SCIENCE

An Introduction to Neuroscience

I. CELLS AND THE ANATOMY OF THE BRAIN 15%
- A. Neurons
  1. Parts of the Neuron
  2. The Morphology of Neurons
  3. Grey Matter and White Matter
- B. Glia
  1. Oligodendrocytes and Schwann Cells
  2. Astrocytes
  3. Microglia
- C. The Anatomy of the Central Nervous System
  1. The Meninges
  2. The Lobes of the Brain
  3. Subcortical Structures
  4. The Brainstem
  5. The Spinal Cord
  6. The Ventricular System
- D. The Anatomy of the Peripheral Nervous System
  1. The Somatic Nervous System
  2. The Autonomic Nervous System
     a. The Sympathetic Division
     b. The Parasympathetic Division

II. NEURAL COMMUNICATION 20%
- A. The Resting Membrane Potential
  1. Ionic Concentrations
  2. Electrical Potentials
  3. Ion Channels and Pumps
  4. Equilibrium Potential
     a. The Nernst Equation
     b. The Goldman Equation
- B. The Action Potential
  1. The Phases of the Action Potential
  2. Reaching Threshold
  3. Voltage Gated Sodium Channels
  4. Voltage Gated Potassium Channels
  5. Action Potential Conduction
     a. The Nodes of Ranvier and Saltatory Conduction
- C. Synaptic Transmission
  1. The Presynaptic Cell
  2. The Axon Terminal
  3. Vesicles and Neurotransmitters

4. The Process of Exocytosis
5. The Postsynaptic Cell
    a. Ionotropic Receptors
    b. Metabotropic Receptors
6. Neuropharmacology
    a. Neurotransmitter Receptor Agonists
    b. Neurotransmitter Receptor Antagonists
7. Neurotransmitter Systems
    a. Catecholamines
    b. Serotonin
    c. Acetylcholine

III. SENSORY AND MOTOR SYSTEMS 35%

A. The Visual System
    1. The Retina
        a. Photoreceptors
        b. Phototransduction
        c. Retinal Circuitry
    2. The Retinofugal Pathway
        a. Crossing Fibers Give Rise to Depth Perception
    3. The Lateral Geniculate Nucleus
        a. LGN Input Layers
        b. Receptive Fields in the LGN
    4. The Primary Visual Cortex
        a. The Layers of the Visual Cortex
        b. Spatial Maps in the Visual Cortex
    5. The Dorsal Extrastriate Pathway
        a. Motion Perception
    6. The Ventral Extrastriate Pathway
        a. Object Recognition
B. The Auditory System
    1. The Middle Ear
        a. The Ossicles
    2. The Inner Ear and the Cochlea
        a. Cochlear Structure
        b. The Basilar Membrane and the Organ of Corti
        c. Auditory Transduction via Inner Hair Cells
    3. The Auditory Pathway
        a. Auditory Localization
        b. The Medial Geniculate Nucleus (MGN) of the Thalamus
    4. The Primary Auditory Cortex
        a. Tonotopic Mapping of the Auditory Cortex
C. The Chemical Senses
    1. Gustation/Taste
        a. The Five Tastes
        b. Tastebuds and Taste Cells

c. Taste Transduction
d. Cranial Nerves—Pathways to the Brain

2. Olfaction/Smell
   a. Smell Receptor Neurons and Smell Transduction
   b. Glomeruli of the Olfactory Bulb
3. Population Coding of Odors and Tastes

D. The Somatosensory System
1. The Touch Receptors
   a. Touch Receptive Fields
   b. Two-Point Discrimination
   c. Dermatomes
2. Temperature Receptors
3. Pain Transduction
4. Pathways to the Brain
   a. The Dorsal Column Medial Lemniscal System
   b. The Anterolateral Spinothalamic System
5. The Primary Somatosensory Cortex
   a. Somatotopic Mapping of the Somatosensory Cortex
   b. The Sensory Homunculus

E. The Motor System
1. The Primary Motor Cortex
   a. Motor Planning
2. The Descending Motor Pathways
   a. The Lateral Pathways: Corticospinal and Rubrospinal
   b. The Ventromedial Pathways: Vestibulospinal, Tectospinal, and Reticulospinal
3. The Basal Ganglia
   a. The Circuitry of the Basal Ganglia
4. The Cerebellum
   a. The Circuitry of the Cerebellum
   b. Motor Learning

IV. SYNAPTIC PLASTICITY AND MEMORY 15%

A. Experience-Based Cortical Changes
1. Monocular Deprivation
2. Rodent Barrel Fields
3. Phantom Limb Syndrome

B. Strengthening and Weakening Synapses
1. Habituation and Sensitization
2. Long-term Potentiation at Synapses

C. Memory Systems
1. The Circuitry of the Hippocampus
2. The Encoding and Storage of Memory

V. TECHNOLOGY AND NEUROSCIENCE 15%

A. Methods of Perturbing the Brain
1. Electrical Stimulation

2. Optogenetics
3. Transcranial Magnetic Stimulation

B. Methods of Recording from the Brain
1. EEG
2. MRI
3. Brain–Computer Interface

C. Computational Neuroscience
1. Modeling Neurons
2. Artificial Intelligence and Neuroscience

D. Computational Psychiatry