

## PHY2011 Revision Notes

### Topic 5A: How our skeletal muscles work to do things

**Muscle:** The number of muscle fibres that are bound together by connective tissue.

- In all its forms, muscle tissue makes up nearly half the body's mass.
- Muscle allows for movement, which is a basic manifestation of life.
- Muscle is the “machine of movement”

### Muscle Tissue

#### 4 Important Functions of Muscle Tissue (specialised for contraction)

- Produces body movements
- Maintains posture and body position
- Stabilises joints
- Generates heat

#### 4 Characteristics that Enable Muscle Tissue to Perform These Functions

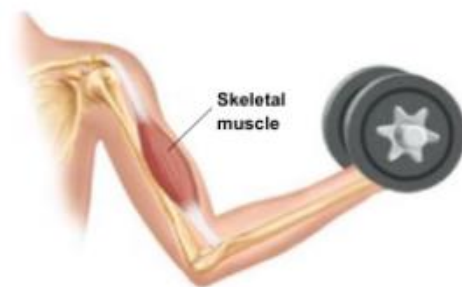
- Excitability (Responsiveness): The ability to receive and respond to a stimulus.
- Contractility: The ability to shorten forcibly when stimulated.
- Extensibility: The ability to be stretched for e.g. when relaxed.
- Elasticity: The ability to recoil to resting length after it has been stretched.

### 3 Types of Muscle Tissue

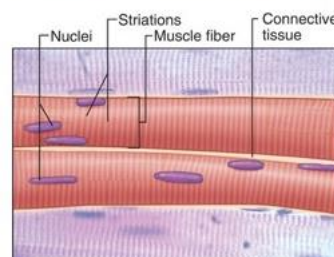
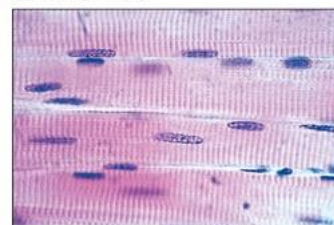
- Skeletal
- Cardiac
- Smooth

#### Skeletal Muscle

- Composed of skeletal muscle fibres (cells), connective tissue, nerves and blood vessels
- Consists of long cylindrical, striated fibres and has numerous peripheral nuclei.
- In addition to moving the bones of the skeleton, skeletal muscle maintains posture, stabilises joints and generates heat.
- Skeletal muscle contraction is voluntary and is controlled by the somatic nervous system

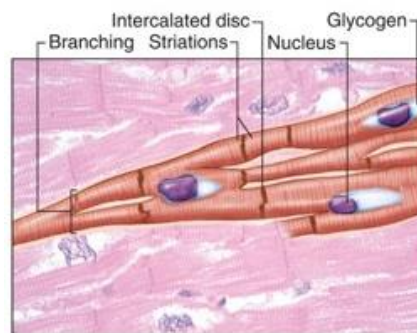
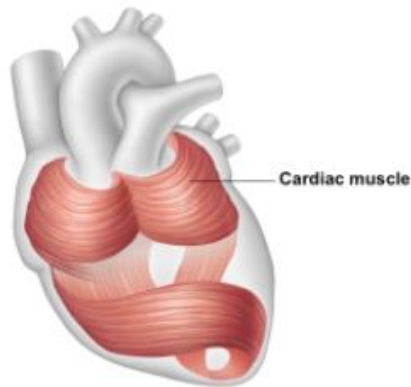


(a) Skeletal muscle



## Cardiac Muscle

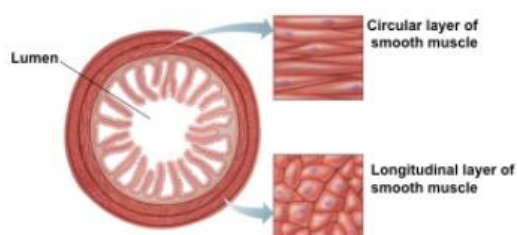
- Located in the heart, and forms the bulk of the myocardium.
- Contraction is stimulated by the intrinsic conduction system of the heart.
- The rate and force of contraction are modified by the autonomic nervous system (ANS).
- Contraction is involuntary and cannot be consciously controlled.
- The heart serves as a pump and when cardiac muscle contracts, it propels blood into and through the pulmonary and systemic circuits.



## Smooth Muscle

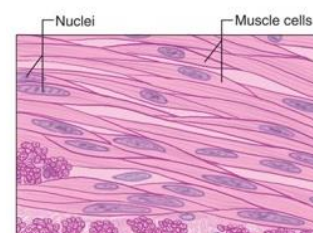
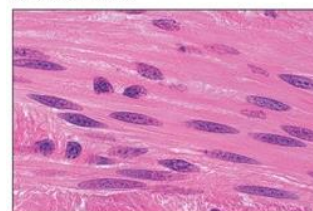
- Found mainly in the walls of hollow visceral organs, for example, the stomach, respiratory passages, uterus and urinary bladder.
- Contraction is involuntary and is controlled by the ANS.
- Smooth muscle contractions forces fluid and other substances through internal body channels (for example, food through the digestive tract)
- Contractions regulate the passage of substances through internal body openings (for example, the emptying of the bowel and bladder)
- Contractions alter blood vessel and pupil diameter.

Smooth muscle of the small intestines



The submucosa of the small intestines contains two layers of smooth muscle - an inner circular layer and an outer longitudinal layer.

(c) Smooth muscle



## Myofibrils and Myofilaments

**Myofibrils:** Cylindrical elements made up of bundles of myofilaments

**Myofilaments:** Composed of thick and thin filaments of myofibrils that are constructed from proteins. They are arranged into Sarcomeres.

Muscle cells are specialised cells that can:

- Generate force
- Shorten

## Contraction

- Contraction involves the interaction of 2 proteins: actin and myosin.
- The interaction of actin and myosin is controlled by intracellular  $\text{Ca}^{2+}$

## Skeletal Muscle Structure

**Sarcomere:** The basic contractile unit of skeletal muscle. It is geometric in structure and creates the striated pattern of skeletal muscle.

Z Line: Structure running across myofibril at each end of striated muscle sarcomere; anchors one end of thin filaments and titin.

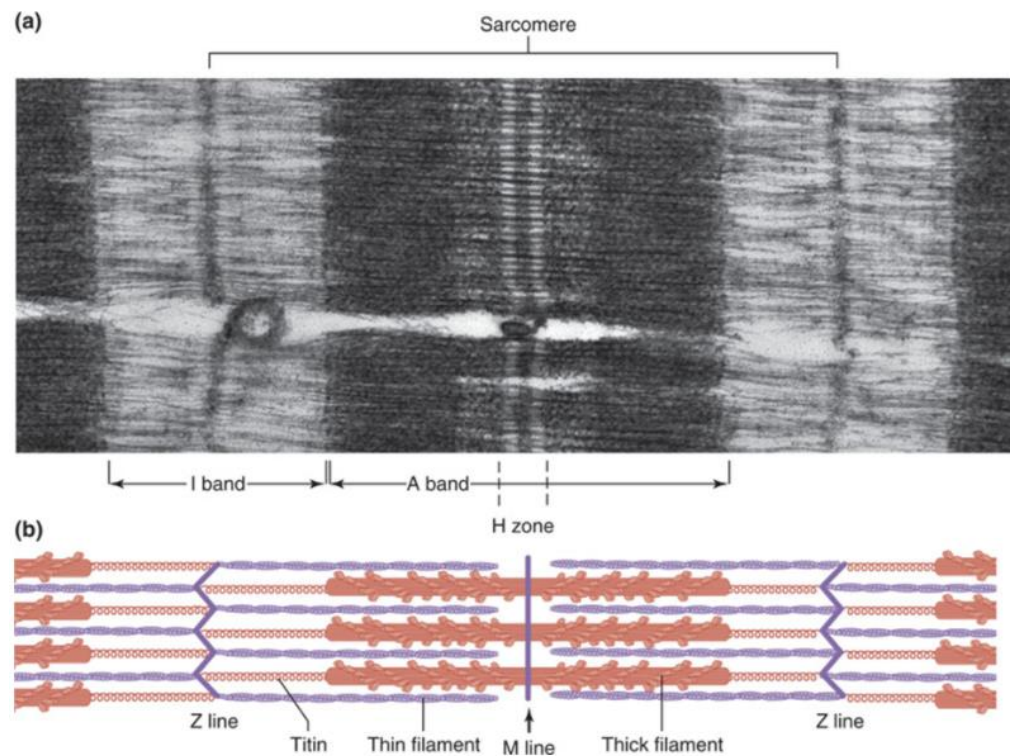
I Band: One of transverse bands making up repeating striations of cardiac and skeletal muscle; located between A bands of adjacent sarcomeres and bisected by Z line.

A Bands: One of the transverse bands making up repeated striations of cardiac and skeletal muscle; region of aligned myosin-containing thick filaments.

H Zones: One of transverse bands making up striated pattern of cardiac and skeletal muscle; light region that bisects A band

**M Line:** A transverse stripe occurring at the centre of the A band in cardiac and skeletal muscle; location of energy-generating enzymes and proteins connecting adjacent thick filaments.

**Titin:** Protein that extends from the Z line to the thick filaments and M line of skeletal muscle sarcomere.



### Structural Arrangements

- Thick and thin filaments are arranged in a hexagonal array in the region of filament overlap.
- Each thick filament is surrounded by 6 thin filaments.