

EXERCISE PHYSIOLOGY

Section 1: Nervous System

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1.1 Introduction and Objectives

INTRODUCTION

The body is made up of a number of working systems. These systems are responsible for maintaining the functioning of our body. One of these systems is the **nervous system**.

The nervous system is the electrical wiring of the body responsible for sending information to the brain, processing it and finally, doing something about it.

In an adult human, the longest neuron is around *2 metres in length*, running from the toe to the brain. This pales into insignificance when compared to the matching neuron in a giraffe, which in some can be *5 metres in length*!

Impulses can travel along neurons at staggering speeds. In large neurons, impulse speeds can be around 270 metres per second.

OBJECTIVES

The following objectives relate directly to Unit Standard 12543 (version 4) "*Apply knowledge of exercise physiology to physical activity*" – specifically:

Element 1: Describe the structure and function of the major physiological systems important in physical activity.

1.1 The neuromuscular system is described as it relates to its structure and function.

By the end of this section you should be able to

(As you complete each item, tick the box)

- o distinguish between the Central and Peripheral Nervous Systems.
- o identify the structure of a nerve.
- o identify the components of a neuron.
- o distinguish between sensory and motor neurons.
- o describe the terms neural chain, synapse and motor unit.
- o explain and apply the Principle of Recruitment.

1.2 Central and Peripheral Nervous Systems

The nervous system is divided into two main sections. These are the:

- a. Central Nervous System (CNS)
- b. Peripheral Nervous System (PNS)

1. Central Nervous System

The CNS takes responsibility for processing the sensory data that comes from our senses. With this information it has to sort and filter in order to produce a response that is appropriate.

The CNS has two main components:

- a. _____
- b. _____

2. Peripheral Nervous System

The PNS takes responsibility for linking the CNS to all other parts of the body. Therefore once the CNS has developed an appropriate response, the PNS carries those signals to the correct location. For example muscles.

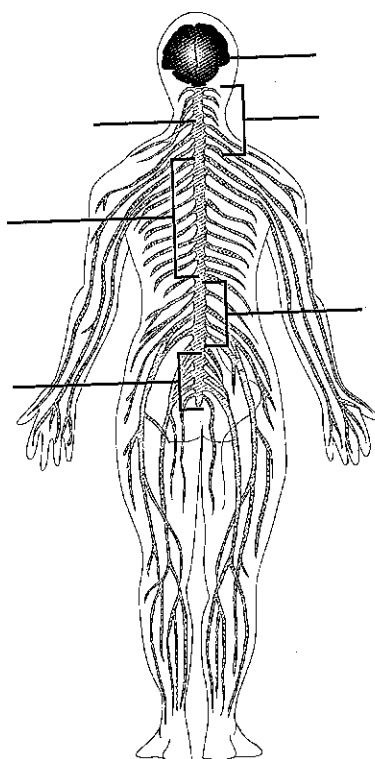
The PNS consists of:

- _____
- _____

Task

On the illustration to the right:

- a. Label the parts of the CNS
- b. Colour the CNS one colour
- c. Using your knowledge of anatomy, label the following parts of the PNS on the illustration:
 - i. Cervical Nerves
 - ii. Sacral Nerves
 - iii. Thoracic Nerves
 - iv. Lumbar Nerves
- d. Colour the PNS a different colour



1.3 Nerves, Neurons and Synapses

1. Nerves

Nerves make up the Peripheral Nervous System. They are made up of a collection of neurons surrounded by a fatty tissue.

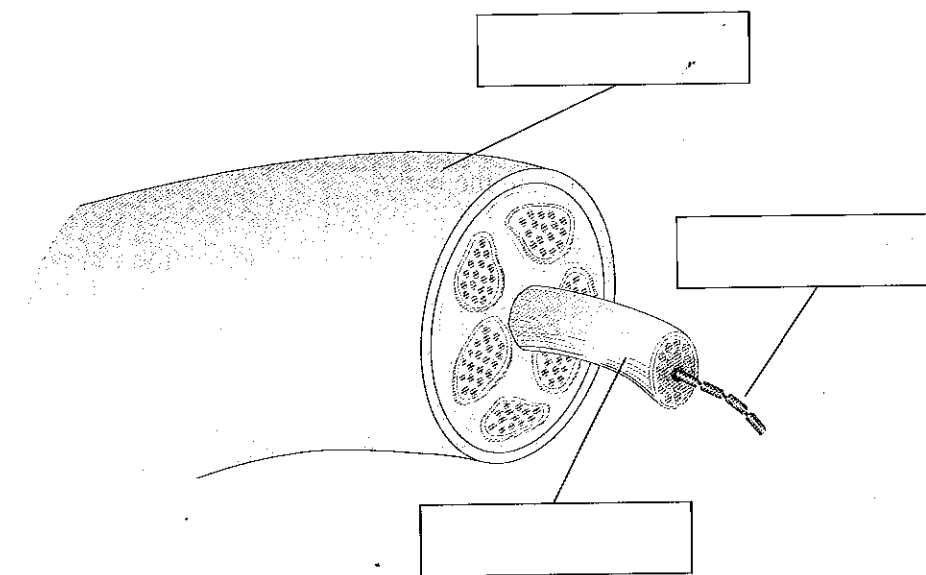
2. Neurons

Neurons are the structural unit of the nervous system. Just like a nerve, they are surrounded by fatty tissue.

Why are both nerves and neurons surrounded by fatty tissue?

- _____
- _____

The structure of a nerve can be illustrated below:



We can now pull one of these neurons out to look at it in greater detail.

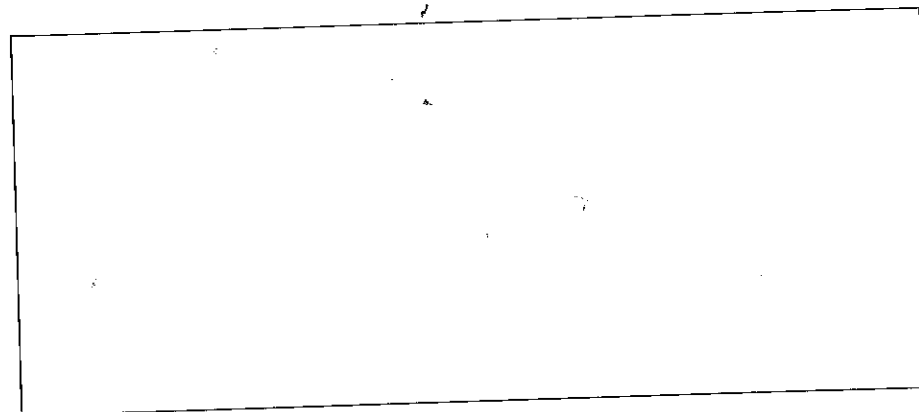
1.4 Motor Units

A single motor neuron cannot be responsible for stimulating an entire muscle. Why?

Instead, a single motor unit will be responsible for stimulating a few muscle fibres within a particular muscle.

Therefore a **motor unit** is defined as:

In the space below, draw an example of a motor unit.



As a consequence a muscle has *different numbers* of motor neurons stimulating its muscle fibres.

The number of fibres affected by a motor neuron depends upon the precision of movement the muscle is required to make.

Describe the motor unit structure of a *precise* muscle like those involved in handwriting.

Describe the motor unit structure of a *large* muscle responsible for powerful movements such as quadriceps.

1.5 All or None Law

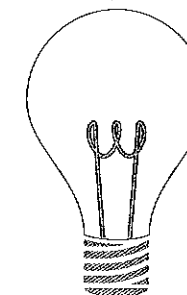
This law states that:

A motor neuron will not stimulate the fibres it attaches to until _____

Once this has been achieved, all the fibres of that motor unit contract _____

We can draw a similarity between this law and a motor unit, to turning on a light from a switch.

Until you supply enough force to turn on the switch, no lights will go. Once you have flicked the light switch, all the lights will go on and shine as brightly as they can.



Why is it desirable to have **fibres** not contracting until a certain electrical intensity is reached?

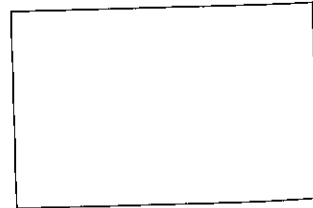
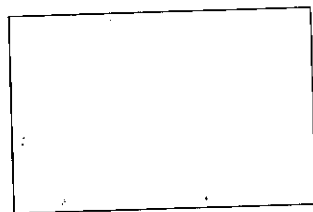
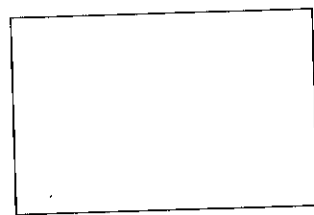
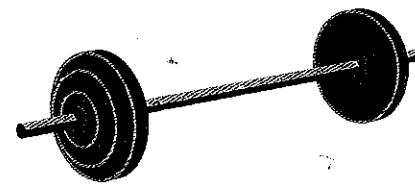
Do different **motor units** have different thresholds of intensity? Why? Why not?

1.6 Principle of Recruitment

How is it that a muscle such as the wrist flexors can produce delicate movements such as holding a pen and also gross movements such as gripping a hockey stick?

We have to realise that muscles have a range of sizes of motor units within them. If we did not, then a muscle would only be able to produce a constant force with no variation.

The *Principle of Recruitment* can be summarised as we try to lift the weight below:



This process continues until the object is lifted, or until there are no more motor units available.

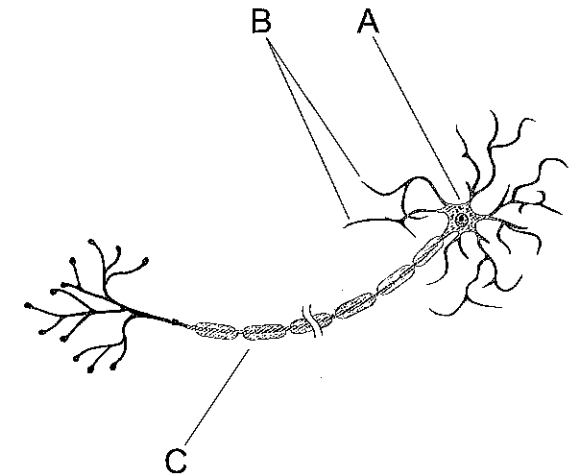
What do you suppose is the purpose of strength training with respect to motor units and the Principle of Recruitment?

1.7 Revision Questions

Question 1

Label and explain the functioning of A–C on the illustration of a neuron.

A = _____
B = _____
C = _____



Question 2

Draw on the illustration which way the signal travels along the neuron.

Question 3

Circle the correct answer:

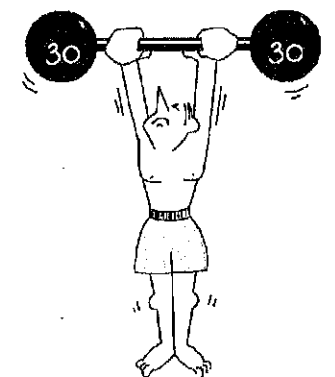
A motor neuron sends signals *to/from* the brain *to/from* muscles.

Question 4

Describe the components of the Central Nervous System.

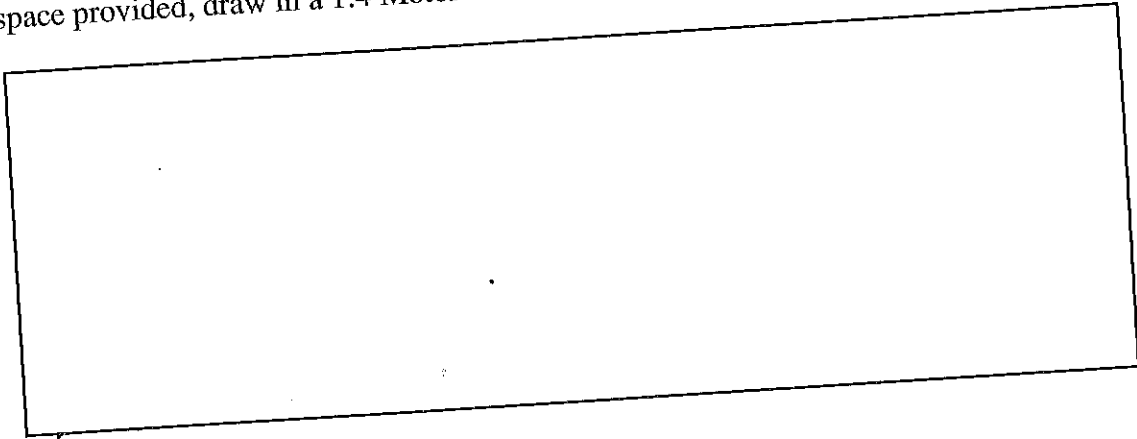
Question 5

Explain how the Principle of Recruitment would work in lifting a 60 kg weight.



Question 6

In the space provided, draw in a 1:4 Motor Unit.

**Question 7**

Why do we have fat surrounding a nerve and neurons?

Question 8

Why is it inappropriate to have a single neuron responsible for transmitting impulses over a great distance?

Question 9

Explain how we produce delicate and gross movements with respect to motor units?
