The muscular system

Level 2 Anatomy and physiology
for exercise and fitness instructors

Learning outcomes

By the end of this session you will be able to:

- Identify the three types of muscle tissue
- Define the characteristics and functions of the three types of muscle tissue
- Describe the basic structure and function of skeletal muscle
- Name and locate major superficial and deep skeletal muscles

Learning outcomes

By the end of this session you will be able to:

- Describe the structure and function of the pelvic floor muscles
- Describe the different types of muscle action
- Identify the joint actions brought about by specific muscle actions
- Identify skeletal muscle fibre types and their characteristics

Muscle tissue

There are three different types of muscle tissue

- Voluntary / skeletal
- Involuntary /smooth
- Cardiac

Voluntary muscle tissue

- Striated
- Under conscious control
- Controlled by somatic nervous system,
- Found in consciously controlled skeletal muscles

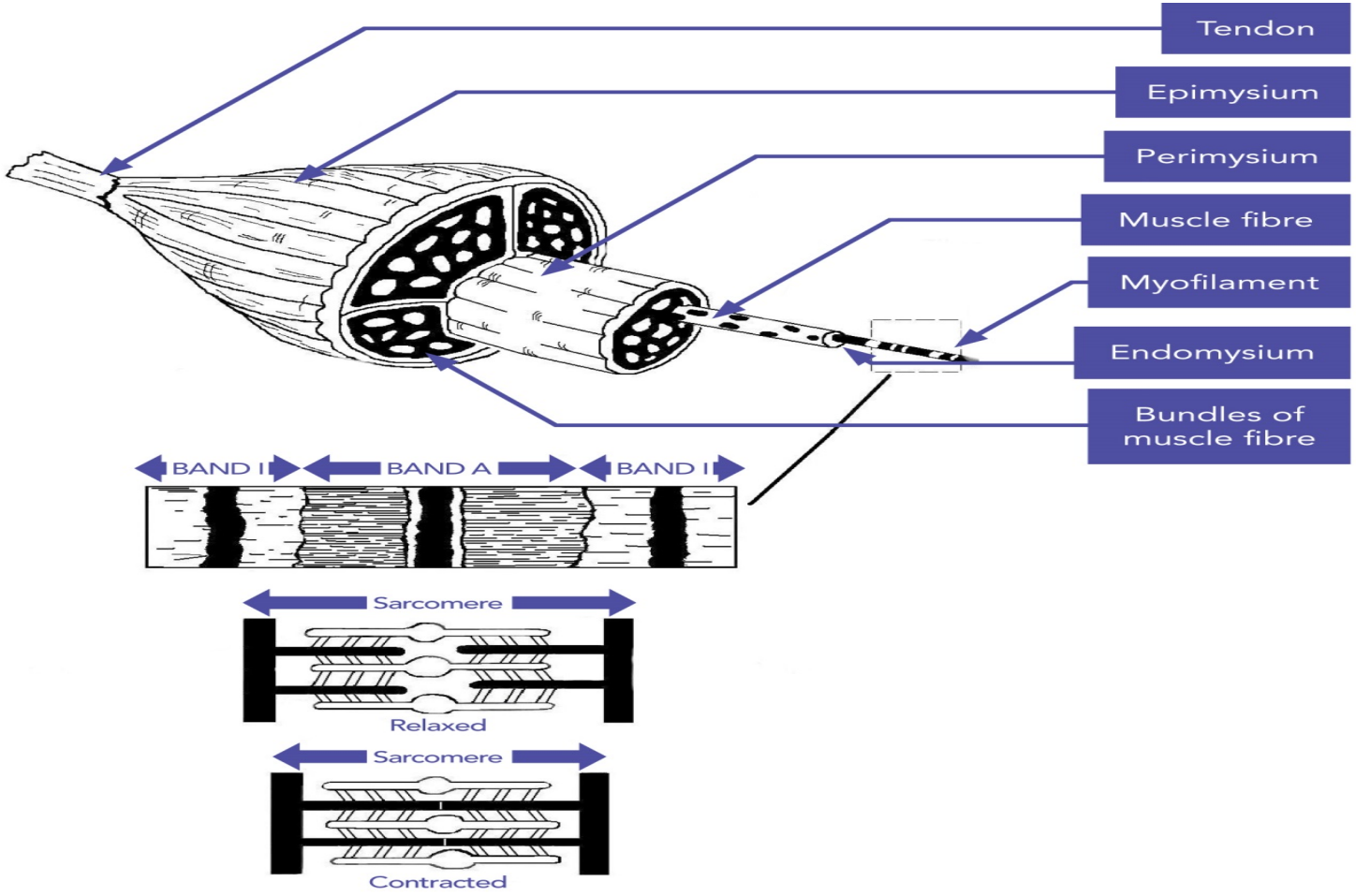
Involuntary muscle tissue

- Visceral or smooth
- Under unconscious control
- Controlled by autonomic nervous system
- Found in structures not under conscious control

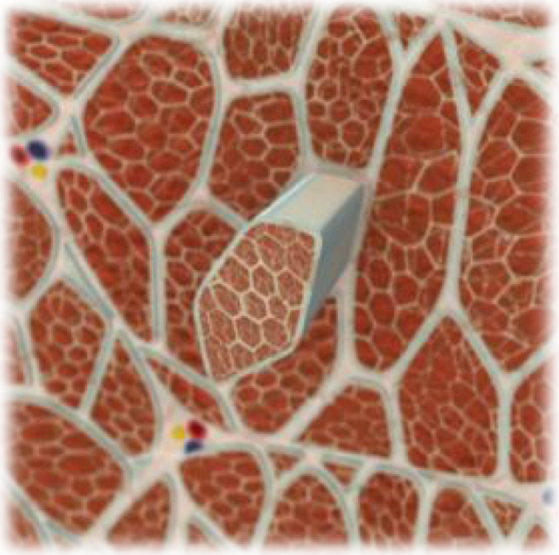
Cardiac muscle tissue

- Striated
- Involuntary, under unconscious control
- Initiated by the sinoatrial node (SA node), in the heart

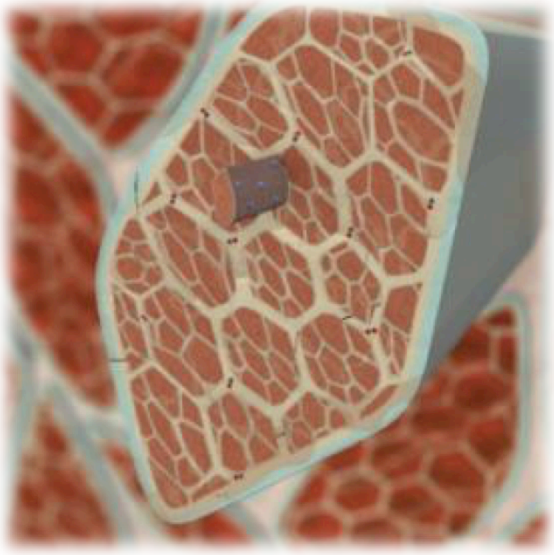
Muscle structure



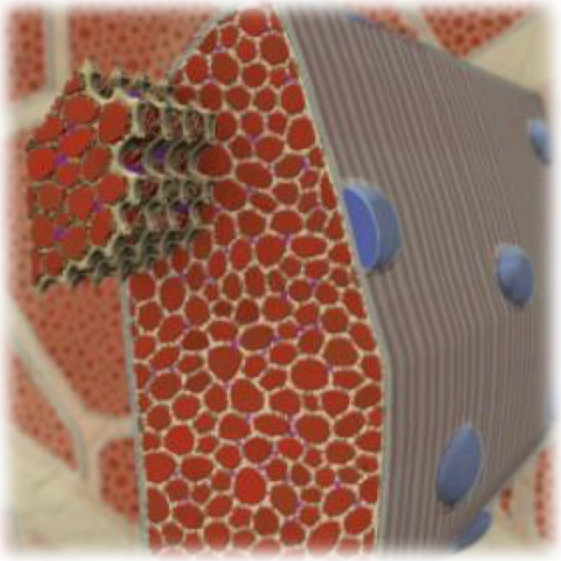
Muscle structure



Muscle fibre



Myofibril



Myofilament

Muscle structure

Muscle is made up of:

- Water (70%)
- Protein (23%)
- Minerals and substrates (7%)

Muscles cross joints and attach to bones

- Tendons - muscle fascia converges to form the tendon which attaches to the bones
- Aponeurosis (flattened tendons) of other muscles e.g. abdominals
- Directly onto the bone via muscle fascia

Muscle function

- Contract to create movement
- Generate heat (shivering)
- Keep the body upright by resisting the force of gravity
- Protect the skeletal system by preventing excessive or unwanted movement
- Stabilise joints along with the ligaments
- Have contractility, extensibility, elasticity and excitability
- Can be agonists (prime movers), antagonists, synergists, fixators

Muscle contractions – General rules

- Muscles pull
- A muscle crosses at least one joint
- A muscle contracts along its line of fibre
- Muscles work in pairs - front and back e.g. biceps and triceps

Agonist / Antagonist

Prime mover / agonist

The muscle responsible for bringing about the action
e.g. biceps curl agonist is the bicep

Antagonist

The opposite muscle that relaxes for movement to occur

e.g. biceps curl antagonist is the tricep

Synergist

When performing an exercise, other muscles may also join in and assist the prime mover

These muscles are called synergists

e.g. when performing a leg curl, if the workload is heavy, the gastrocnemius will assist the hamstrings (prime mover) to perform knee flexion

Fixator

Muscles can contract statically to fix parts of the body to maintain a stable position

When a muscle performs this function, it is called a fixator

A biceps curl can be used to illustrate the different roles of the muscles and muscle groups:

Prime mover - biceps

Antagonist - triceps

Fixator - deltoid

Synergist - brachialis

Types of muscle contraction

Concentric

- Muscle develops tension and shortens, overcoming load and gravity

Eccentric

- Muscle lengthens (with tension), resisting gravity, returning a load to the starting position in a controlled manner

Types of muscle contraction – Isometric/static

A muscle contracts and develops tension but the muscle length remains the same (no joint movement)

e.g. press-up – if the body is raised to the halfway point and the position is held, there are static contractions in the pectorals and triceps. If an arm is raised and held out, there is a static contraction of the deltoid

e.g. plank

Types of muscle contraction – Isotonic

Together, concentric and eccentric contractions are also often referred to as isotonic contractions

Isotonic means movement that is occurring as a result of the contraction, with one bone getting closer or further away from another bone depending upon the contraction

Delayed onset muscle soreness (DOMS)

DOMS describes muscle pain, soreness or stiffness that is felt 12–72 hours after exercise

This is most common:

- At the beginning of a new exercise programme
- After a change in sports activities
- After an increase in the duration or intensity of exercise or activity
- After eccentric training

Valsalva effect

During resistance training, it is recommended to exhale during the lifting phase (on the effort) and inhale during the lowering phase to keep the blood pressure response under control

The valsalva effect results in decreased return of blood to the heart, reduced cardiac output and abnormal elevation of blood pressure and heart rate

Muscle fibre types

Skeletal muscles are made from several different types of fibre and vary in two ways:

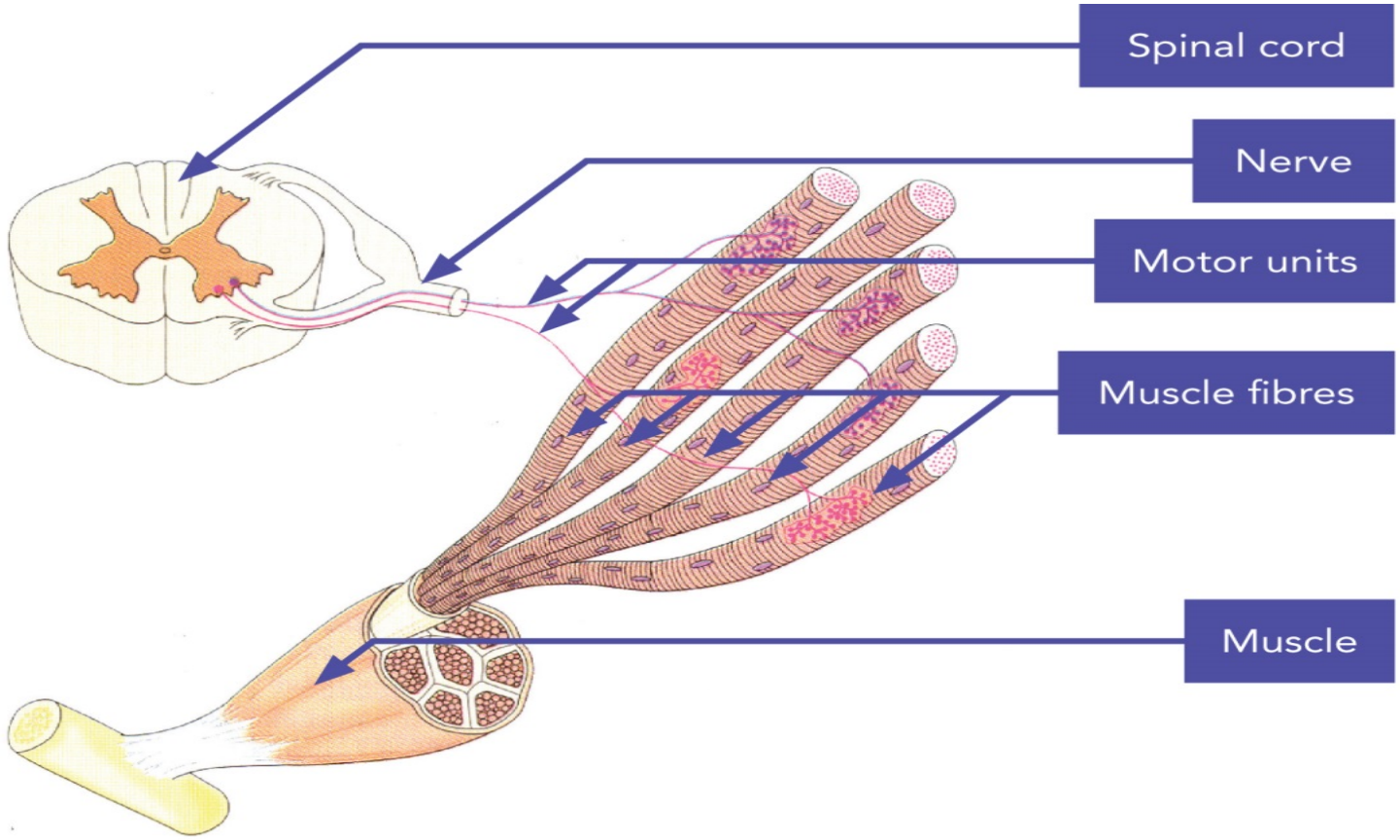
- Colour
- Speed of contraction

Slow twitch fibres	Fast twitch fibres	
Type I	Type IIb	Type IIa
slow oxidative fibres	fast glycolytic fibres	fast oxidative glycolytic
red in colour	white in colour	pink in colour
Good blood supply		
contain large numbers of mitochondria	contain low numbers of mitochondria	more mitochondria than type IIb
Slower to fatigue		
endurance type activities	strength / anaerobic type activities	assist type1 & typeIIb

Sliding filament theory

- Occurs within the sarcomere
  - The ‘unit’ of muscular contraction
- Requires calcium and ATP
  - Nervous stimulus causes the myosin heads to attach to the actin forming cross bridges
  - Myosin heads pivot and pull actin towards the centre of the sarcomere
  - Process is repeated and myosin attaches further along the actin

Motor units and recruitment



Muscle fibre recruitment

The nervous system controls muscular contraction

Motor units consist of a single motor nerve and all the muscle fibres it innervates

All of the fibres in that motor will be recruited when the stimulus is sent from the nervous system (all or none law)

More units will be recruited when more strength is required

Motor units and recruitment

The strength of a muscular contraction will be affected by:

- The frequency of nerve impulses coming into the muscle cell
- The number of motor units activated