Animal Muscle Chapter

Experiments

Basic Level Difficulty Rating: Can Be Done With:

AM-1: Skeletal Muscle, Weight and Work

AM-2: Skeletal Muscle, Summation and Tetanus

AM-3: Heart Muscle

AM-6: Frog Electrocardiogram (ECG)

AM-7: Crayfish Heart

AM-8: Byssal Retractor Muscle

Advanced Level Difficulty Rating: Can Be Done With:

AM-4: Uterine Motility

AM-5: Intestinal Motility

AM-9: Crayfish Gut Pharmacology

AM-10: Frog Nerve/Muscle Prep -Summation, Tetanus and Fatigue in an Intact Nerve/Muscle Prep

Overview

Movement of different parts of an organism is accomplished through the contraction of muscles. The contractions actually take place inside muscle cells that are specialized into structures known as muscle fibers. Muscle fibers contain two major types of protein molecules that perform two different functions. One molecule is myosin that provides the force for movement, and the other molecule is actin that forms the structural elements on which the myosin molecules act.

Each myosin molecule is composed of two polypeptide chains, each with a globular head and a long tail. Myosin molecules are laid down so the tails form a thick filament with the heads hanging off the sides of the filament (Figure AM-0-1). Actin is a globular protein that is linked together with other actin units to form a double helix that is part of a thin filament. Each myosin head contains a binding site for actin and an enzyme that breaks down ATP and releases energy for movement. The myosin and actin bind to each other to form crossbridges that permit the two filaments to slide across each other as the myosin head undergoes a conformational change.

As some of the crossbridges hold the filaments in place, the myosin heads at other crossbridges break their bonds with actin units, stretch out, and bind to new actin units. Again, the filaments slide past each other and the muscle shortens when the shape of the myosin head changes. The rapid making and breaking of the bonds between actin and myosin is known as *crossbridge cycling*.

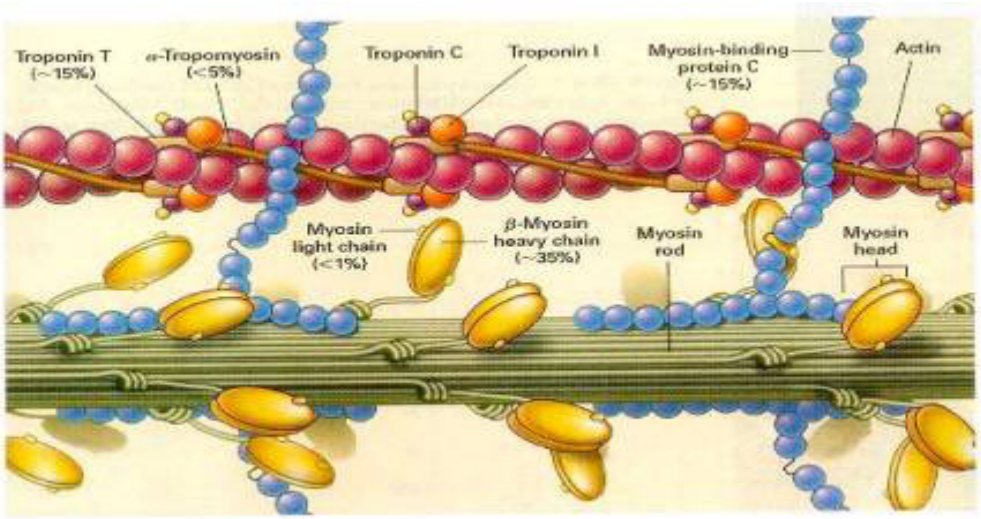

Figure AM-0-1: Diagrams of the thick and thin filaments that slide across each other in a muscle fiber.

While many cells contain contractile proteins, muscles cells are specialized for contraction. The arrangement of the myosin and actin in these cells and the control of contraction depends upon the type of muscle. Muscle can be characterized as striated or smooth. Striated muscle includes skeletal and cardiac muscle and derives its name from the banded or striated appearance created by repeating units called sarcomeres (Figure AM-0-2). Sarcomeres are about two microns in length and are joined end-to-end at Z lines. Thin actin filaments are joined to the Z-lines and project towards the center of the sarcomere, where they overlap with the thick filaments.

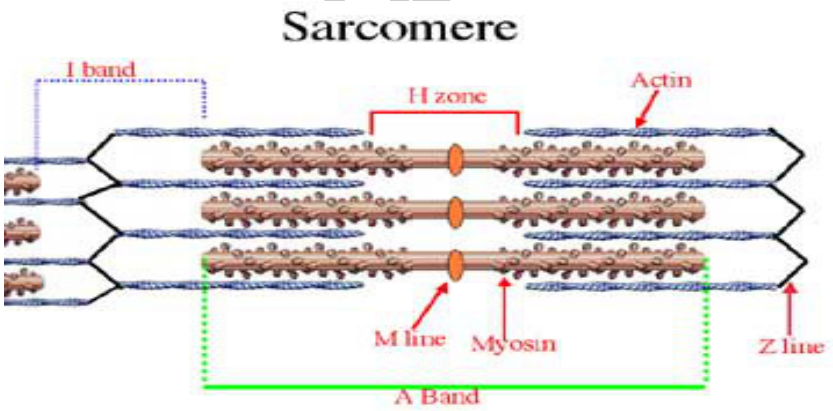

Figure AM-0-26: A diagram of a sarcomere showing the lines, bands, and the thick (myosin) and thin (actin) filaments.

Smooth muscle lacks the banded appearance and the sarcomeres found in striated muscle. The thick and thin filaments are connected to the sarcolemma (muscle cell membrane), so that crossbridge cycling changes the shape of the smooth muscle cell.