The nervous system

Level 2 Anatomy and physiology
for exercise and fitness instructors

Learning outcomes

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

- Describe the role and functions of the nervous system
- Describe the principles of muscle contraction
- Describe the ‘all or none law’/motor unit recruitment
- Describe how exercise can enhance neuromuscular connections and improve motor skills

The nervous system

Functions

- Controls all the actions of all bodily systems
- Maintains ‘homeostasis’ in the body enabling it to operate effectively

The nervous system

Sensory input

- Sense changes inside and outside the body

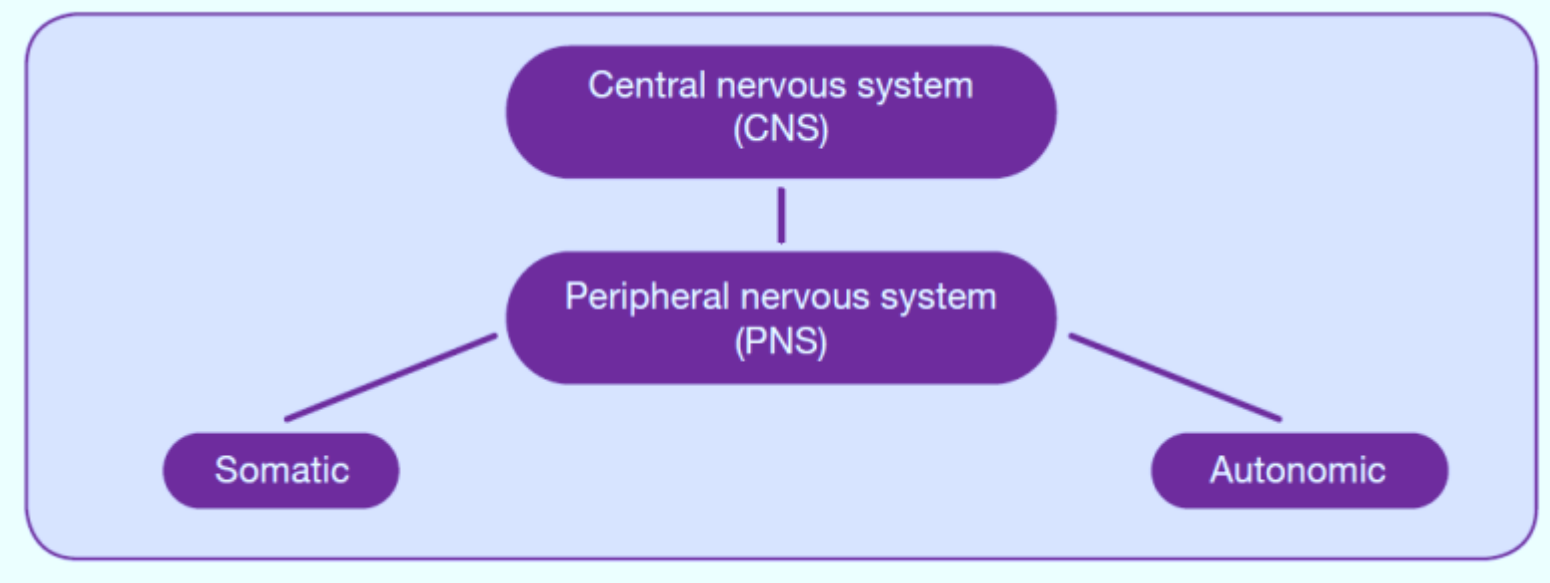
Interpretation

- Analyse and interpret incoming information

Motor output

- Respond to information by activating the relevant bodily system

The nervous system structure



The nervous system

Central nervous system (CNS)

- The brain and the spinal cord

The peripheral nervous system

- 31 pairs of nerves that branch from the spinal cord
- Sends messages back to the CNS
- Two branches:
    - Somatic (voluntary)
    - Autonomic (involuntary)
        - Sympathetic (fight or flight, war)
        - Parasympathetic (rest and digest)

The central nervous system (CNS)

- The brain and the spinal cord
  - Receives messages from the peripheral nervous system (PNS)
  - Interpretation
  - Sending out the correct motor response
  - The brain is responsible for interpretation of messages and the spinal cord is responsible for the transfer of messages in and out of the CNS and spinal reflexes

The peripheral nervous system (PNS)

- The incoming and outgoing nerves to the spinal cord
  - Afferent nerves – sensory neurons carrying information about changes
  - Efferent nerves – carry information about the required response to a change

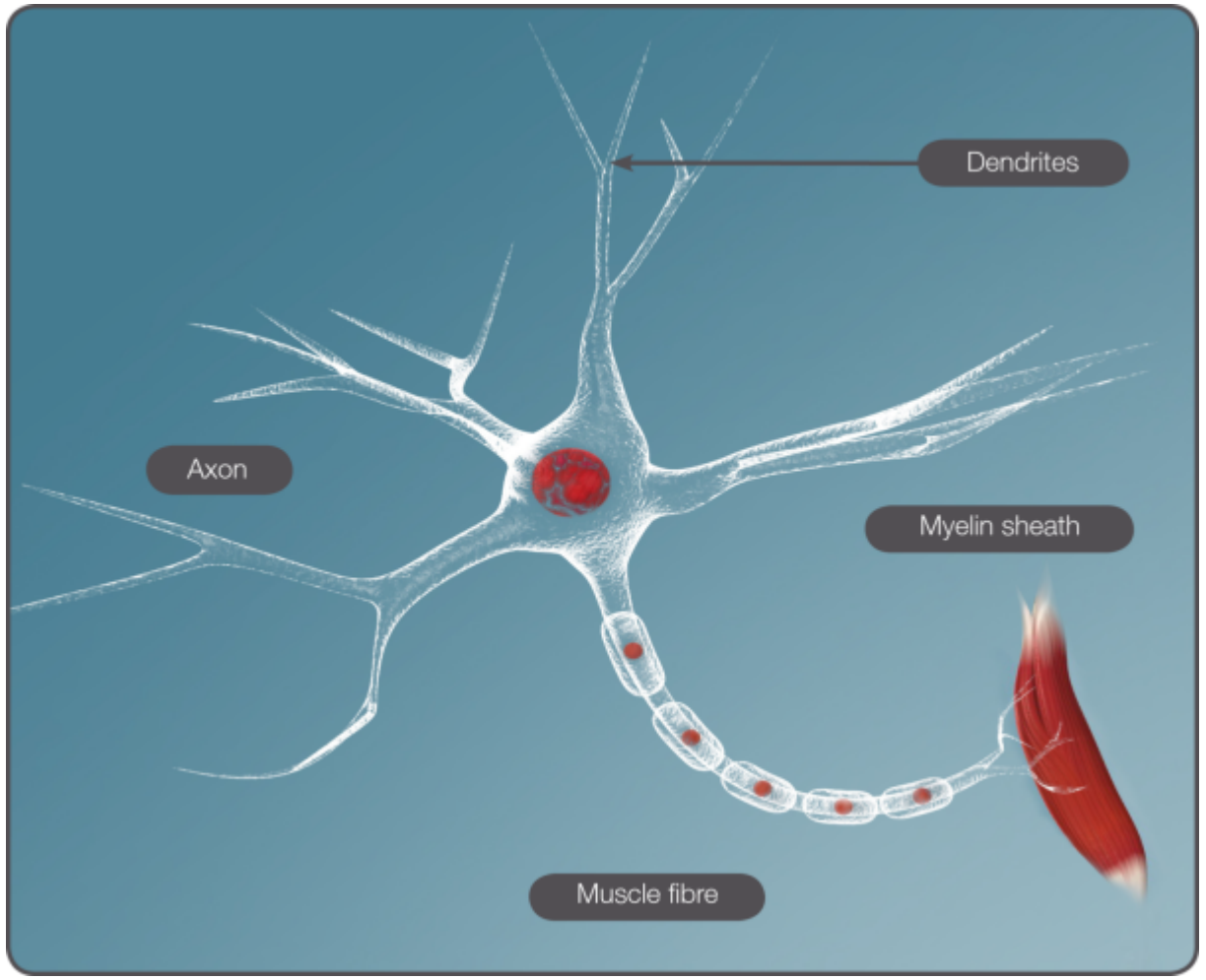
The somatic nervous system

- Concerned with changes in the external environment.
- Senses movement, touch, pain, skin temperature etc.
- Under conscious control

The autonomic nervous system

- Concerned with changes in the internal environment.
- Senses hormonal status, functioning of internal organs, controls cardiac and smooth (involuntary) muscles and the endocrine glands that secrete hormones
- Not under conscious control

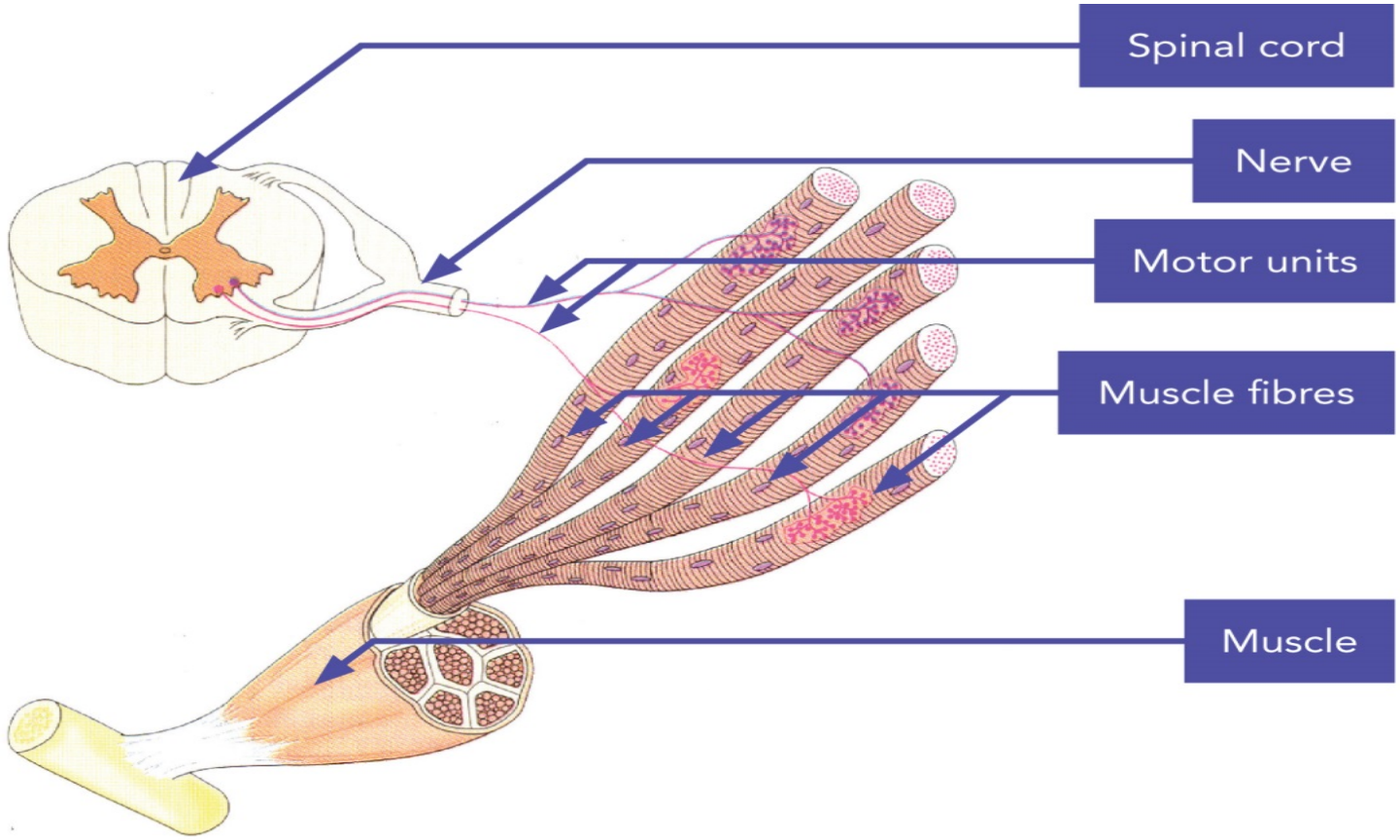
The structure of a neuron



Structure of a neuron

- Dendrites – carry incoming action potentials
- Axons – transmit action potentials
- Nucleus – cell's control centre and regulates cell activity
- Myelin sheath – insulates axons to speed up transmission of the action potentials
- Nucleus – regulates cell activity
- Axon terminals – interface between neuron and other cells
- Synaptic end bulbs – neurotransmitter is released

Motor units and recruitment



Motor units and recruitment

- A motor unit is a motor neuron and the muscle fibres it innervates

- 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

Motor units and recruitment

- Motor units are recruited in order of size
- Large motor units contain large numbers of type 2b fibres – strength, speed and power
- Small motor units contain large numbers of type 1 fibres – endurance and fine control
- Motor units can be recruited simultaneously to create a quick forceful contraction, or in an alternating sequence to provide longer, less intense contractions

Motor units and recruitment

To generate:

- A greater amount of force, the nervous system ‘recruits’ a larger number of motor units

- A lesser degree of force, the nervous system ‘recruits’ a smaller number of motor units

The ‘all or none’ law

- When an impulse is sent down a neuron all the muscle fibres within that motor unit will be innervated
- Firing a nerve within a motor unit generates the stimulus needed to fully contract all the associated muscle fibres
- The motor unit is either on or off
- There is no partial stimulation or contraction of a motor unit or its fibres

The effects of exercise on the nervous system

- Improvement in the frequency of nerve impulses to muscles (neuromuscular pathways)
- Increase in the number of motor units recruited (the more motor units activated, the stronger the muscular contraction)
- Strengthening/growing new connections within the nervous system
- Speeding up the frequency of nerve impulses to motor units
- Improving synchronous recruitment of motor units, resulting in stronger muscle contraction