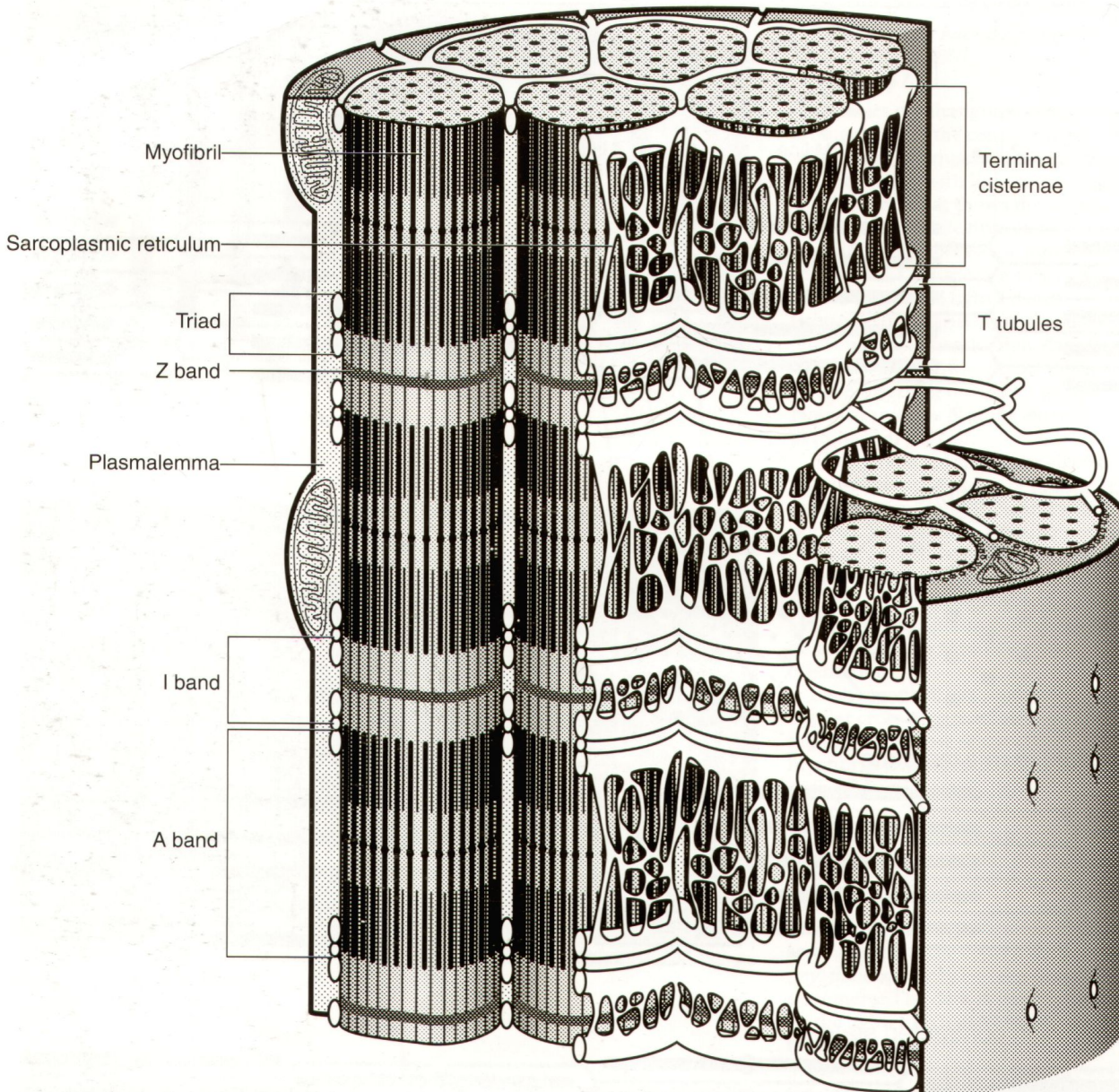


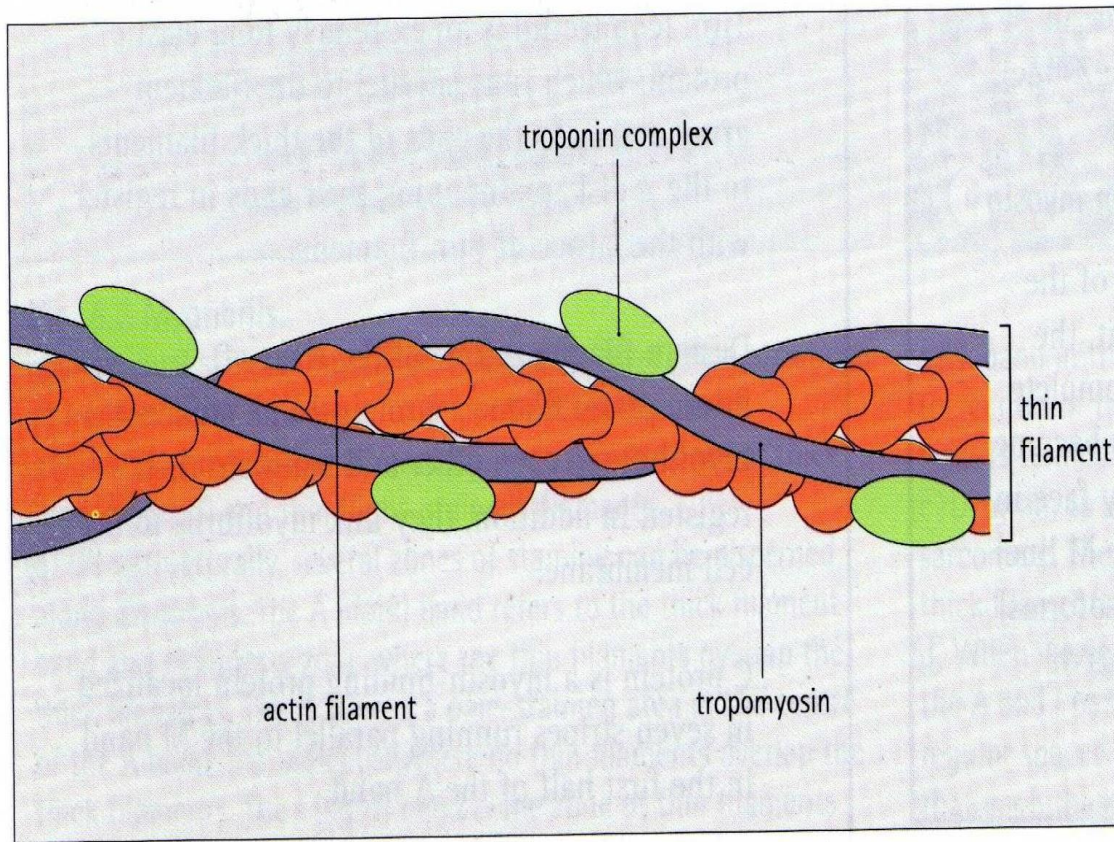
# The structure of sarcomere



# Sarcotubular system

is composed of agranular (smooth) sarcoplasmic reticulum (L-tubules) and T-tubules

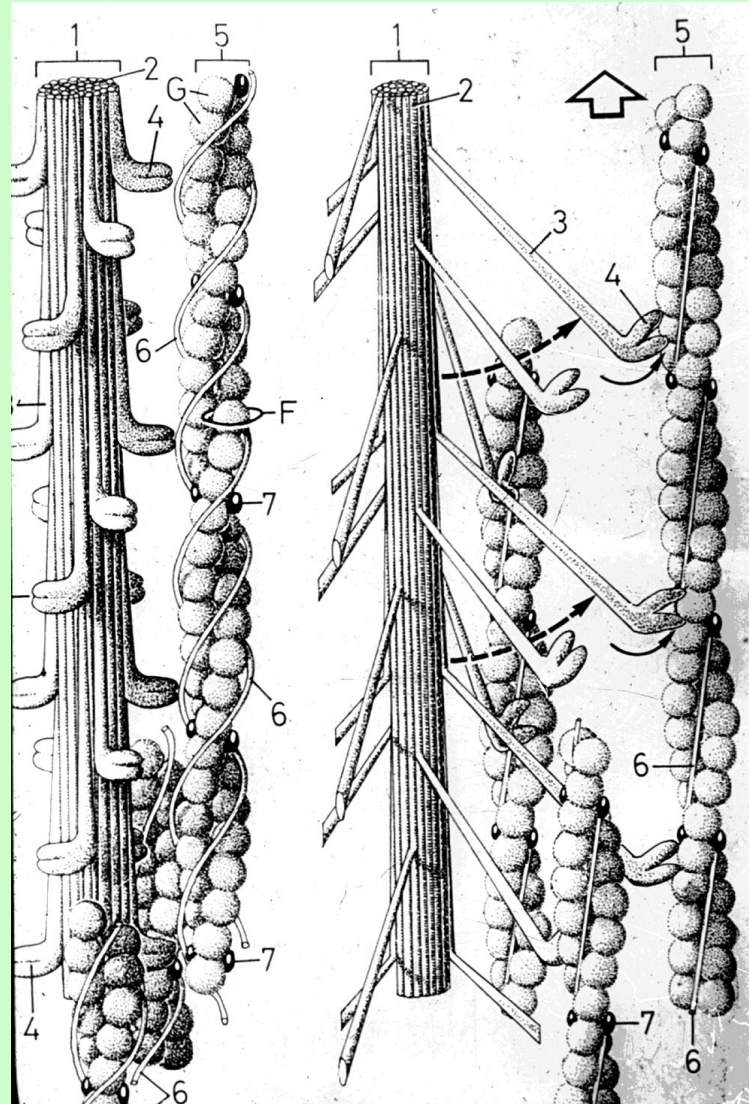


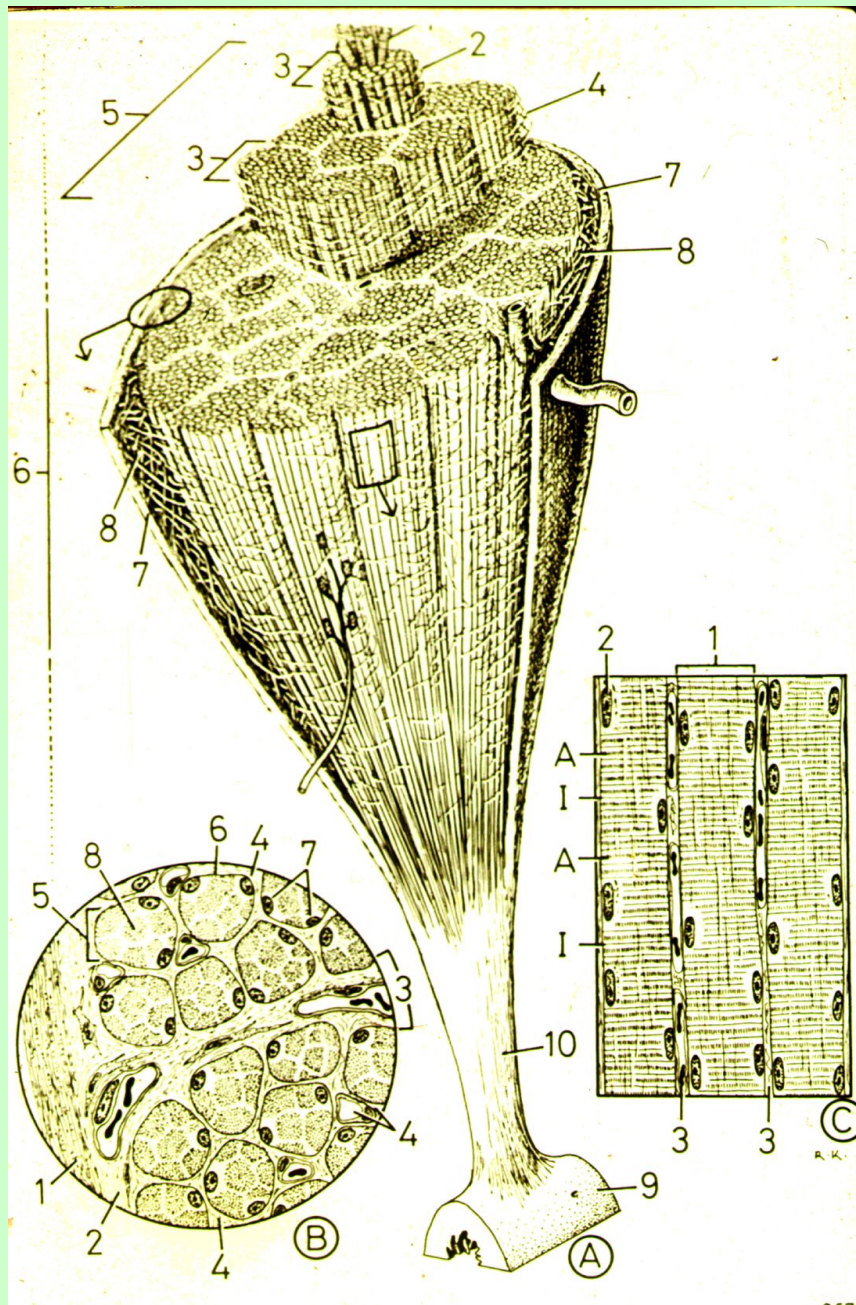


**Fig. 5.6 Control of muscle contraction.** Tropomyosin is a long rod-like protein that winds around an actin filament to stabilize and stiffen it.

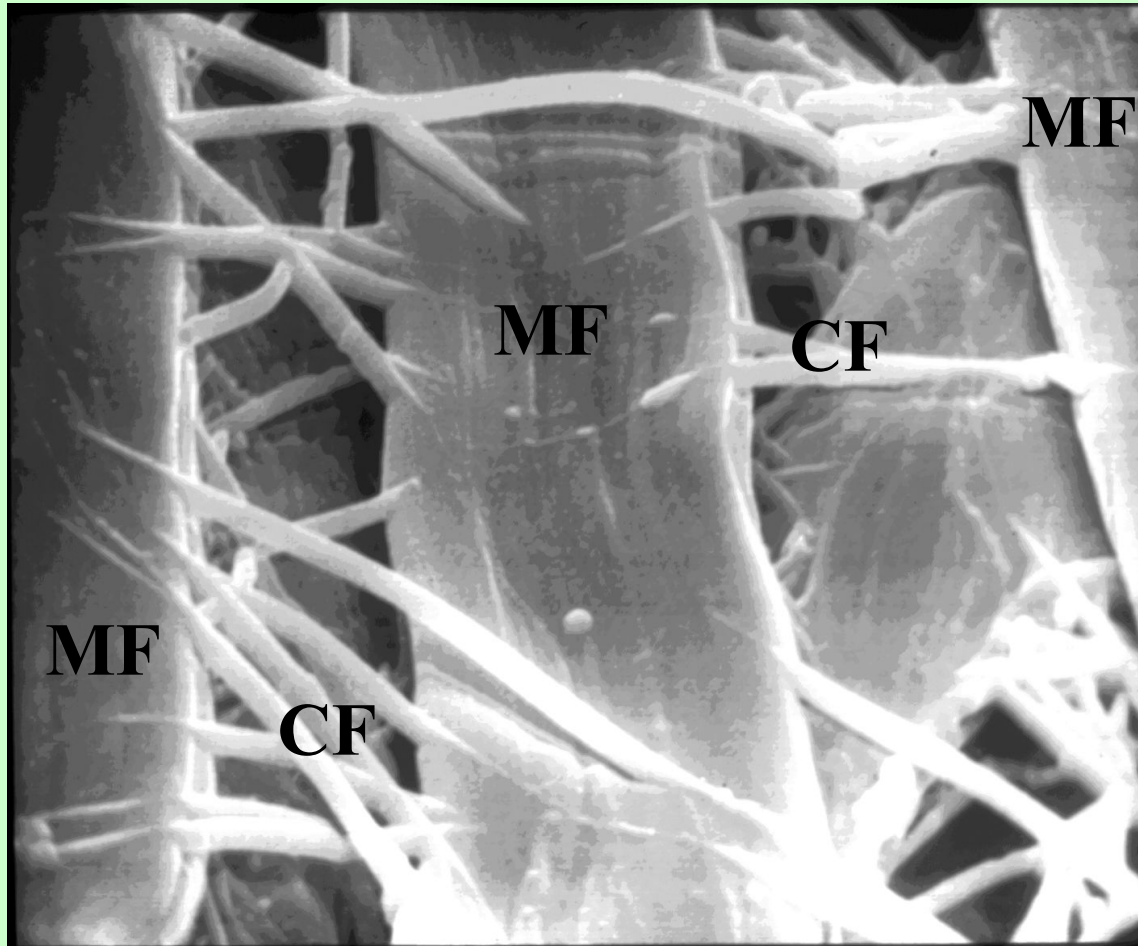
The troponin complex, which regulates the binding of actin to myosin, is attached to tropomyosin and composed of three separate polypeptides termed troponin T, I and C. Troponin T binds the complex to tropomyosin and positions the complex on the actin filament at the site where actin would bind to myosin. Troponin I physically prevents myosin binding to actin. Troponin C binds  $\text{Ca}^{++}$  ions, which cause a conformational change in the troponin complex, allowing myosin access to the actin filament.

# Contraction cycle of skeletal muscle

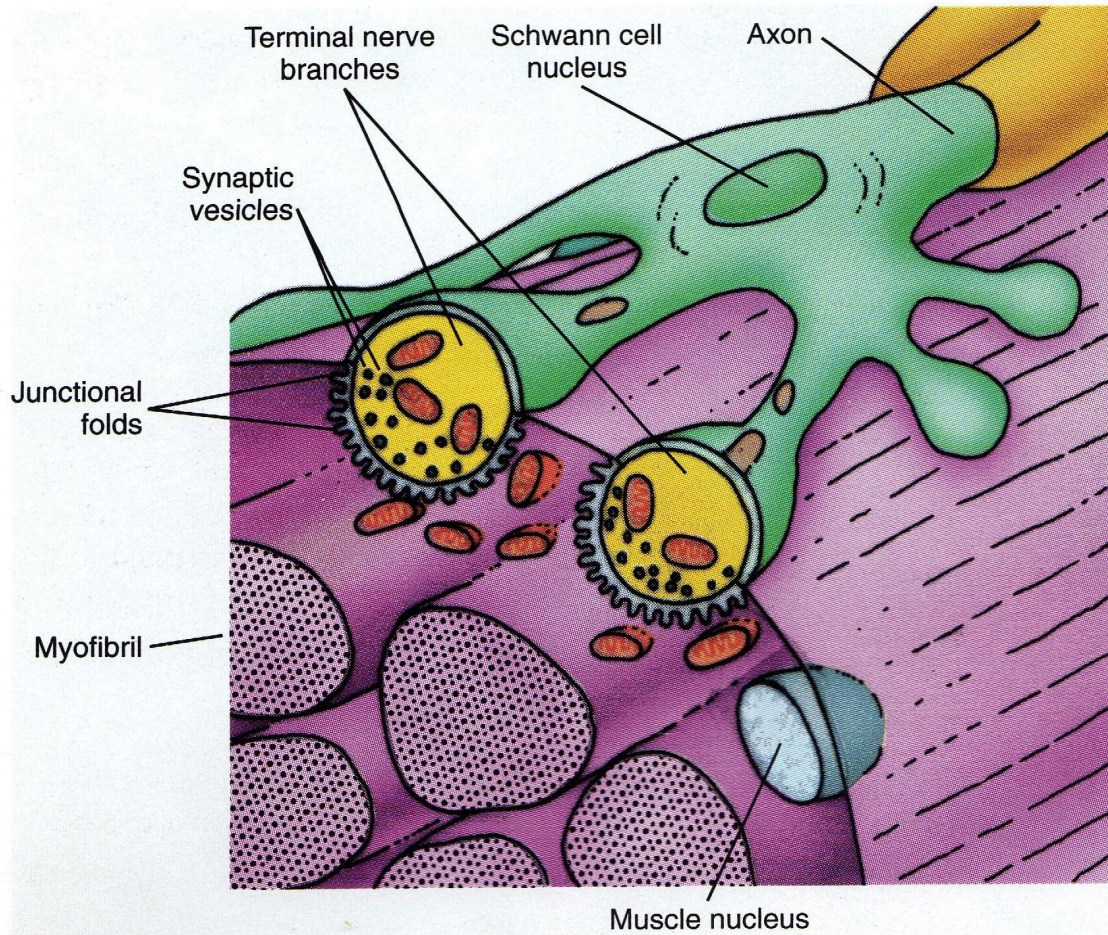


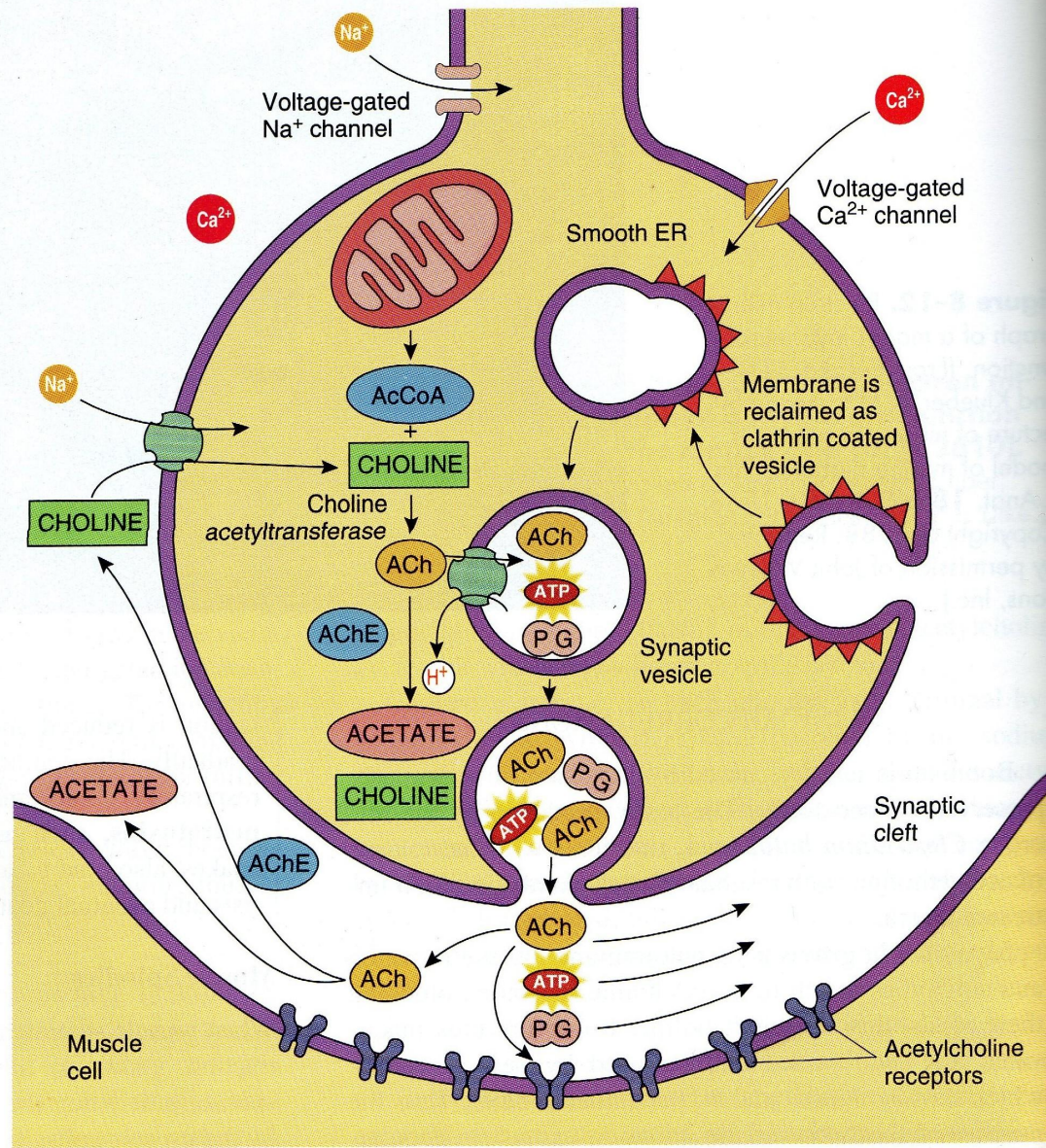


# Scanning electron micrograph of striated muscle fibers (MF) endomysium (collagen fibers-CF)





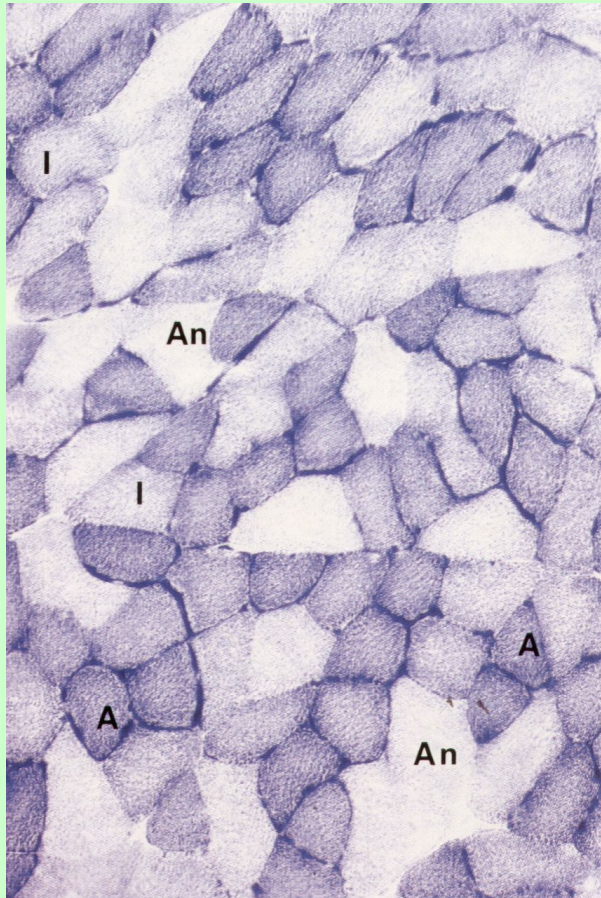




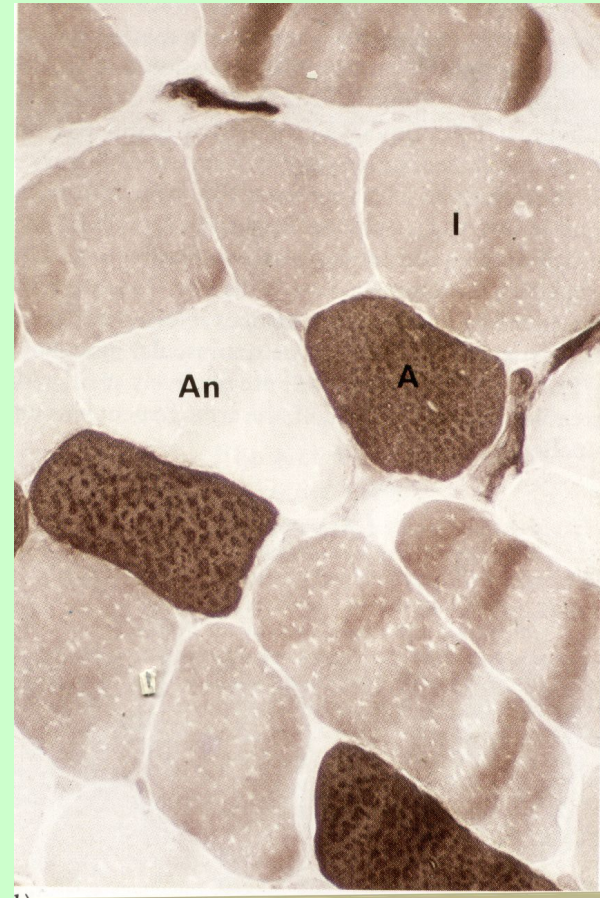
# Skeletal muscle fiber Types

| <b>Main features and properties</b>            | <b>Red fibers<br/>slow-twitch</b> | <b>White fibers<br/>fast-twitch</b> | <b>Intermediate<br/>fibers</b>      |
|--|-----------------------------------|-------------------------------------|-------------------------------------|
| <b>Size of motoneurons serving this fibers</b> | <b>small</b>                      | <b>large</b>                        | <b>large</b>                        |
| <b>Diameter</b>                                | <b>smaller</b>                    | <b>larger</b>                       | <b>between red and white fibers</b> |
| <b>Number of mitochondria</b>                  | <b>numerous</b>                   | <b>less</b>                         | <b>between</b>                      |
| <b>Myofibers</b>                               | <b>thinner</b>                    | <b>thicker</b>                      | <b>between</b>                      |
| <b>Myoglobin</b>                               | <b>large amounts</b>              | <b>less myoglobin</b>               | <b>between</b>                      |
| <b>Glycogen</b>                                | <b>less</b>                       | <b>large amounts</b>                | <b>between</b>                      |
| <b>Blood supply</b>                            | <b>rich</b>                       | <b>poor</b>                         | <b>between</b>                      |
| <b>Fatigue</b>                                 | <b>great resistance fatigue</b>   | <b>fatigue rapidly</b>              | <b>between</b>                      |
| <b>Contraction</b>                             | <b>slowly</b>                     | <b>Fast (more rapidly)</b>          | <b>between</b>                      |

# Type of muscle fibres



The activity of the specific  
mitochondrial enzyme  
succinate dehydrogenase



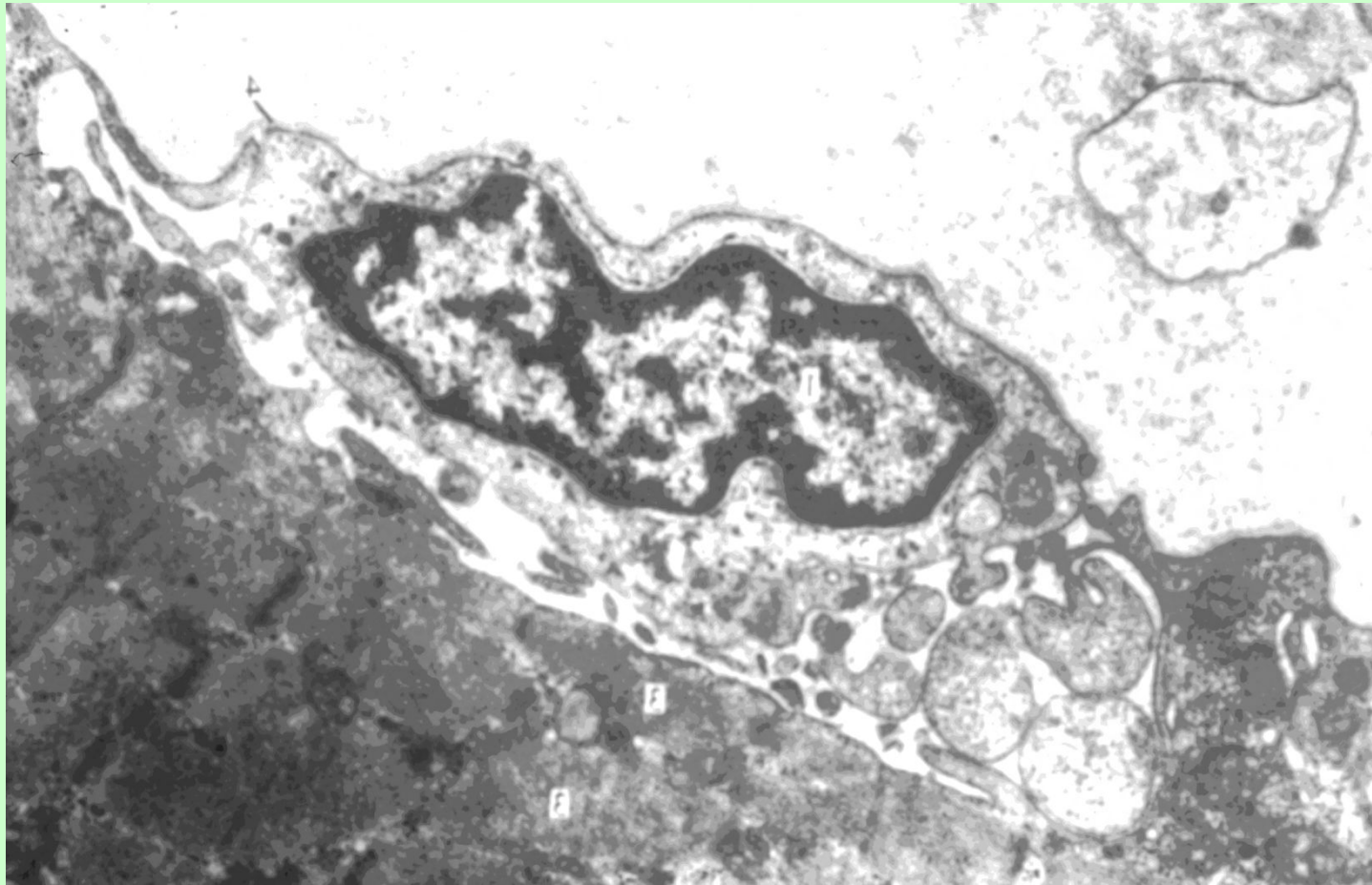
ATP-ase activity

**Aerobic (type I), anaerobic (type II) and intermediate fibres**

# **Histogenesis of Skeletal Muscle Fibers**

- 1. From the myotomes arise myoblasts (two cell populations).**
- 2. a) On one side presumptive myoblasts differentiate into true myoblasts.**  
**b) On other, presumptive myoblasts remain undifferentiated and give rise to satellite cells.**
- 3. a) True myoblasts range in rows, fuse together and form myotube.**  
**b) Satellite cells adhere to myotube.**
- 4. Myotube gradually differentiates into skeletal muscle fiber.**

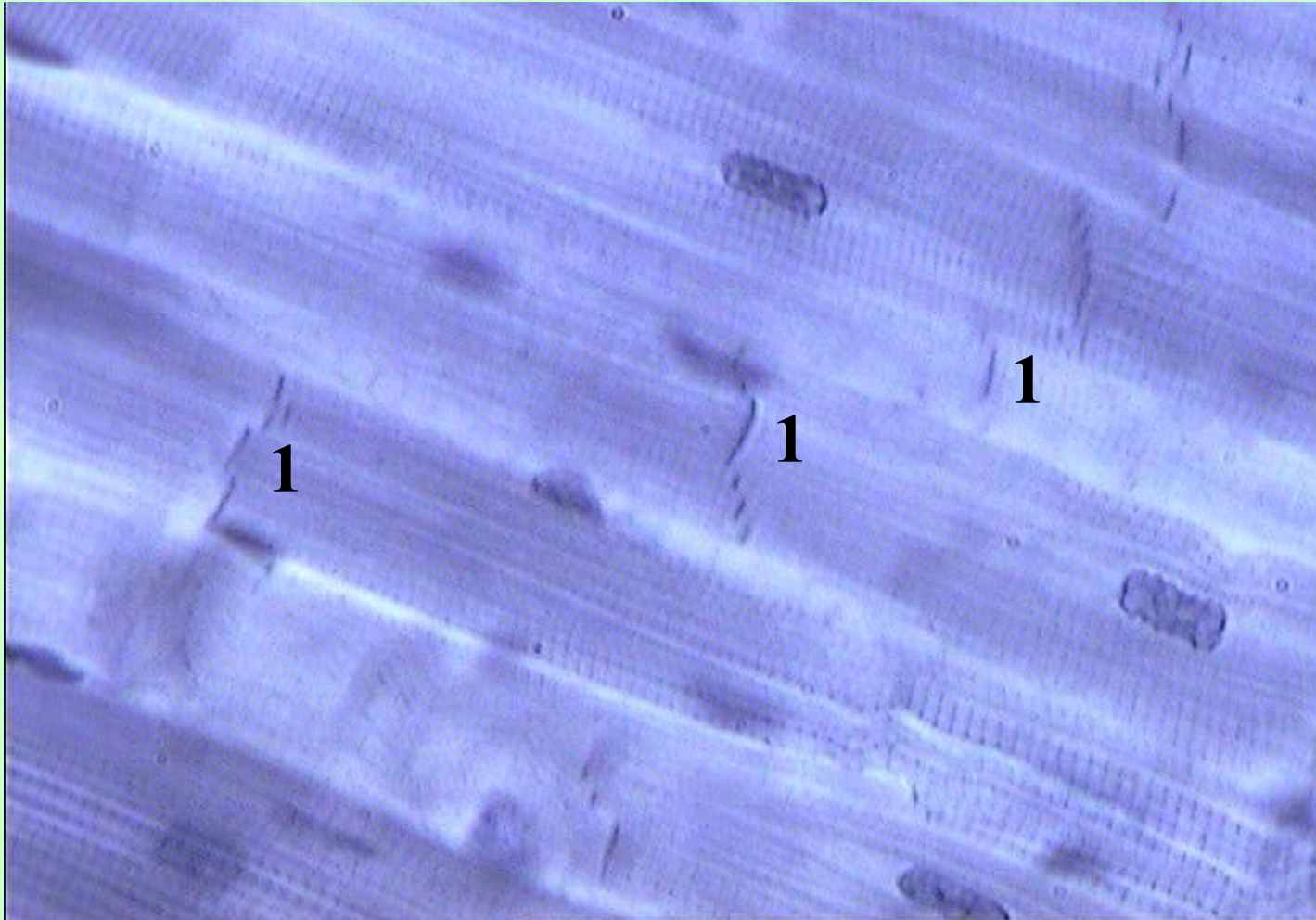
# Satellite cell



# General Features of Cardiac Muscle Tissue

1. It is formed of striated muscle cells.
2. Each muscle cell contains one or two nuclei. They are located in the central part of the cell.
3. Each muscle cell contains parallel myofibrils (40% of the myofibrils in the cell), which are transversely striated.
4. Each cardiac muscle cell contains many (40% of the mitochondria in the cell).
5. Cardiac muscle cells are joined end - to - end by the intercalated discs (junctional complex of the two cell membranes of two adjacent cardiac muscle cells).
6. Cardiac muscle is involuntary striated muscle.

# Cardiac muscle tissue



**1 - intercalated disks**



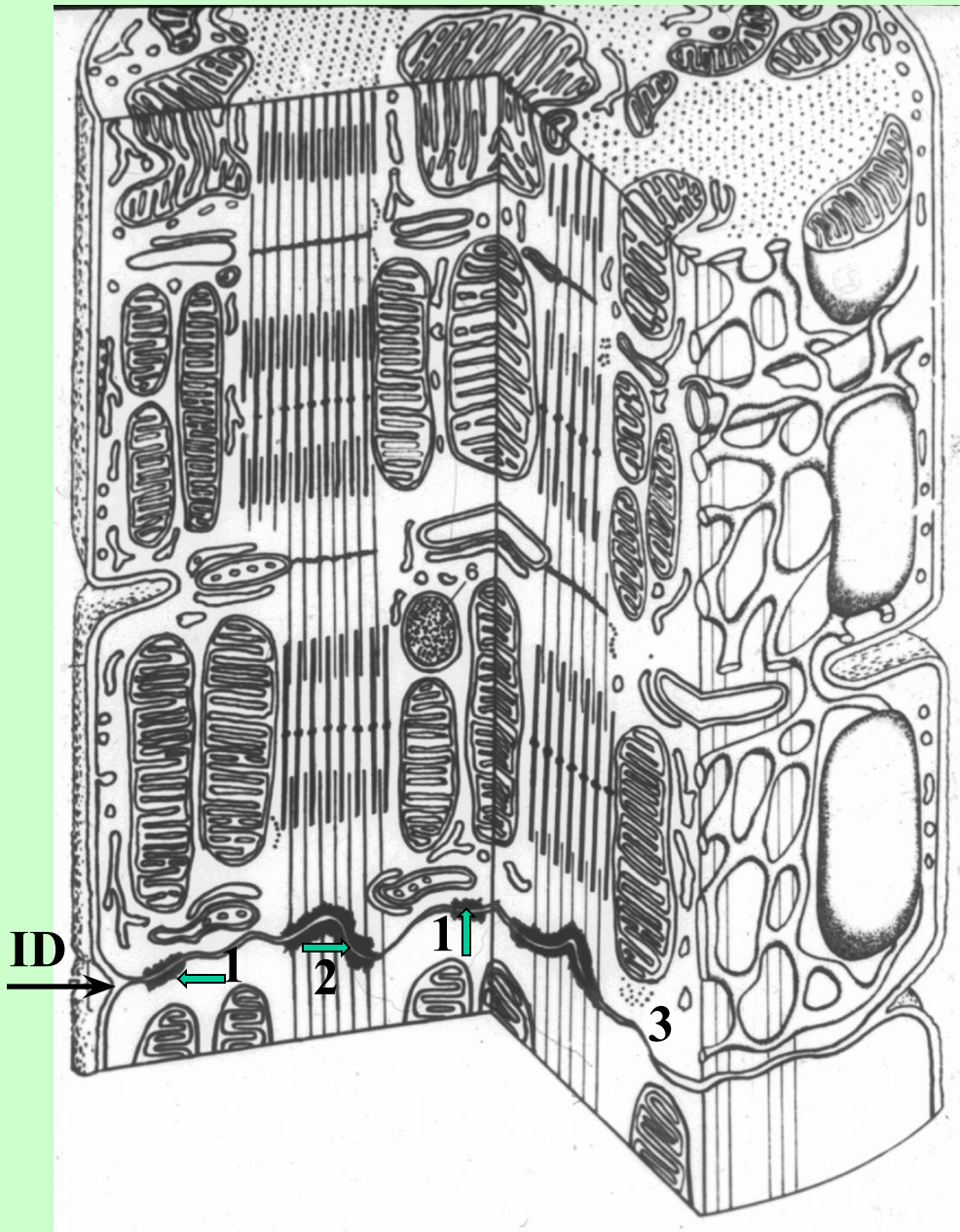
# Cardiac muscle cells

**ID - Intercalated disk:**

**1 - desmosomes;**

**2 - fascia adherens;**

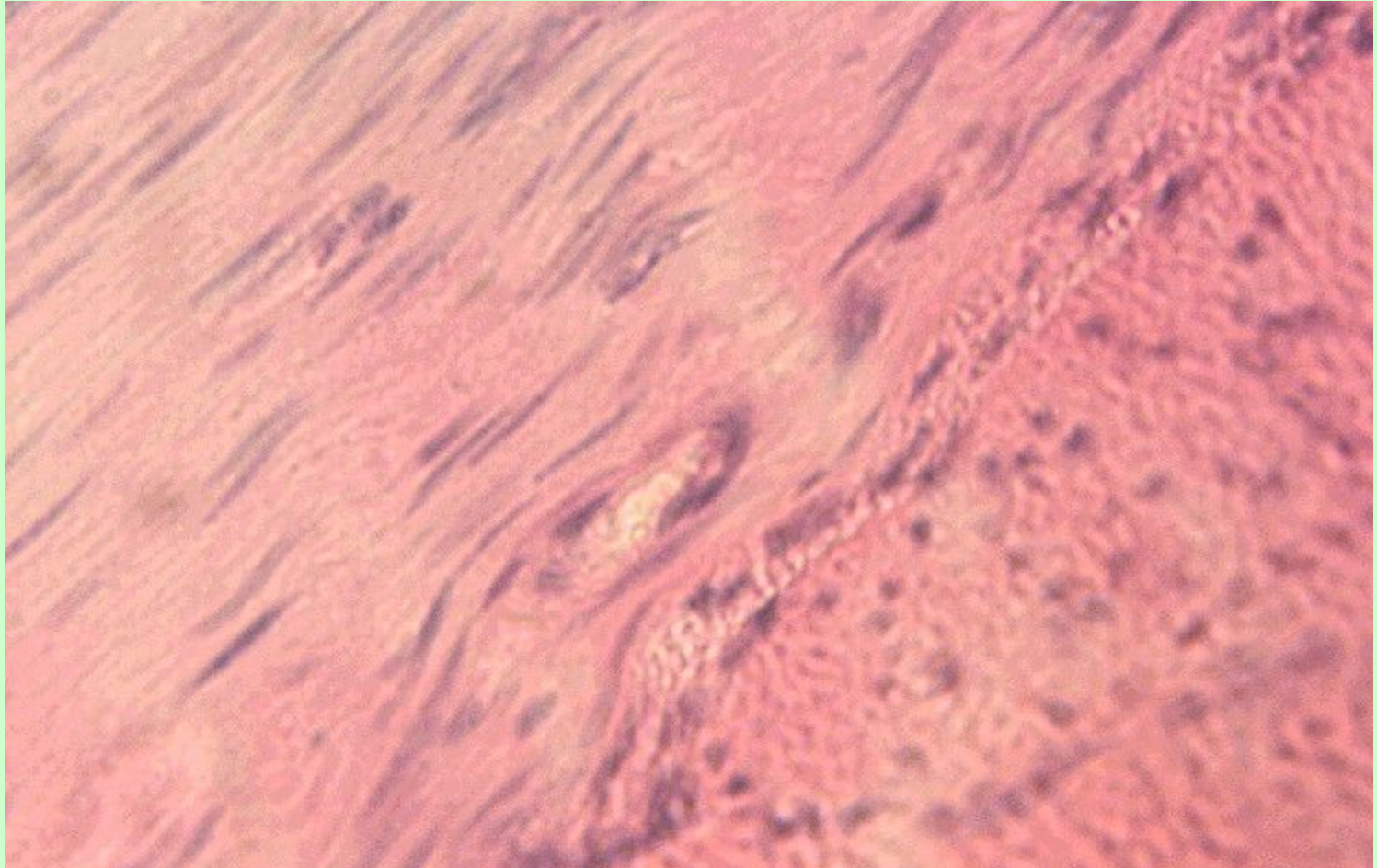
**3 - nexus.**



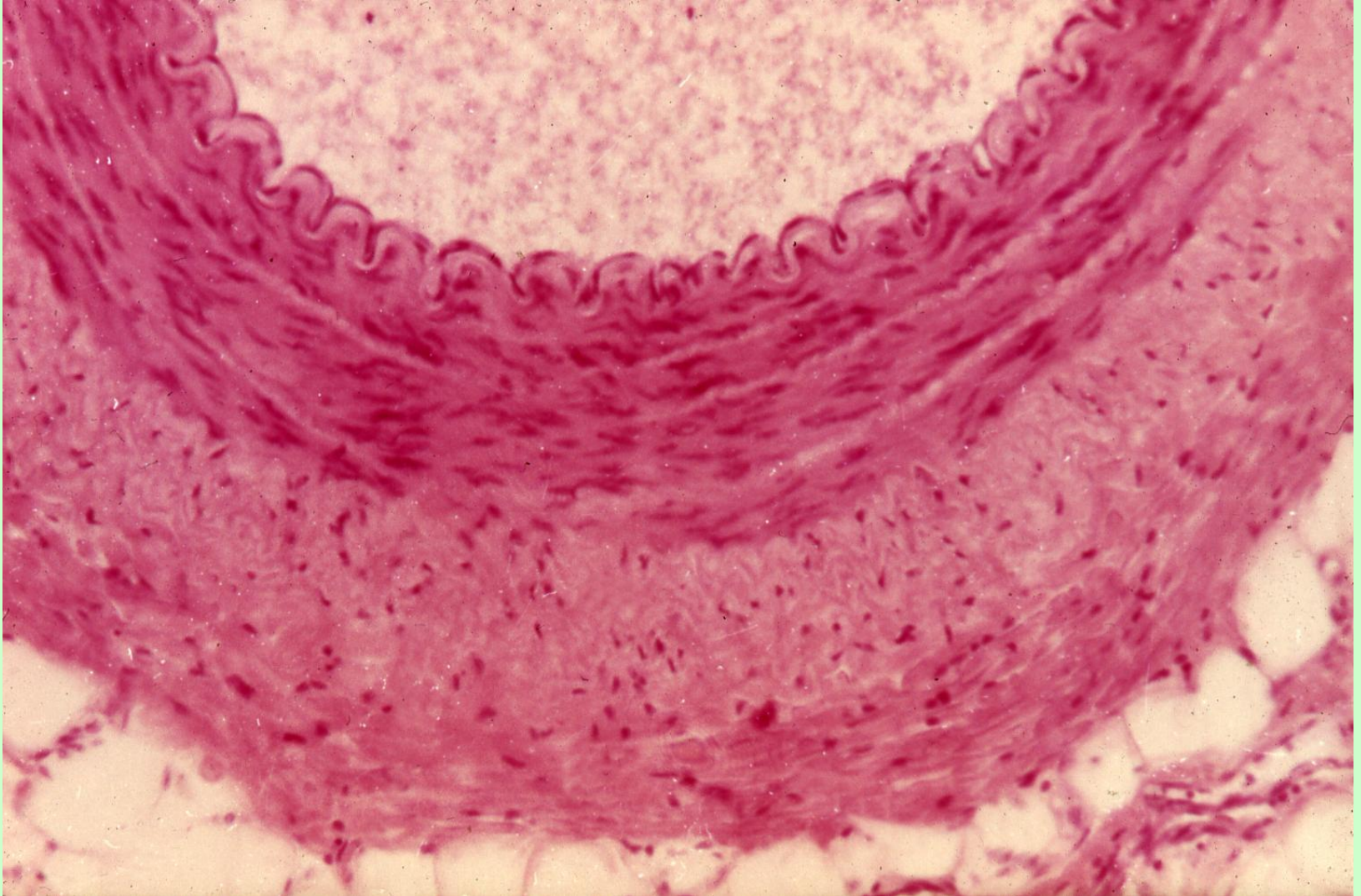
# **General Features of Smooth Muscle Tissue**

- 1. It is formed of smooth muscle cells.**
- 2. Each smooth muscle cell contains one rod-shape nucleus. It is located in the center of the cell.**
- 3. Each smooth muscle cell contains myofibrils. They lack any cross striations.**
- 4. Smooth muscle tissue is called involuntary muscle, because it is not controlled by the will.**

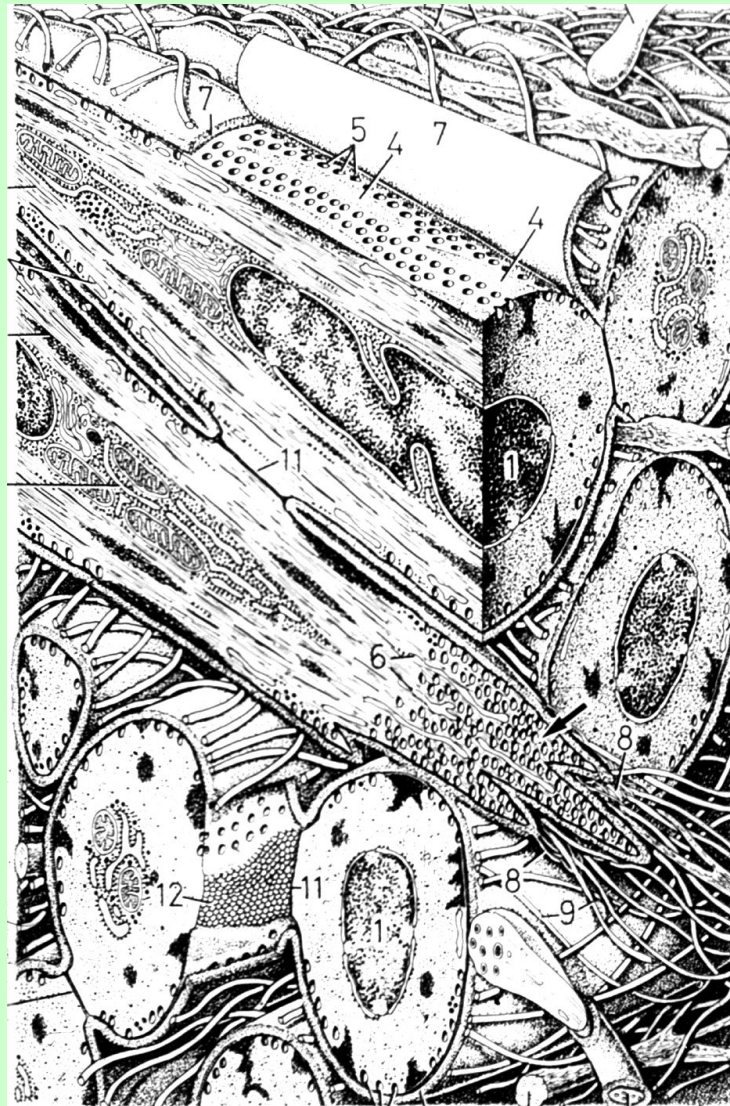
# Smooth muscle tissue



# Muscular artery



# Smooth muscle tissue



# Smooth muscle cells

## Molecular biology of contraction

- 1 - thin (actin) filaments;
- 2 - thick (myosin) filaments;
- 3 - dense bodies

