

Major-15
Neurobiology and integration of AI in modern neurobiology

Course Description

The course is designed to provide the students a comprehensive knowledge about Basic organization of nervous system, This course will give brief idea about how individual neurons in the brain function, how they generate action potential, how neurons communicate with one another, and how different systems is coordinated with the nervous system. This course will give a brief idea about the different neurological disorders and their remedy. This course also give a basic idea about the application of Artificial Intelligence (AI) in modern neurobiology.

Objective

- Understand the fundamental structure and function of the nervous system.
- Explore key concepts in Neurobiology
- Analyze the coordination between neurobiology and different physiological systems
- Understand the different neurological disorders
- Understanding the integration of AI in Modern neurobiology

Course outcome

- To understand basic concept of organisation of human nervous system, its components and their interrelationship among different physiological system
- To comprehend and analyse how brain exerts its functional regulation on physiologocial function via down-stream molecular signalling.
- To discuss and analyze biochemical events and pathophysiological changes leading to mental & behaviuoral disorders and critically evaluate new possible therapies being investigated to treat neurological disease.
- To understand the application of AI in neurobiology

Difficulty Level: 400

Mode of Instruction LST (Lecture, Seminar and Tutorial)

Theory
(4 Credit)

Unit I: Introduction to Neurobiology

Components of the Nervous System, Neuron and Glial Cells - Different Types, Structure, Function.

Organization of Nervous System- CNS, PNS. PNS- Somatic Nervous System; Autonomic Nervous System- Sympathetic and Parasympathetic System; Enteric Nervous System

Origin and Differentiation of Neurons

Unit 2: Brain and Spinal Cord

Embryological development, blood-brain barrier, CSF, structural and functional organization, Spinal cord anatomy, Spinal Nerves, Spinal Meninges, Grey and White Matter of the spinal cord

Reflex action: coordination of the spinal cord and the peripheral nervous system

Unit 3: Neuronal Communication

Electrical potentials Neurilemma and their molecular basis.

Types of Synapses, Receptors, and Neurotransmitters. Propagation of nerve impulses and their molecular basis.

Synapse: Synaptic transmission and Neuromodulation. Integration of synaptic functions: Synaptic plasticity

Neurotransmitters: Classification, synthesis, release and functions, inactivation of Neurotransmitters
Sensory receptors and their types; Responses to key sensory stimuli/ impulses: Light (Vision), Smell (Olfactory), Auditory (Hearing), Touch (Tactile) and Taste (Gustatory)

Unit 4: Higher Brain Function

Brain regions and their specialised functions: Hypothalamus and the autonomic nervous system

Learning and Memory, Emotions, and Behaviour.

Brain motor mechanism: Sensory motor integration. Nature of Somatic motor actions in reference to muscles.

Unit 5: Applied Neurobiology

Applications of Neurobiology in Psychology, and Medicine: Overview of some Neurological Disorders (Alzheimer's, Parkinson's, Schizophrenia, etc.).

Neural mechanisms in maintenance of Circadian rhythms and their relationship to sleep-wake cycles; Sleep-related disorders: insomnia, sleep apnea, and shift work disorder; Role of sleep in mood regulation, stress (anxiety and depression) management;

Mental wellness: Role of lifestyle, mindfulness, and early intervention

Advances in neuroscientific research: Brain imaging tools (EEG, fMRI, PET)

Unit 6: Integration of AI in Neurobiology

Application of AI in neurobiology: Brain-Computer Interfaces (BCIs) and AI, Neuroimaging and AI, Neural signal processing and AI

Early Detection of Neurological Disorders Using AI: Early Detection of Alzheimer's Disease: Multimodal Integration and Biomarker Discovery, Predictive Models for Seizure Management in Patients with Epilepsy, Autism Spectrum Disorder: Early Detection via Neuroimaging and Behavioral Analyses, AI-Driven Mental Health Diagnostics and Personalized Interventions, Parkinson's Disease: Early Detection of Motor and Non-Motor Symptoms

Seminar

Credits: 02

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| 1. PPT Presentation | 15marks |
| 2. Manuscript submission | 10 marks |

Suggested reading:-

1. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
2. Brain-Computer Interfaces: Principles and Practice (2012). Editors: Jonathan R. Wolpaw, Elizabeth Winter Wolpaw. Oxford University Press
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Essentials of Neural Science and Behavior. I Edition, New York: McGraw-Hill
5. Gross C. G. A Hole in Head- More tales in the history of neuroscience. Cambridge MIT Press, First edition, 2012.
6. Hell, J. W., Ehlers, M. D., (Editors), Structural and functional organization of the synapse, Springer, 2008
7. Kandel, E.R., Schwartz, J.H. and Jessell, T.M. (2000). Principles of Neural Science. IV Edition, McGraw-Hill Companies. Kandel, E.R., Schwartz, J.H. and Jessell, T.M. (1995).
8. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
9. Longstaff, A. Developmental Biology. Sinauer Associates, 6th Edition, 2010.
10. Mark F. Bear, Barry W. Connors, and Michael A. Paradiso (2015). Neuroscience: Exploring the Brain. IV Edition.

11. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
12. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Wiley and Sons, 2009
13. Turkington, C., The Brain and Brain Disorders, Viva Books, 2009