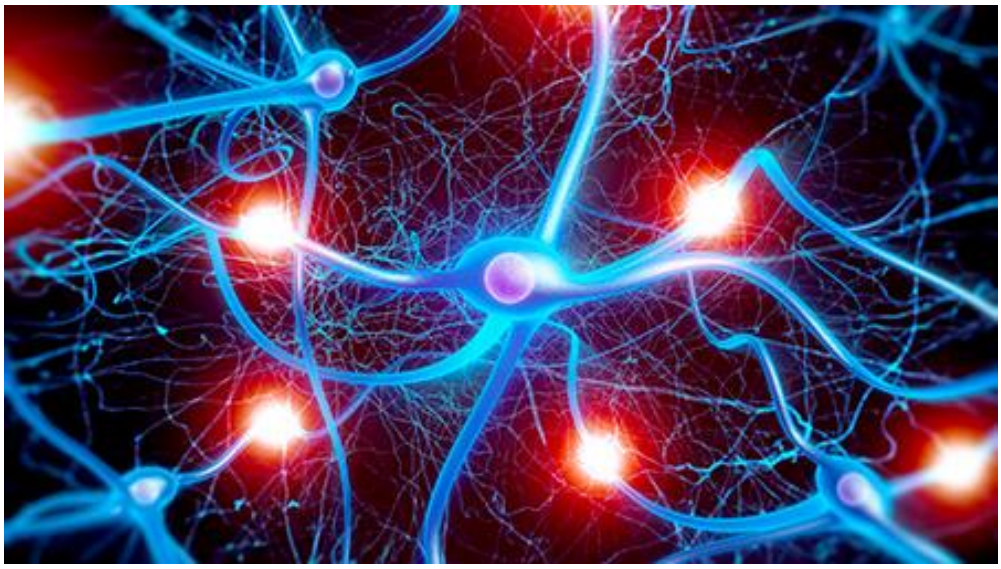
1.4 The Neuromuscular System

Name _____

Class_____



Content	Additional Information	Pupil comments – How confident do you feel on this topic?
Characteristics and functions of different muscle fibre types for a variety of sporting activities	Slow twitch (type I) Fast glycolytic (type IIx) Fast oxidative glycolytic (type IIa)	
Nervous system	Sympathetic and parasympathetic	
Role of proprioceptors in PNF	Muscle spindles. Golgi tendon organ	
The recruitment of muscle fibres	Motor units Spatial summation Wave summation All or none law Tetanic	

.

The Neuromuscular System:

Quite simply, this is how the **autonomic nervous system** and **muscular system** work together in order to create different types of muscle movement and contractions.

Recap – what are the two parts of the autonomic nervous system and what are they responsible for?

_____

_____

_____

_____

Recap – which receptor system is located in the muscles and detects muscle movement?

_____

Types of Muscle Fibre

All muscles are made up of individual **fibres**, each containing myofibrils, which are small strands which work together to make your muscles contract.

Hint:

Make sure you remember which is type I, type IIa and type IIX

Muscle fibres can either be:

Slow Oxidative (type I – slow twitch)

Fast Oxidative Glycolytic (type IIa – fast twitch)

Fast Glycolytic (type IIx – fast twitch)

Athletes with **slow twitch** fibres tend to do better in endurance events such as _____ and _____. This type of muscle fibre may contract slowly but it can work for long periods of time without rest.

Athletes with **fast twitch** fibres tend to better in events that require a short burst of intense exercise such as _____ and _____.

Most muscles contain both **slow twitch** and **fast twitch** muscle fibres. Name 3 sports where it is important to have both slow twitch and fast twitch muscle fibres. Explain why.

_____

_____

_____

_____ twitch muscle fibres are darker in colour because they have a good oxygen supply and contain **myoglobin** (used to transport oxygen to muscles).

_____ twitch muscle fibres are lighter in colour because they contain less oxygen.

Muscle Fibre	Sport/Event	Aerobic Capacity	Speed/Power of Contraction	Resistance to Fatigue
Type I				
Type IIa				
Type IIx				

Which athletics event would require a large amount of type IIa muscle fibres? Why?

_____

_____

_____

_____

_____

_____

The Recruitment of Muscle Fibres

Every muscle contains a range of fast and slow twitch muscle fibres. The type of muscle fibre present in your muscles is largely down to genetics. However, over time training can affect the type of muscle fibres present in your body.

What types of training could result in an increase of type IIx muscle fibres?

_____

What types of training could result in an increase of type I muscle fibres?

_____

Motor Units:

Every muscle contains a large number of **motor units**. Each motor unit can only contain one type of muscle fibre. Motor units also always contain a **motor neurone** which is responsible for passing on signals from the brain to the muscle fibres.

For example if your brain signals for you to start jogging:

- The brain sends a signal via the _____ nervous system to the motor neurone in the _____
- The motor neurone the sends an impulse to the _____ _____ muscle fibres in the quadriceps
- The muscle fibres then respond by _____ which causes movement

Contracting	Quadriceps	Slow Twitch	Sympathetic

Type of Activity:

The brain will recruit different types of muscle fibres based on the type of activity. In the example above, slow twitch muscle fibres will be recruited due to the low intensity of jogging.

If you were to begin lifting heavy weights, which type of muscle fibres would be recruited?

_____

The All or None Law:

After a motor neurone has stimulated the muscle fibres within a motor unit, they will either all contract or none will contract. It is impossible for only some of the muscle fibres to contract.

The intensity of the stimulation must be high enough to result in a contraction.

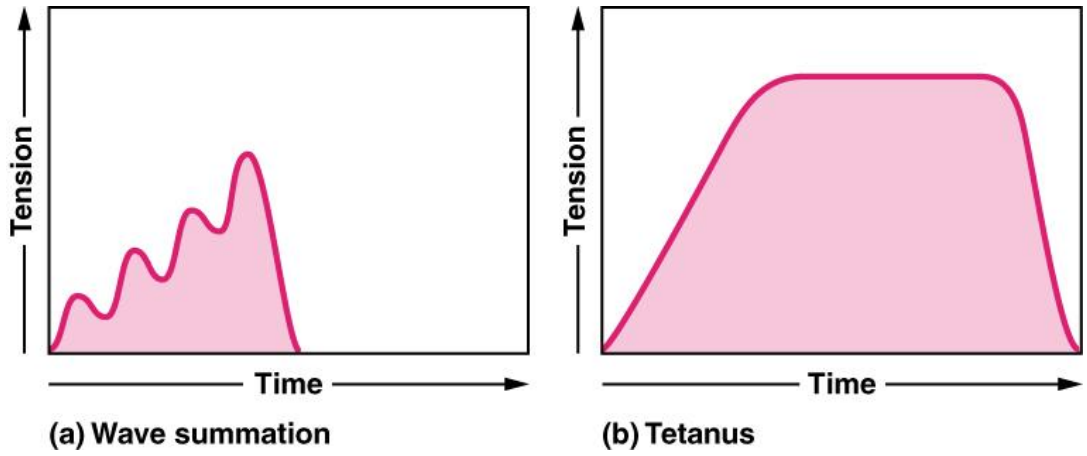
Increasing the Strength of a Contraction:

Obviously, there are times when a greater strength of contraction is required from the muscles. There are two different ways that this can be achieved.

Wave Summation & Tetanic Contraction:

Wave Summation is where a greater frequency in nerve impulses results in a more powerful contraction. The next impulse will begin before the last has finished so that there is **no time for the muscle to relax** and the size of contraction will increase.

If the impulses are fast enough, then a sustained contraction will occur, known as a **tetanic contraction.**



Spatial Summation:

This is where there is a recruitment of further motor units in order to increase the strength of a muscle contraction. The motor neurones of several motor units are sent impulses at the same time, resulting in a more powerful contraction.

A long jumper requires a powerful muscle contraction on take-off. How do they use wave summation to ensure a powerful contraction?

_____

_____

_____

_____

How do they use spatial summation to ensure a powerful contraction?

_____

_____

_____

_____

PNF – Proprioceptive Neuromuscular Facilitation:

This is an advanced stretching technique that is widely used to increase flexibility. Have a go at the technique by following the steps below:

1. A stretch is performed with the help of a partner, until tension is felt in the muscle
2. The performer will then immediately isometrically contract the muscle by pushing back against the partner for approximately 8 seconds
3. The muscle then briefly relaxes before the partner pushes against it once again, going past the normal range of movement for approximately 20 seconds
4. The performer then rests for 30 seconds before repeating the procedure

Why would a gymnast benefit from PNF?

_____

_____

_____

Proprioceptors:

The proprioceptors in the muscles, tendons and joints have a role to play in PNF. The two types of proprioceptors involved are the **muscle spindles** and the **golgi tendon organs.**

The **muscle spindles** are also known as **stretch receptors** and will send a signal to the medulla oblongata if a muscle is overstretching. An impulse will then be sent to the muscle and the **stretch reflex** will be initiated**,** contracting the muscle in order to prevent over stretching.

How do the muscle spindles work during the first stage of PNF stretching?

_____

_____

_____

The **golgi-tendon organs** detect tension levels within a muscle. When a muscle contracts isometrically a signal will be sent to the brain. An impulse will then be sent to the muscle and it will relax.

How do the golgi-tendon organs play a role in PNF stretching?

_____

_____

_____

Use the boxes below to explain the step by step process of how the muscle spindles and golgi tendon organs prevent injury.

Muscle Spindles:	Golgi Tendon Organs:

Sample Exam Questions

Fast twitch glycolytic muscle fibres (type IIx) are used to produce powerful contractions.

Identify **two** characteristics of fast twitch glycolytic muscle fibres (type IIx). **(2 marks)**

_____

_____

_____

Performers have to improve the capacity of the appropriate muscle fibres for their sport and to recover as quickly as possible following exercise.

Name the muscle fibre type in use during an endurance race **and** identify the physiological characteristics that allow these muscle fibres to work for an extended period of time. **(3 marks)**

_____

_____

_____

_____

_____

_____

Explain how wave summation allows a gymnast to gain the required height in a floor routine.

_____

_____

_____

_____

_____

_____

Muscle spindles are proprioceptors located between the muscle fibres.

Outline the role of muscle spindles. **(3 marks)**

_____

_____

_____

_____

_____

_____

Key Terms:

Neuromuscular System – The nerves and the muscles working together in order to produce different movements

Type I Slow Oxidative - A slow twitch muscle fibre used during endurance events

Type IIa Fast Oxidative Glycolytic – A fast twitch muscle fibre with some resistance to fatigue

Type IIx Fast Glycolytic – A fast twitch muscle fibre capable of producing a powerful contraction

Motor Unit – Made up of a motor neurone and skeletal muscle fibres

Motor Neurone – Nerve cells located in the motor unit. Receive impulses sent from the brain

Wave Summation – Repeated nerve impulses resulting in a stronger contraction

Tetanic Contraction – A number of fast impulses resulting in a sustained muscle contraction

Spatial Summation – A number of motor units receiving impulses at the same time, resulting in a more powerful contraction

PNF – Proprioceptive Neuromuscular Facilitation. An advanced stretching technique

Proprioceptors – Receptors found in the muscles tendons and joints. Relay messages to the brain regarding muscle movement

Muscle Spindles – A proprioceptor that prevents a muscle from overstretching

Golgi Tendon Organs – A proprioceptor that detects tension and signals for a muscle to relax

Isometric Contraction – When a muscle contracts without any movement at a joint