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BASIC BIOLOGY
Biological and Biochemical Foundations of Living Systems

- Restriction Enzyme Digests
- DNA Ligation Reactions
- An Introduction to Transfection
- Plasmid Purification
- Bacterial Transformation: Electroporation
- DNA Gel Electrophoresis
- PCR: The Polymerase Chain Reaction

NEUROSCIENCE
Chemical and Physical Foundations of Biological Systems

- An Introduction to Neurophysiology
- Patch Clamp Electrophysiology
- Calcium Imaging in Neurons
- An Introduction to Neuroanatomy
- An Introduction to Behavioral Neuroscience
- An Introduction to Cellular and Molecular Neuroscience
- An Introduction to Developmental Neurobiology
DEVELOPMENTAL BIOLOGY

Biological and Biochemical Foundations of Living Systems

- An Introduction to Developmental Genetics
- Genetic Engineering of Model Organisms
- Explant Culture for Developmental Studies
- An Introduction to Stem Cell Biology
- Induced Pluripotency
- An Introduction to Organogenesis
- An Introduction to Aging and Regeneration
- Tissue Regeneration with Somatic Stem Cells

GENETICS

Biological and Biochemical Foundations of Living Systems

- An Overview of Genetic Analysis
- Genetic Crosses
- Genetic Screens
- An Overview of Genetics and Disease
- SNP Genotyping
- Cytogenetics
- An Overview of Gene Expression
- An Overview of Epigenetics
- DNA Methylation Analysis
• Chromatin Immunoprecipitation
• Recombineering and Gene Targeting

CELL BIOLOGY
Biological and Biochemical Foundations of Living Systems
• An Introduction to Cell Division
• Cell Cycle Analysis
• An Introduction to Cell Motility and Migration
• An Introduction to Endocytosis and Exocytosis
• An Introduction to Cell Metabolism
• The ATP Bioluminescence Assay
• Detecting Reactive Oxygen Species
• An Introduction to Cell Death
• The TUNEL Assay

GENERAL CHEMISTRY
Chemical and Physical Foundations of Biological Systems
• Solutions and Concentrations
• Determining the Density of a Solid and Liquid
• Determining the Empirical Formula
• Determining the Solubility Rules of Ionic Compounds
• Using a pH Meter
• Introduction to Titration
• Ideal Gas Law
• Spectrophotometric Determination of an Equilibrium Constant
• Le Chatelier's Principal
• Freezing-Point Depression to Determine an Unknown Compound
• Determining Rate Laws and the Order of Reaction
• Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
• Coordination Chemistry Complexes

**ORGANIC CHEMISTRY**

*Chemical and Physical Foundations of Biological Systems*

• Introduction to Catalysis
• Assembly of a Reflux System for Heated Chemical Reactions
• Degassing Liquids with Freeze-Pump-Thaw Cycling
• Preparing Anhydrous Reagents and Equipment
• Purifying Compounds by Recrystallization
• Separation of Mixtures via Precipitation
• Solid-Liquid Extraction
• Fractional Distillation
• Growing Crystals for X-Ray Diffraction Analysis
• Performing 1D Thin Layer Chromatography
• Column Chromatography
ANALYTICAL CHEMISTRY

Biological and Physical Foundations of Biological Systems

- Sample Preparation for Analytical Characterization
- Ultraviolet-Visible (UV-Vis) Spectroscopy
- Gas Chromatography (GC) with Flame-Ionization Detection
- High-Performance Liquid Chromatography (HPLC)
- Ion-Exchange Chromatography
- Introduction to Mass Spectrometry

BIOCHEMISTRY

Biological and Biochemical Foundations of Living Systems

- Dialysis: Diffusion Based Separation
- Enzyme Assays and Kinetics
- Chromatography-Based Biomolecule Purification Methods
- Two-Dimensional Gel Electrophoresis
- Metabolic Labeling
- Electrophoretic Mobility Shift Assay (EMSA)
- Photometric Protein Determination
- Density Gradient Ultracentrifugation
- Reconstitution of Membrane Proteins
- Förster Resonance Energy Transfer (FRET)
PHYSICS I
Chemical and Physical Foundations of Biological Systems

- Newton's Laws of Motion
- Force and Acceleration
- Vectors in Multiple Directions
- Kinematics and Projectile Motion
- Newton's Law of Universal Gravitation
- Conservation of Momentum
- Friction
- Hooke's Law and Simple Harmonic Motion
- Equilibrium and Free-Body Diagrams
- Torque
- Rotational Inertia
- Angular Momentum
- Energy and Work
- Enthalpy
- Entropy

PHYSICS II
Chemical and Physical Foundations of Biological Systems

- Electric Fields
- Electric Potential
- Magnetic Fields
- Electric Charge in a Magnetic Field
- Ohm's Law
- Series and Parallel Resistors
- Capacitance
- Inductance
- Semiconductors
- Photoelectric Effect
- Reflection and Refraction
- Interference and Diffraction
- Standing Waves
- Sound Waves and Doppler Shifts

ENVIRONMENTAL MICROBIOLOGY

Biological and Biochemical Foundations of Living Systems

- Gram Staining of Bacteria from Environmental Sources
- Community DNA Extraction from Bacterial Colonies
- Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis
- RNA Analysis of Environmental Samples Using RT-PCR
- Quantifying Environmental Microorganisms and Viruses Using qPCR
- Water Quality Analysis via Indicator Organisms
- Detection of Bacteriophages in Environmental Samples
- Bacterial Growth Curve Analysis and its Environmental Applications
BEHAVIORAL SCIENCE
Psychological, Social, and Biological Foundations of Behavior

- An Introduction to Learning and Memory
- Fear Conditioning
- Spatial Memory Testing Using Mazes
- An Introduction to Cognition
- Electroencephalography
- Eye Tracking in Cognitive Experiments
- An Introduction to Motor Control
- Balance and Coordination Testing
- Assessing Dexterity with Reaching Tasks
- An Introduction to Reward and Addiction
- Positive Reinforcement Studies
- Self-Administration Studies
- An Introduction to Modeling Behavioral Disorders and Stress
- Modeling Social Stress
- Anxiety Testing

EXPERIMENTAL PSYCHOLOGY
Psychological, Social, and Biological Foundations of Behavior

- Ethics in Psychology Research
- Perspectives on Experimental Psychology
- Observational Research
• The Simple Experiment: Two-Group Design
• The Multi-Group Experiment
• Within-Subjects Repeated-Measures Design
• Realism in Experimentation
• Pilot Testing
• The Factorial Experiment
• Self-Reported vs. Behavioral Measures of Recycling
• Reliability in Psychology Experiments
• Placebos in Research
• Manipulating an Independent Variable through Embodiment
• Experimenting Using a Confederate

COGNITIVE PSYCHOLOGY
Psychological, Social, and Biological Foundations of Behavior

• Dichotic Listening
• Measuring Reaction Time and Donders' Method of Subtraction
• Perspective on Cognitive Psychology
• Visual Search for Features and Conjunctions
• Binocular Rivalry
• Multiple Object Tracking
• Approximate Number Sense Test
• Mental Rotation
• Prospect Theory
- Measuring Verbal Working Memory Span
- The Precision of Visual Working Memory with Delayed Estimation
- Verbal Priming
- Incidental Encoding
- Visual Statistical Learning
- Motor Learning in Mirror Drawing

DEVELOPMENTAL PSYCHOLOGY

Psychological, Social, and Biological Foundations of Behavior

- Habituation: Studying Infants Before They Can Talk
- Using Your Head: Measuring Infants' Rational Imitation of Actions
- The Rouge Test: Searching for a Sense of Self
- Numerical Cognition: More or Less
- Mutual Exclusivity: How Children Learn the Meanings of Words
- How Children Solve Problems Using Causal Reasoning
- Metacognitive Development: How Children Estimate Their Memory
- Executive Function and the Dimensional Change Card Sort Task
- Categories and Inductive Inferences
- The Costs and Benefits of Natural Pedagogy
• Piaget's Conservation Task and the Influence of Task Demands
• Children's Reliance on Artist Intentions When Identifying Pictures
• Measuring Children's Trust in Testimony
• How Praise Influences Children's Motivation
• Memory Development: Demonstrating How Repeated Questioning Leads to False Memories
What are Proteins?
- Protein Organization
- Protein Folding
- Macromolecules
- The Central Dogma
- What is Gene Expression?
- The DNA Helix
- DNA Packaging
- Organization of Genes
- Karyotyping
- Replication in Prokaryotes
- Replication in Eukaryotes
- Transcription
- Translation
- Ribosomes
- What are Nucleic Acids?
- Phosphodiester Linkages
- RNA Structure
- Types of RNA
- MicroRNAs
- RNA Splicing
- Proofreading
- Mismatch Repair
- Nucleotide Excision Repair
- Mutations

Epigenetic Regulation
- RNA Interference
- What is Metabolism?
- First Law of Thermodynamics
- Second Law of Thermodynamics
- Kinetic Energy
- Potential Energy
- Free Energy
- Activation Energy
- Induced-fit Model
- Hydrolysis of ATP
- Phosphorylation
- Feedback Inhibition
- What is Glycolysis?
- Energy-requiring Steps of Glycolysis
- Energy-releasing Steps of Glycolysis
- Pyruvate Oxidation
- The Citric Acid Cycle
- Electron Transport Chains
- Chemiosmosis
- Electron Carriers
- Fermentation
BIOLOGICAL AND BIOCHEMICAL FOUNDATIONS OF LIVING SYSTEMS

- Dietary Connections
- What are Cells?
- Cell Size
- Eukaryotic Compartmentalization
- What are Lipids?
- The Fluid Mosaic Model
- What is an Electrochemical Gradient?
- Diffusion
- Osmosis
- Tonicity in Animals
- Protein Associations
- Facilitated Transport
- Primary Active Transport
- Secondary Active Transport
- Receptor-mediated Endocytosis
- Pinocytosis
- Phagocytosis
- Exocytosis
- Contact-dependent Signaling
- The Nucleus
- Microtubules
- Mitochondria
- The Extracellular Matrix
- Tissues
- Prokaryotic Cells
- Bacterial Signaling
- Genomic DNA in Prokaryotes
- Binary Fission
- Replication in Prokaryotes
- Bacterial Transformation
- What are Viruses?
- Viral Structure
- Lytic Cycle of Bacteriophages
- Lysogenic Cycle of Bacteriophages
- Retrovirus Life Cycles
- Viral Recombination
- Viral Mutations
- Mitosis and Cytokinesis
- What is the Cell Cycle?
- Interphase
- Positive Regulator Molecules
- Negative Regulator Molecules
- Intracellular Signaling Cascades
- Spermatogenesis
- Oogenesis
- Fertilization
- Cleavage and Blastulation
- Gastrulation
- Neurulation
- Cell Migration
- Determination
BIOLOGICAL AND BIOCHEMICAL FOUNDATIONS OF LIVING SYSTEMS

- Induced Pluripotent Stem Cells
- Embryonic Stem Cells
- What is a Nervous System?
- The Sympathetic Nervous System
- The Parasympathetic Nervous System
- Neuron Structure
- Glial Cells
- Action Potentials
- The Resting Membrane Potential
- Long-term Potentiation
- Long-term Depression
- Ion Channels
- G-protein Coupled Receptors
- Synaptic Signaling
- Enzyme-linked Receptors
- What is the Endocrine System?
- Intracellular Hormone Receptors
- Cell-surface Signaling
- Feedback Loops
- Hypothalamic-Pituitary Axis
- Paracrine Signaling
- Endocrine Signaling

- What are Second Messengers?
- Intracellular Signaling Cascades
- The Respiratory System
- Breathing
- Lung Capacity
- Gas Exchange and Transport
- Anatomy of the Circulatory System
- Anatomy of the Heart
- The Cardiac Cycle
- Blood Flow
- Physiology of the Circulatory System
- What is the Immune System?
- Cell-mediated Immune Responses
- Humoral Immune Responses
- Antibody Structure
- Affinity and Avidity
- Cross-reactivity
- Allergic Reactions
- Inflammation
- Vaccinations
- What is Monogastric Digestion?
- Anatomy of the Intestines
- Accessory Organs
- Lipid Digestion
- Protein Digestion
BIOLICAL AND BIOCHEMICAL FOUNDATIONS OF LIVING SYSTEMS

- Carbohydrate Digestion
- Neural Regulation
- Hormonal Regulation
- Kidney Structure
- Filtration
- Urea Cycle
- Hormonal Regulation
- Spermatogenesis
- Fertilization
- Skeletal Muscle Anatomy
- Muscle Contraction
- Classification of Skeletal Muscle Fibers
- Cross-bridge Cycle
- Motor Units
- What is the Skeletal System?
- Bone Structure
- Joints
- Bone Remodeling
- Somatosensation

SCIENTIFIC INQUIRY AND REASONING SKILLS

- Thermosensation
- Levels of Organization
- Taxonomy
- Phylogeny
- Inductive Reasoning
- Deductive Reasoning
- Correlation and Causation
- The Scientific Method
PSYCHOLOGICAL, SOCIAL, AND BIOLOGICAL FOUNDATIONS OF BEHAVIOR

- What is a Sensory System?
- The Tongue and Taste Buds
- Gustation
- Olfaction
- Hearing
- Hair Cells
- The Cochlea
- The Vestibular System
- The Retina
- Somatosensation
- Thermosensation

CHEMICAL AND PHYSICAL FOUNDATIONS OF BIOLOGICAL SYSTEMS

- The Periodic Table and Organismal Elements
- Atomic Structure
- Electron Behavior
- Electron Orbital Model
- Molecules and Compounds
- Molecular Shapes
- Carbon Skeletons
- Covalent Bonds
- Ionic Bonds
- Hydrogen Bonds
- Van der Waals Interactions
- pH
- Solvents
- Specific Heat
- Vaporization
- What are Proteins?
- Protein Organization
- Protein Folding
- What are Carbohydrates?
CHEMICAL AND PHYSICAL FOUNDATIONS OF BIOLOGICAL SYSTEMS

- What are Lipids?
- What are Nucleic Acids?
- Cohesion
- States of Water
- Blood Flow
- Gas Exchange and Transport
- Lung Capacity
- Physiology of the Circulatory System
- Diffusion and Osmosis
- Diffusion
- Osmosis
- Cellular Respiration
- Chemical Reactions
- Redox Reactions
- Isotopes
- What is an Electrochemical Gradient?

- Electron Transport Chains
- What is a Sensory System?
- Hearing
- Hair Cells
- The Retina
- Vision
- The Periodic Table and Organismal Elements
- Adhesion
- Electron Carriers
- Glial Cells
- Action Potentials
- The Resting Membrane Potential
- Long-term Potentiation
- Long-term Depression
- Energy-requiring Steps of Glycolysis
JoVE Journal Relevant Videos

- *Synthesis of Monocyte-Targeting Peptide Amphiphile Micelles for Imaging of Atherosclerosis* - keyword - Hydrophobic/Hydrophilic Amino Acids - Biological and Physical Foundations of Biological Systems
- *Protein WISDOM: A Workbench for In Silico De novo Design of BioMolecules* - keyword - Hydrophobic/Hydrophilic Amino Acids - Biological and Physical Foundations of Biological Systems
- *A Protocol for Computer-Based Protein Structure and Function Prediction* - keyword - Protein Structure - Biological and Physical Foundations of Biological Systems
- *Mass Spectrometric Approaches to Study Protein Structure and Interactions in Lyophilized Powders* - keyword - Protein Structure - Biological and Physical Foundations of Biological Systems
- **Capillary Electrophoresis Separation of Monoclonal Antibody Isoforms Using a Neutral Capillary** - keyword - Isoelectric Point Protein Separation - Biological and Physical Foundations of Biological Systems
- **Highly Sensitive and Quantitative Detection of Proteins and their Isoforms by Capillary Isoelectric Focusing Method** - keyword - Isoelectric Point Protein Separation - Biological and Physical Foundation of Biological Systems
- **Total Protein Extraction and 2-D Gel Electrophoresis Methods for Burkholderia Species** - keyword - Isoelectric Point Protein Separation - Biological and Physical Foundations of Biological Systems
- **Electrophoretic Separation of Proteins** - keyword - Electrophoresis Protein Separation - Biological and Physical Foundations of Biological Systems
- **A Novel Saturation Mutagenesis Approach: Single Step Characterization of Regulatory Protein Binding Sites in RNA Using Phosphorothioates** - keyword - Protein Binding - Biological and Physical Foundations of Biological Systems
- **Dissipative Microgravimetry to Study the Binding Dynamics of the Phospholipid Binding Protein Annexin A2 to Solid-Supported Lipid Bilayers using a Quartz Resonator** - keyword - Protein Binding - Biological and Physical Foundations of Biological Systems
- **Profiling of Methyltransferases and Other S-Adenosyl-L-Homocysteine-binding Proteins by Capture Compound Mass Spectrometry** - keyword - Protein Binding - Biological and Physical Foundations of Biological Systems
- **Measuring Protein Binding to F-actin by Co-sedimentation** - keyword - **Protein Binding** - Biological and Physical Foundations of Biological Systems

- **DNA Polymerase Activity Assay Using Near-Infrared Fluorescent Labeled DNA Visualized by Acrylamide Gel Electrophoresis** - keyword - **Michaelis-Menten Kinetics** - Biological and Physical Foundations of Biological Systems

- **An Optimized Hemagglutination Inhibition (HI) Assay to Quantify Influenza-Specific Antibody Titers** - keyword - **Enzyme Inhibition Assay** - Biological and Physical Foundations of Biological Systems

- **Visualization of Mitochondrial DNA Replication to Individual Cells by EdU Signal Amplification** - keyword - **DNA Replication** - Chemical and Physical Foundations of Biological Systems

- **Profiling DNA Replication Timing Using Zebrafish as an In Vivo Model System** - keyword - **DNA Replication** - Chemical and Physical Foundations of Biological Systems

- **Direct Observation of Enzymes Replicating DNA Using a Single-Molecule DNA Stretching Assay** - keyword - **DNA Replication** - Chemical and Physical Foundations of Biological Systems

- **Application of Stopped-Flow Kinetics Methods to Investigate the Mechanism of Action of a DNA Repair Protein** - keyword - **DNA Repair** - Chemical and Physical Foundations of Biological Systems

- **Genetics Studies of Human DNA Repair Proteins Using Yeast as a Model System** - keyword - **DNA Repair** - Chemical and Physical Foundations of Biological Systems