

Access to Higher Education Unit

This unit forms part of an Access to HE Diploma. If delivering the graded version of this unit, please refer to the Provider Handbook for details on grading descriptors and the application of these across units within your programme.

Unit Title: Physics of Animal Senses

Graded Unit Reference Number: GA33VET06

Ungraded Unit Reference Number: UA33VET06

Module: Biology; Veterinary

Level: Three [3]

Credit Value: Three [3]

Minimum Guided Learning Hours: 30

Units barred for selection against this unit:

- **Physics of the Senses (GA33PHY17 / UA33PHY17)**

Learning Outcome (The Learner will):	Assessment Criterion (The Learner can):
1. Understand the physical properties of light and sound	1.1 Explain the differences between the transmission of sound and light waves.
	1.2 State and apply the wave equation ($v = f\lambda$) to solve quantitative problems involving sound and light.
	1.3 Explain refraction and reflection of light and sound.
	1.4 Solve quantitative problems using refractive index equations ($n = c/v$ and Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$) in animal-relevant contexts.
2. Understand the role of the eye in image formation and colour vision	2.1 Describe the roles of the lens and cornea of the mammalian eye in producing a focused image on the retina.
	2.2 Explain the function of rods and cones as transducers in mammals.

Learning Outcome (The Learner will):	Assessment Criterion (The Learner can):
	2.3 Interpret data comparing the trichromatic theory in humans, and dichromatic theory in the domestic cat, and use this to explain differences in colour perception.
3. Understand the role of the ear and other sensory mechanisms in animal perception of sound and vibration	3.1 Describe how the outer, middle and inner sections of the mammalian ear collect and amplify sound vibrations. 3.2 Explain the role of sensory inner ear hair cells in the cochlea as transducers in mammals. 3.3 Interpret data to explain how arthropods, such as spiders or cockroaches, use specialist mechanoreceptive hairs to detect sound or vibration.
4. Understand the reasons for defects and compensatory adaptations in vision and hearing	4.1 Explain the causes of hyperopia (long sight), myopia (short sight) and astigmatism in mammals. 4.2 In cases where animals are myopic, (e.g. moles) explain how they compensate for reduced visual acuity through increased reliance on other sensory modalities. 4.3 Explain how damage or dysfunction affecting the outer, middle or inner ear can impair hearing in mammals.

Indicative Content

Learners could cover the following:

(The information below is provided for guidance only and is not mandatory)

LO1	AC1.1 – AC1.4 Nature of waves: • Definition of waves as energy transfer without net movement of particles. • Sound waves: longitudinal waves; require a medium; compression and rarefaction. • Light waves: electromagnetic; transverse; do not require a medium. • Comparison of propagation in air, water and biological tissues. Wave properties: • Frequency, wavelength, wave speed and amplitude. • Relationship between frequency and perceived pitch (sound) and colour (light). • Amplitude and perceived loudness (sound) and brightness (light). Wave equation: • Use of the wave equation $v = f\lambda$. • Rearranging the equation and applying it to calculate missing variables.
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	- Quantitative problems using realistic animal-focused examples (e.g. frequencies detectable by bats or dogs). Reflection and refraction: - Reflection of light (e.g. eyeshine in nocturnal mammals; tapetum lucidum). - Reflection of sound (e.g. echolocation in bats and dolphins). - Refraction of light when passing between media of different density (air, cornea, lens, water). - Effect of refraction on image formation. Refractive index: - Definition of refractive index. - Use of $n = c / v$ to compare light speed in different media. - Application of Snell's Law ($n_1 \sin\theta_1 = n_2 \sin\theta_2$) to simple ray-tracing problems. - Biological relevance of refraction in animal eyes (e.g. curved cornea, spherical lens).
LO2	AC2.1 – AC2.3 Structure and function of the eye: - Overview of mammalian eye anatomy with emphasis on cornea, lens, retina and optic nerve. - Role of the cornea in initial refraction of light. - Role of the lens in fine focusing via accommodation. - Formation of inverted images on the retina. Photoreceptors as transducers: - Definition of transduction as conversion of physical energy into nerve signals. - Structure and function of rods: - High sensitivity to light - Monochrome vision - Role in low-light and night vision. - Structure and function of cones: - Colour vision - High visual acuity - Function in bright light. - Distribution of rods and cones across the retina in mammals. Colour vision theories: - Trichromatic theory in humans: three cone types sensitive to different wavelengths. - Dichromatic vision in species such as domestic cats. - Comparison of spectral sensitivity ranges. - Interpretation of comparative data or graphs showing cone sensitivity. - Functional implications of colour vision differences on behaviour, hunting and environmental interaction.
LO3	AC3.1 – AC3.3 Structure of the mammalian ear: - Overview of outer, middle and inner ear. - Outer ear role in sound collection and direction. - Middle ear ossicles (malleus, incus, stapes) and mechanical amplification. - Inner ear structure, including the cochlea.

	Sound transduction in the cochlea: • Fluid movement within the cochlea in response to vibrations. • Role of the basilar membrane. • Function of inner ear hair cells as mechanoreceptors. • Conversion of mechanical vibration into electrical nerve impulses. • Frequency discrimination and tonotopic organisation (overview). Non-mammalian sensory mechanisms: • Mechanoreceptive hairs in arthropods. • Examples such as spiders detecting web vibrations or cockroaches sensing air movement. • Comparison between vertebrate auditory systems and invertebrate vibration sensing. • Interpretation of simple experimental or observational data on vibration detection. • Ecological significance of vibration sensing for predator avoidance or communication.
LO4	AC4.1 – AC4.3 Vision defects: • Definition and causes of: ◦ Myopia (short sight) ◦ Hyperopia (long sight) ◦ Astigmatism. • Relationship between eye shape, lens curvature and image position on the retina. • Basic ray diagrams illustrating image misplacement. Compensatory sensory adaptations: • Examples of animals with reduced visual acuity (e.g. moles). • Increased reliance on other senses such as: ◦ Touch (vibrissae/whiskers) ◦ Hearing ◦ Olfaction. • Trade-offs between sensory investment and ecological niche. • Adaptive advantage of multisensory integration. Hearing impairment: • Causes of dysfunction in: ◦ Outer ear (e.g. blockage, structural damage) ◦ Middle ear (e.g. ossicle damage, infection) ◦ Inner ear (hair cell damage, noise exposure). • Effects on sound transmission and transduction. • Consequences for behaviour and survival. • Overview of temporary vs permanent hearing loss.