Unit 63: Scientific Basis of Neurosensory Science: Applied Physics and Measurement

Level: 4

Unit type: Optional (Life Science)

Credit value: 15

Guided learning hours: 120

Unit summary

In this unit, you will develop an understanding of the concepts of instrumentation used in the neurosensory sciences together with an appreciation of the physical and mathematical principles that underpin these concepts and measurements. The application of the knowledge gained in this unit will be applied and contextualised as you perform routine technical skills, and you will develop and build your professional practice in accordance with Good Scientific Practice.

Unit assessment requirements

There are no specific assessment requirements for this unit. Please refer to the assessment strategy in *Annexe B*.

Additional information

AC1.1–1.10 includes:

- atomic structure: the Bohr atom, charge, concept of free electrons, isotopes.

AC1.2 includes:

- electricity: current, potential difference, resistance, Ohm's law, resistivity, capacitors, rectification, circuits with resistors and capacitors, AC/DC, period, RMS values, static and dynamic instrument characteristics, measurement errors.

AC1.5 includes:

- how to calculate unknown from known quantities.

AC1.7 includes:

- electrical circuits, their components, terminology and symbols
- how voltage, current and resistance can be calculated for complex circuits.

AC2.2 includes:

- magnetism and electromagnetism: induction, electromagnetic radiation and their interactions with matter
- typical wavelength bands for infrared, the colour spectrum and ultraviolet.

AC2.3 includes:

- light and lasers: electromagnetic spectrum, wave and quantum theories, polarisation, lasers, refraction, reflection.

AC3.3 includes:

- sound and ultrasound: wave formation, simple harmonics, propagation, transmission through different media, diffraction/scatter, absorption, frequency, amplitude, velocity, acoustic interface and impedance, intensity, gain, decibel scale, measurement of sound
- what happens to velocity, frequency and wavelength as a sound wave travels through different media, and the reflection and refraction of sound.

AC3.6 includes:

- the attenuation, interference and diffraction of sound waves
- the Doppler effect and acoustic resonance.

AC3.7 includes:

- the frequencies used
- meaning of A- and B-mode.

AC4.1 includes:

- body mechanics: limb movement and lever
- basal metabolic rate (BMR), energy power and work.

AC5.1 includes:

- units of measurement
- how pressure varies with depth in a fluid.

AC5.2 includes:

- the relationship between the flow rate of a fluid and its velocity.

AC5.3 includes:

- the difference between laminar and turbulent flow.

AC5.8 includes:

- fluid flow through tubes: Poiseuille's law, laminar and turbulent flow.

AC6.6 includes:

- percentages
- statistics: descriptive, sampling, distribution, parametric/non-parametric, errors, variance, logarithms, graphs: use of in clinical practice.

AC7.1 includes the wider clinical environment.

AC7.2 includes:

- dedicated versus non-dedicated environments, e.g., wards, intensive care, theatres, individual's home.

AC7.3 could include:

- the potential for artefacts/interference filters and amplifiers, e.g. gain, sensitivity, common-mode rejection ratio (CMRR), noise.

AC8.1 includes:

- electrical
- ionising radiation
- magnetic resonance imaging
- electromagnetic radiation.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria outline the requirements that the learner is expected to meet to achieve the learning outcomes and the unit.

Learning outcomes		Assessment criteria		Evidence type	Portfolio reference	Date
1	Understand the principles of electricity that underpin measurements in neurosensory sciences	1.1	Know the structure of the atom and atomic charges, electrostatic forces, potential difference and free electrons			
		1.2	Explain different methods of producing electricity, magnetism and electromagnetism and magnetic induction			
		1.3	Explain the properties of conductors, insulators and resistors			
		1.4	Explain the meaning of conventional and electron current flow			
		1.5	Know units of electrical measurement for voltage, current, resistance, power and capacitance			
		1.6	Compare how DC and AC current is generated and measured			
		1.7	Describe how transformers change the relationship between voltage and current in AC circuits			

Learning outcomes		Assessment criteria		Evidence type	Portfolio reference	Date
2	Understand the principles of electromagnetic radiation and light that underpin measurements in neurosensory sciences	2.1	Describe the fundamental properties and descriptive terminology for electromagnetic radiation			
		2.2	Describe the properties of the different wavelengths that comprise the electromagnetic spectrum			
		2.3	Explain the difference between wave (electromagnetic) and quantum theories of light			
		2.4	Describe the properties of diffraction, coherence, polarisation and phase and use this terminology to describe laser light			
		2.5	Describe the properties of reflection and refraction of light			
		2.6	Describe how light intensity is measured			

Learning outcomes		Assessment criteria		Evidence type	Portfolio reference	Date
3	Understand the principles of wave motion and sound that underpin measurements in neurosensory sciences	3.1	Describe how mechanical waves are generated by vibrators and oscillators			
		3.2	Describe the characteristics of mechanical transverse and longitudinal waves			
		3.3	Explain the relationships between and units of measurement of velocity, frequency and wavelength of a sound wave			
		3.4	Explain the relationships between, and units of measurement of: loudness and amplitude; and frequency and pitch			
		3.5	Describe the sensitivity of the human ear to varying levels of loudness and pitch			
		3.6	Describe the basic principles of harmonics and standing waves			
		3.7	Describe the basic principles of diagnostic ultrasonography			

Learning outcomes		Assessment criteria		Evidence type	Portfolio reference	Date
4	Understand the principles of mechanics and body mechanics that underpin measurements in neurosensory sciences	4.1	Describe different forms of energy and the law of conservation of energy			
		4.2	Define power and know how to calculate power from energy			
		4.3	Describe energy conversion in humans			
		4.4	Describe the meaning of basal metabolic rate in the context of work, energy and power			
		4.5	Explain how the principles of force and torques are applied to the study of human biomechanics			
5	Understand the principles of fluids and fluid dynamics that underpin measurements in neurosensory sciences	5.1	Describe the concepts of density and pressure as applied to fluids			
		5.2	Explain how the velocity changes as fluid passes through tubes of different diameters			
		5.3	Explain the relationship between laminar flow and the viscosity of a fluid			
		5.4	Explain the relationship between resistance to laminar flow and viscosity, length and radius of a tube as expressed in Poiseuille's law			
		5.5	Describe factors that may be responsible for turbulent flow			

Learning outcomes		Assessment criteria		Evidence type	Portfolio reference	Date
6	Understand the principles of mathematics and statistics that underpin measurements in neurosensory sciences	6.1	Differentiate between basic, supplementary and derived International System of Units (SI)			
		6.2	Know how to use appropriate metric units, prefixes and exponential notation when describing data			
		6.3	Calculate the mean and standard deviation from data relevant to own area of work			
		6.4	Explain the use and calculation of statistics in neurosensory sciences			
		6.5	Explain the purpose and limitations of the use of paired and unpaired t-testing			
7	Understand how different environments can affect neurosensory measurement systems	7.1	Explain the importance of physics and measurement in neurosensory sciences			
		7.2	Describe the range of settings in which neurosensory science investigations are undertaken			
		7.3	Explain the potential effect of the environment on measurement systems used in own area of work			
		7.4	Discuss how the physical characteristics affect the quality of measured data			
		7.5	Evaluate strategies to minimise the effect of the environment on neurosensory measurements			

Learning outcomes		Assessment criteria		Evidence type	Portfolio reference	Date
8	Understand the health and safety systems that underpin neurosensory physiological measurements	8.1	Explain the health and safety policies, legislation and regulatory framework in own area of work			
		8.2	Explain the incident reporting structure in own area of work			
		8.3	Explain the roles and responsibilities of staff for health and safety systems in own area of work			
		8.4	Explain personal responsibilities regarding health and safety systems within own area of work			
9	Understand the quality-assurance processes in own department which underpin safety and good practice	9.1	Explain the key components of the quality-management processes within own area of work			
		9.2	Explain the process of service accreditation for own area of work			
		9.3	Explain how quality management contributes to safe and effective high-quality care			

Learner name: ____ Date: ____________________________

Learner signature: ______________________________________ Date: ____________________________

Assessor signature: _____________________________________ Date: ____________________________

Internal verifier signature: _______________________________ Date: ____________________________

(*if sampled*)