Summary

Optional Unit - Neurobiology and behaviour Current

Subject	Year	Start date	Duration
Biology	IB1	Week 1, May	6 weeks 25 hours

Course Part

Optional Unit

Curriculum

Syllabus Content

Options

Option A: Neurobiology and behaviour

Core

A.1 Neural development

Nature of science:

Use models as representations of the real world - developmental neuroscience uses a variety of animal models.

Understandings:

The neural tube of embryonic chordates is formed by infolding of ectoderm followed by elongation of the tube.

Neurons are initially produced by differentiation in the neural tube.

Immature neurons migrate to a final location.

An axon grows from each immature neuron in response to chemical stimuli.

Some axons extend beyond the neural tube to reach other parts of the body.

A developing neuron forms multiple synapses.

Synapses that are not used do not persist.

Neural pruning involves the loss of unused neurons.

The plasticity of the nervous system allows it to change with experience.

Applications and skills:

Application: Incomplete closure of the embryonic neural tube can cause spina bifida.

Application: Events such as strokes may promote reorganization of brain function.

Skill: Annotation of a diagram of embryonic tissues in Xenopus, used as an animal model, during neurulation.

A.2 The human brain

Nature of science:

Use models as representations of the real world—the sensory homunculus and motor homunculus are models of the relative space human body parts occupy on the somatosensory cortex and the motor cortex.

Understandings:

The anterior part of the neural tube expands to form the brain.

Different parts of the brain have specific roles.

The autonomic nervous system controls involuntary processes in the body using centres located mainly in the brain stem.

The cerebral cortex forms a larger proportion of the brain and is more highly developed in humans than other animals.

The human cerebral cortex has become enlarged principally by an increase in total area with extensive folding to accommodate it within the cranium.

The cerebral hemispheres are responsible for higher order functions.

The left cerebral hemisphere receives sensory input from sensory receptors in the right side of the body and the right side of the visual field in both eyes and vice versa for the right hemisphere.

The left cerebral hemisphere controls muscle contraction in the right side of the body and vice versa for the right hemisphere.

Brain metabolism requires large energy inputs.

Applications and skills:

Application: Visual cortex, Broca's area, nucleus accumbens as areas of the brain with specific functions.

Application: Swallowing, breathing and heart rate as examples of activities coordinated by the medulla.

Application: Use of the pupil reflex to evaluate brain damage.

Application: Use of animal experiments, autopsy, lesions and fMRI to identify the role of different brain parts.

Skill: Identification of parts of the brain in a photograph, diagram or scan of the brain.

Skill: Analysis of correlations between body size and brain size in different animals.

A.3 Perception of stimuli

Nature of science:

Understanding of the underlying science is the basis for technological developments - the discovery that electrical stimulation in the auditory system can create a perception of sound resulted in the development of electrical hearing aids and ultimately cochlear implants.

Understandings:

Receptors detect changes in the environment.

Rods and cones are photoreceptors located in the retina.

Rods and cones differ in their sensitivities to light intensities and wavelengths.

Bipolar cells send the impulses from rods and cones to ganglion cells.

Ganglion cells send messages to the brain via the optic nerve.

The information from the right field of vision from both eyes is sent to the left part of the visual cortex and vice versa.

Structures in the middle ear transmit and amplify sound.

Sensory hairs of the cochlea detect sounds of specific frequency.

Impulses caused by sound perception are transmitted to the brain via the auditory nerve.

Hair cells in the semicircular canals detect movement of the head.

Applications and skills:

Application: Red-green colour-blindness as a variant of normal trichromatic vision.

Application: Detection of chemicals in the air by the many different olfactory receptors.

Application: Use of cochlear implants in deaf patients.

Skill: Labelling a diagram of the structure of the human eye.

Skill: Annotation of a diagram of the retina to show the cell types and the direction in which light moves.

Skill: Labelling a diagram of the structure of the human ear.

Additional higher level

A.4 Innate and learned behaviour

Nature of science:

Looking for patterns, trends and discrepancies - laboratory experiments and field investigations helped in the understanding of different types of behaviour and learning.

Understandings:

Innate behaviour is inherited from parents and so develops independently of the environment.

Autonomic and involuntary responses are referred to as reflexes.

Reflex arcs comprise the neurons that mediate reflexes.

Reflex conditioning involves forming new associations.

Learned behaviour develops as a result of experience.

Imprinting is learning occurring at a particular life stage and is independent of the consequences of behaviour.

Operant conditioning is a form of learning that consists of trial and error experiences.

Learning is the acquisition of skill or knowledge.

Memory is the process of encoding, storing and accessing information.

Applications and skills:

Application: Withdrawal reflex of the hand from a painful stimulus.

Application: Pavlov's experiments into reflex conditioning in dogs.

Application: The role of inheritance and learning in the development of birdsong.

Skill: Analysis of data from invertebrate behaviour experiments in terms of the effect on chances of survival and reproduction.

Skill: Drawing and labelling a diagram of a reflex arc for a pain withdrawal reflex.

A.5 Neuropharmacology

Nature of science:

Assessing risks associated with scientific research - patient advocates will often press for the speeding up of drug approval processes, encouraging more tolerance of risk.

Understandings:

Some neurotransmitters excite nerve impulses in postsynaptic neurons and others inhibit them.

Nerve impulses are initiated or inhibited in post-synaptic neurons as a result of summation of all excitatory and inhibitory neurotransmitters received from presynaptic neurons.

Many different slow-acting neurotransmitters modulate fast synaptic transmission in the brain.

Memory and learning involve changes in neurons caused by slow-acting neurotransmitters.

Psychoactive drugs affect the brain by either increasing or decreasing postsynaptic transmission.

Anesthetics act by interfering with neural transmission between areas of sensory perception and the CNS.

Stimulant drugs mimic the stimulation provided by the sympathetic nervous system.

Addiction can be affected by genetic predisposition, social environment and dopamine secretion.

Applications and skills:

Application: Effects on the nervous system of two stimulants and two sedatives.

Application: The effect of anesthetics on awareness.

Application: Endorphins can act as painkillers.

Skill: Evaluation of data showing the impact of MDMA (ecstasy) on serotonin and dopamine metabolism in the brain.

A.6 Ethology

Nature of science:

Testing a hypothesis - experiments to test hypotheses on the migratory behaviour of blackcaps have been carried out.

Understandings:

Ethology is the study of animal behaviour in natural conditions.

Natural selection can change the frequency of observed animal behaviour.

Behaviour that increases the chances of survival and reproduction will become more prevalent in a population.

Learned behaviour can spread through a population or be lost from it more rapidly than innate behaviour.

Applications and skills:

Application: Migratory behaviour in blackcaps as an example of the genetic basis of behaviour and its change by natural selection.

Application: Blood sharing in vampire bats as an example of the development of altruistic behaviour by natural selection.

Application: Foraging behaviour in shore crabs as an example of increasing chances of survival by optimal prey choice.

Application: Breeding strategies in coho salmon populations as an example of behaviour affecting chances of survival and reproduction.

Application: Courtship in birds of paradise as an example of mate selection.

Application: Synchronized oestrus in female lions in a pride as an example of innate behaviour that increases the chances of survival and reproduction of offspring.

Application: Feeding on cream from milk bottles in blue tits as an example of the development and loss of learned behaviour.