38.4B: Skeletal Muscle Fibers

Skeletal muscles are composed of striated subunits called sarcomeres, which are composed of the myofilaments actin and myosin.

Learning Objectives

• Outline the structure of a skeletal muscle fiber

Key Points

• Muscles are composed of long bundles of myocytes or muscle fibers.
• Myocytes contain thousands of myofibrils.
• Each myofibril is composed of numerous sarcomeres, the functional contractile region of a striated muscle. Sarcomeres are composed of myofilaments of myosin and actin, which interact using the sliding filament model and cross-bridge cycle to contract.

Key Terms

• **sarcoplasm**: The cytoplasm of a myocyte.
• **sarcoplasmic reticulum**: The equivalent of the smooth endoplasmic reticulum in a myocyte.
• **sarcolemma**: The cell membrane of a myocyte.
• **sarcomere**: The functional contractile unit of the myofibril of a striated muscle.
Skeletal Muscle Fiber Structure

Myocytes, sometimes called muscle fibers, form the bulk of muscle tissue. They are bound together by perimysium, a sheath of connective tissue, into bundles called fascicles, which are in turn bundled together to form muscle tissue. Myocytes contain numerous specialized cellular structures which facilitate their contraction and therefore that of the muscle as a whole.

The highly specialized structure of myocytes has led to the creation of terminology which differentiates them from generic animal cells.

Generic cell > Myocyte
Cytoplasm > Sarcoplasm
Cell membrane > Sarcolemma
Smooth endoplasmic reticulum > Sarcoplasmic reticulum

Myocyte Structure

Myocytes can be incredibly large, with diameters of up to 100 micrometers and lengths of up to 30 centimeters. The sarcoplasm is rich with glycogen and myoglobin, which store the glucose and oxygen required for energy generation, and is almost completely filled with myofibrils, the long fibers composed of myofilaments that facilitate muscle contraction.

The sarcolemma of myocytes contains numerous invaginations (pits) called transverse tubules which are usually perpendicular to the length of the myocyte. Transverse tubules play an important role in supplying the myocyte with Ca$^+$ ions, which are key for muscle contraction.

Each myocyte contains multiple nuclei due to their derivation from multiple myoblasts, progenitor cells that give rise to myocytes. These myoblasts are located to the periphery of the myocyte and flattened so as not to impact myocyte contraction.
Figure \(\PageIndex{1}\): **Myocyte: Skeletal muscle cell**: A skeletal muscle cell is surrounded by a plasma membrane called the sarcolemma with a cytoplasm called the sarcoplasm. A muscle fiber is composed of many myofibrils, packaged into orderly units.

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**Myofibril Structure**

Each myocyte can contain many thousands of myofibrils. Myofibrils run parallel to the myocyte and typically run for its entire length, attaching to the sarcolemma at either end. Each myofibril is surrounded by the sarcoplasmic reticulum, which is closely associated with the transverse tubules. The sarcoplasmic reticulum acts as a sink of Ca\(^+\) ions, which are released upon signalling from the transverse tubules.

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**Sarcomeres**

Myofibrils are composed of long myofilaments of actin, myosin, and other associated proteins. These proteins are organized into regions termed sarcomeres, the functional contractile region of the myocyte. Within the sarcomere actin and myosin, myofilaments are interlaced with each other and slide over each other via the sliding filament model of contraction. The regular organization of these sarcomeres gives skeletal and cardiac muscle their distinctive striated appearance.
This diagram of a microfibril includes the terms sarcomere, Z-line, M-line, thin filament, and thick filament.

Figure \(\PageIndex{1}\):

**Sarcomere**: The sarcomere is the functional contractile region of the myocyte, and defines the region of interaction between a set of thick and thin filaments.

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**Myofilaments (Thick and Thin Filaments)**

Myofibrils are composed of smaller structures called myofilaments. There are two main types of myofilaments: thick filaments and thin filaments. Thick filaments are composed primarily of myosin proteins, the tails of which bind together leaving the heads exposed to the interlaced thin filaments. Thin filaments are composed of actin, tropomyosin, and troponin. The molecular model of contraction which describes the interaction between actin and myosin myofilaments is called the cross-bridge cycle.