The Fundamentals of Brain and Behaviour

Overview:

Neuroscience is at the heart of everything we do. The brain is the most complex organ in the human body, and understanding how it works is key to understanding behaviour, cognition, and neurological health. This badge introduces participants to the foundational principles of neuroscience, including neural communication, brain structures, and neuroplasticity. Through an exploration of neuroanatomy, neurotransmission, and neurophysiology, participants gain a comprehensive understanding of how the brain governs sensory processing, movement, and higher cognitive functions.

Learning Outcomes:

- Understand the basic structure and function of the nervous system
- Describe the process of neurotransmission and synaptic signaling
- Identify major brain regions and their roles in behaviour and cognition
- Describe neuroplasticity and neurodevelopment
- Recognize how the nervous system interacts with the peripheral systems
- Apply neuroscience principles to real-world problems in health, behaviour, and cognition

Module 1: Introduction to Neuroscience-Overview of Neuroscience

- History and major milestones
- Branches of neuroscience (molecular, cellular, cognitive, computational, etc.)
- Relevance of neuroscience in medicine, AI, and psychology
- Evolution of the nervous system

Module 2: Neuroanatomy and Neurophysiology-Brain Structures and Functions

- Cerebral cortex and lobes
- Subcortical structures (thalamus, basal ganglia, hippocampus)
- Brainstem and cerebellum
- Spinal cord structure and function
- Neuron types, structure, and function
- Neuroglia: Astrocytes, oligodendrocytes, Schwann cells, and microglia

Module 3: Cellular and Molecular Neuroscience-Neuronal Communication

- Resting membrane potential
- Action potentials and their propagation
- Synaptic transmission (chemical vs. electrical synapses)
- Major neurotransmitters (glutamate, GABA, dopamine, serotonin, etc.)
- Mechanisms of neurotransmitter release, reuptake, and degradation
- Role of neuromodulators in behaviour

Module 4: Sensory and Motor Systems

- Somatosensory system (touch, pain, temperature)
- Vision, auditory, olfactory, gustatory systems
- Integration of sensory information in the brain
- Motor pathways (corticospinal, extrapyramidal)
- Role of basal ganglia and cerebellum in movement
- Disorders of motor control (Parkinson’s, Huntington’s)

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Module 5: Neurodevelopment and Plasticity-Brain Development

- Neurulation and early brain formation
- Neuronal migration and differentiation
- Synaptogenesis, pruning, and myelination
- Mechanisms of synaptic plasticity (LTP, LTD)
- Hebbian learning and neural networks
- Neurogenesis in the adult brain

Module 6: Cognitive and Behavioural Neuroscience

- Attention, perception, and consciousness
- Decision-making and executive function (role of prefrontal cortex)
- Language and communication (Broca's & Wernicke's areas)
- Limbic system and emotional regulation
- Neurobiology of stress and anxiety
- Social cognition and empathy