

Next Step MCAT Outline

The following outline details all of the information you need to know for the MCAT. You will see each topic listed under a “Concept Category” with code like 2C or 5E. The AAMC has organized the MCAT content around general concepts that cut across disciplinary boundaries. To make the material more manageable for you, we have sorted the content into the seven MCAT sciences: biology, chemistry, biochemistry, organic chemistry, physics, psychology, and sociology.

You will see certain topics listed more than once under multiple sciences. For example, amino acids are listed in both the biochemistry and biology sections. When a topic can be covered under multiple sciences, you may get questions that ask about that topic as it’s normally taught in a biochemistry class, or as it’s normally taught in a biology class.

Biology

Biological and Biochemical Foundations of Living Systems

1A: Proteins

- A. Structure
 - a. Protein Structure: Primary, Secondary, Tertiary, Quaternary
 - b. Protein Stability: Folding, Denaturing, Hydrophobic interactions
 - c. Separation Techniques: Isoelectric Point, Electrophoresis
- B. Protein Function: Immune System, Motors
- C. Enzymes
 - a. Catalysts: Reduction of Activation Energy, Cofactors, Coenzymes
 - b. Classification
 - c. Substrate interactions: Active Site, Induced Fit
 - d. Vitamins
 - e. Effects on Enzyme Activity: pH, temperature, etc.
- D. Enzyme Control
 - a. Kinetics: Michaelis-Menten, Cooperativity
 - b. Feedback
 - c. Inhibition: Competitive, Non-competitive
 - d. Regulatory Enzymes: Allosteric enzymes, Zymogens, Covalently-modified enzymes

1B: Molecular Genetics

- A. Nucleic Acids
 - a. Structure, Function
 - b. Nucleotides, Nucleosides: Sugar-Phosphate Backbone, Purines, Pyrimidines
 - c. Watson-Crick Model: Double-Helix, Base-Pair Specificity
 - d. Transmission of genetic information
 - e. Denaturation, Reannealing, Hybridization
- B. DNA Replication and Repair
 - a. Replication Mechanism: Semi-Conservative, Enzymes, Replication Origin
 - b. Replicating the ends of DNA
 - c. Repair: During Replication, Mutation Repair
- C. Genetic Code
 - a. Triplets: Codon-Anticodon, Degeneracy, Wobble Pairing, Missense, Nonsense, Initiation, Termination
 - b. Transcription
 - i. tRNA, mRNA, rRNA, snRNPs, snRNAs

- ii. introns, exons
- c. Translation
 - i. mRNA, tRNA, rRNA
 - ii. ribosomes, initiation, termination co-factors
 - iii. post-translational processing
- D. Chromosomes: Proteins, Repetitive DNA, Supercoiling, Heterochromatin, Euchromatin, Telomeres, Centromeres
- E. Gene Expression
 - a. Prokaryotes: Operons, Jacob-Monod Model, Repression, Positive Control
 - b. Eukaryotes
 - i. transcriptional regulation, DNA binding proteins, transcription factors
 - ii. gene amplification, duplication
 - iii. post-transcriptional control, introns, exons
 - iv. cancer
 - v. regulation of chromatic structure: methylation
 - vi. non-coding RNAs
- F. Biotechnology: Cloning, Restriction Enzymes, cDNA, Hybridization, PCR, Blotting, Electrophoresis, Stem Cells, Applications, Ethics

1C: Classical Genetics

- A. Mendelian Genetics: Phenotype, Genotype, Gene, Locus, Allele, Zygosity, Wild-type, Recessive, Dominant, Co-dominant, Incomplete Dominance, Leakage, Penetrance, Expressivity, Hybridization, Gene Pool
- B. Meiosis and Variability
 - a. Significance, Differences with Mitosis
 - b. Gene Segregation: Independent Assortment, Linkage, Recombination
 - c. Sex-Linkage, Y Chromosome, Sex Determination
 - d. Extranuclear Inheritance
 - e. Mutation: Types, Effects, Errors of Metabolism, Mutagens and Carcinogens
 - f. Genetic Drift
 - g. Crossing-over
- C. Analysis: Hardy-Weinberg, Test Cross, Crossover Frequency, Biometry
- D. Evolution
 - a. Natural Selection: Fitness, Differential Reproduction, Group Selection
 - b. Speciation: Polymorphism, Adaptation, Inbreeding, Outbreeding, Bottlenecks
 - c. Time as gradual random changes in genome

1D: Metabolism

- A. Glycolysis
 - a. Aerobic: Substrates and Products
 - b. Anaerobic: Fermentation
 - c. Net Results
- B. Regulation of Pathways
- C. Krebs Cycle: Reactions, Substrates, Products, Regulation
- D. Metabolism of Fat and Protein
 - a. Fats: Digestion, Transport
 - b. Fatty Acids: Oxidation, Saturated Fats, Unsaturated Fats
 - c. Proteins: Metabolism
 - d. Anabolism: Synthesis of Lipids and Polysaccharides
- E. Oxidative Phosphorylation
 - a. Electron Transport Chain: Substrates, Products, Function
 - b. NADH, NADPH, Flavoproteins, Cytochromes
 - c. ATP Synthase, Chemiosmosis

- d. Net Results
- e. Regulation

2A: Cell Biology

- A. Plasma Membrane
 - a. Composition: Phospholipids, Steroids, Waxes, Proteins
 - i. Receptors
 - b. Solute transport: Thermodynamics, Osmosis, Passive, Active, Na/K Pump, Channels
 - c. Membrane Potential
 - d. Exocytosis, Endocytosis
 - e. Gap Junctions, Tight Junctions, Desmosomes
- B. Membrane-Bound Organelles
 - a. Nucleus: Genetic Information, Nucleolus, Nuclear Envelope, Pores
 - b. Mitochondria: Function, Membranes, Replication
 - c. Lysosomes: Function
 - d. ER: Rough vs. Smooth, Double Membrane, Biosynthesis
 - e. Golgi: Structure and Function
 - f. Peroxisomes: Function
- C. Cytoskeleton: Microfilaments, Microtubules, Intermediate Filaments, Cilia, Flagella, Centrioles, Microtubule Organizing Centers
- D. Epithelial and Connective Cells

2B: Microbiology

- A. Cell Theory: History, Development, Impact
- B. Prokaryotes
 - a. Archaea, Bacteria, Bacilli, Spirilli, Cocci
 - b. Lack of Eukaryotic Features
 - c. Cell Wall, Flagella
 - d. Fission, Exponential Growth
 - e. Quick Adaptation, Antibiotic Resistance
 - f. Types: Aerobic, Anaerobic, Parasitic, Symbiotic
 - g. Chemotaxis
 - h. Genetics: Plasmids, Transformation, Conjugation, Transposons
- C. Viruses
 - a. Structure, Size, Lack of Organelles
 - b. Bacteriophages
 - c. Genome: DNA, RNA
 - d. Life Cycle: Intracellular Reproduction, Attachment, Replication, Release
 - e. Transduction
 - f. Retroviruses
 - g. Prions, Viroids

2C: Cell Division, Cell Development, Reproduction, Embryology

- A. Mitosis: Phases, Structures, Growth Arrest, Control and Loss of Control
- B. Reproduction
 - a. Gametogenesis, Meiosis
 - b. Ovum, Sperm: Formation, Morphology, Contribution to Zygote
 - c. Sequence: Fertilization to Birth
- C. Embryogenesis
 - a. Stages: Fertilization, Cleavage, Blastula, Gastrula, Cell Movements, Neurulation
 - b. Germ Layers: Endoderm, Mesoderm, Ectoderm
 - c. Neural Crest

- d. Environmental Effects
- D. Cell Development
 - a. Specialization: Determination, Differentiation, Tissue Types, Cell communication
 - b. Cell Migration
 - c. Stem Cells
 - d. Gene Regulation
 - e. Apoptosis
 - f. Regeneration, Senescence, Aging

3A: Nervous and Endocrine Systems

- A. Nerve Cell
 - a. Structures: Soma, Dendrites, Axon, Myelin, Nodes of Ranvier
 - b. Synapse: Structure, Neurotransmitters
 - c. Resting Potential, Action Potential
 - d. Excitatory, Inhibitory Fibers, Summation, Firing Frequency
 - e. Glia, Neuroglia
- B. Nervous System
 - a. Function, Organization
 - b. Efferent, Afferent
 - c. Sympathetic, Parasympathetic
 - d. Reflexes: Reflex Arc, Spinal Cord, Supraspinal Circuits
 - e. Endocrine System Integration
- C. Endocrine System
 - a. Function, Major Glands, Major Hormones
 - b. Mechanism of Hormone Action
 - c. Transport of Hormones and Second Messengers

3B: Physiology

- A. Respiratory System: Structure, Function, Thermoregulation, Henry's Law, pH control, Regulation
- B. Circulatory System
 - a. Structures, Functions, Regulation
 - b. Heart: Chambers
 - c. Systolic, Diastolic Pressure
 - d. Pulmonary, System Circulations
 - e. Arteries, Veins, Capillaries
 - f. Blood Composition: Plasma, Cells, Chemicals
 - g. Clotting
 - h. Gas Transport: Oxygen, Carbon Dioxide, Hemoglobin, Hematocrit
 - i. Lymphatic System: Structures, Functions
- C. Immune System
 - a. Innate: Macrophages, Phagocytes
 - b. Adaptive: T-cells, B-cells
 - c. Tissues: Marrow, Spleen, Thymus, Lymph Nodes
 - d. Antigens, Antibodies: Ag Presentation, Ag-Ab Recognition, Structure of Ab
 - e. Autoimmune Diseases
 - f. Major Histocompatibility Complex
- D. Digestive System
 - a. Ingestion, Peristalsis
 - b. Organs: Stomach, Liver, Gall Bladder, Pancreas, Small Intestine, Large Intestine
 - c. Control: Muscular, Endocrine, Nervous
- E. Excretory System
 - a. Homeostasis: bp, osmoregulation, acid balance, nitrogenous waste

- b. Kidney: Cortex, Medulla
 - c. Nephron: Glomerulus, Bowman's Capsule, Tubules, Loop of Henle, Collecting Duct
 - i. filtration, counter-current multiplier, secretion, reabsorption, concentration
 - d. Storage: ureter, bladder, urethra
- F. Reproductive System: Gonads, Genitals, Sexual Development, Menstrual Cycle, Pregnancy, Lactation
- G. Muscle System
 - a. Function: Mobility, Circulatory Assistance, Thermoregulation, Shivering
 - b. Smooth, Striated, Cardiac
 - c. Muscle Structure: T-tubule, Contractile Apparatus, Sarcoplasmic Reticulum, Contractile Velocity
 - d. Cardiac Muscle: Regulation
 - e. Oxygen Debt
 - f. Control: Motor Neurons, Neuromuscular Junction, Motor End Plates, Sympathetic and Parasympathetic, Voluntary, Involuntary
 - g. Sarcomeres
 - h. Troponin, Tropomyosin
- H. Skeletal System
 - a. Function: Support, Protection, Calcium Storage
 - b. Bone Types, Joint Types
 - c. Composition of Bone Matrix and Cells
 - d. Cartilage, Ligaments, Tendons
 - e. Endocrine Regulation
- I. Skin System
 - a. Structure: Layers, Cell Types, Impermeability to Water
 - b. Function: Homeostasis, Osmoregulation, Thermoregulation, Physical Protection
 - c. Hormonal Control

Chemical and Physical Foundations of Biological Systems

4B: Fluids

- A. Circulatory System: Pressure and Flow in Arteries and Veins

4C: Electrochemistry and Circuits

- A. Nerve Cell Propagation: Myelin, Schwann Cells, Insulation, Nodes of Ranvier

5D: Biological Molecules

- A. Nucleotides and Nucleosides: Composition, Purines, Pyrimidines, DNA, Double-Helix

5E: Thermodynamics and Kinetics

- A. Enzymes
 - a. Reaction Types
 - b. Mechanisms: Active Site, Induced-fit, Cofactors, Coenzymes, Vitamins
 - c. Kinetics: Catalysis, Michaelis-Menten, Cooperativity, Environmental Effects
 - d. Inhibition and Regulation

Psychological, Social, and Biological Foundations of Behavior

6A: Sensation

- A. Sensory Processing: Thresholds, Adaptation, Pathways, Receptor Types

- B. Vision
 - a. The Eye: Structure and Function
 - b. Visual Processing: Brain Pathways
- C. Hearing
 - a. The Ear: Structure and Function, Hair Cells
 - b. Auditory Processing: Brain Pathways
- D. Other Senses
 - a. Somatosensation, Nociception
 - b. Taste, Smell: Pheromones
 - c. Vestibular Sense

6B: Cognition, Consciousness, and Memory

- A. Biological Factors Affecting Cognition
- B. Alertness
- C. Sleep and Circadian Rhythms
- D. Emotional Effect on Memory Retrieval
- E. Memory: Changes in Synaptic Connections, Neural Plasticity, Long-Term Potentiation
- F. Language: Brain Areas of Language and Speech

Emotion and Stress

- A. Biological Factors in Perceiving Emotion
- B. Physiological Response to Stress

7A: Behavior

- A. Biological Basis of Behavior
 - a. Nervous System: Neurons, Neurotransmitters
 - i. central and peripheral nervous systems
 - ii. brain: forebrain, midbrain, hindbrain, lateralization, methods of study
 - iii. spinal cord
 - b. Endocrine System: Components, Effects on Behavior
 - c. Genetics: Temperament and Heredity, Adaptive Value of Behaviors
 - i. Regulatory Genes and Behavior
 - ii. Behavior Variation Between Populations
- B. Disorders: Schizophrenia, Depression, Alzheimer's, Parkinson's, Stem-Cell Therapy
- C. Motivation: Biological Drives

7C: Learning

- A. Classical Conditioning: Conditioned and Unconditioned Response, Processes
- B. Operant Conditioning
 - a. Shaping, Extinction
 - b. Reinforcement Schedules and Types
 - c. Punishment, Escape, Avoidance
- C. Biological Effects on Associative Learning

8C: Social Interaction

- A. Animal Signals and Communication
- B. Social Behavior in Animals: Foraging, Mating, Game Theory, Altruism, Inclusive Fitness

Biochemistry

Biological and Biochemical Foundations of Living Systems

1A: Proteins

- A. Amino Acids: configuration, dipolar ions, acidic/basic, hydrophobic/hydrophilic
- B. Structure
 - a. Protein Structure: Primary, Secondary, Tertiary, Quaternary
 - b. Protein Stability: Folding, Denaturing, Hydrophobic interactions, Solvation and Entropy
 - c. Separation Techniques: Isoelectric Point, Electrophoresis
- C. Protein Function: Immune System, Motors
- D. Enzymes
 - a. Catalysts: Reduction of Activation Energy, Cofactors, Coenzymes
 - b. Classification
 - c. Substrate interactions: Active Site, Induced Fit
 - d. Vitamins
 - e. Effects on Enzyme Activity: pH, temperature, etc.
- E. Enzyme Control
 - a. Kinetics: Michaelis-Menten, Cooperativity
 - b. Feedback
 - c. Inhibition: Competitive, Non-competitive, Mixed, Uncompetitive
 - d. Regulatory Enzymes: Allosteric enzymes, Zymogens, Covalently-modified enzymes

1B: Molecular Genetics

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 - a. Structure, Function
 - b. Nucleotides, Nucleosides: Sugar-Phosphate Backbone, Purines, Pyrimidines
 - c. Watson-Crick Model: Double-Helix, Base-Pair Specificity
 - d. Denaturation, Reannealing, Hybridization

1D: Metabolism

- A. Bioenergetics
 - a. Thermodynamics/Bioenergetics: ΔG , K_{eq} , Concentrations, Spontaneity
 - b. Phosphoryl Groups: ATP Hydrolysis, Group Transfers
 - c. Redox: Half-Reactions, Soluble Electron Carriers, Flavoproteins
- B. Carbohydrates: Classification, Configuration, Hydrolysis of Glycosides, Monomers and Polymers
- C. Glycolysis and Gluconeogenesis
 - a. Aerobic: Substrates and Products
 - b. Anaerobic: Fermentation
 - c. Net Results
 - d. Gluconeogenesis and Pentose Phosphate Pathway
- D. Regulation of Pathways
 - a. Regulation of Glycolysis and Gluconeogenesis
 - b. Glycogen Synthesis and Breakdown, Regulation
 - c. Analysis of Metabolic Regulation
- E. Krebs Cycle: Acetyl CoA Production, Reactions, Substrates, Products, Regulation
- F. Metabolism of Fat and Protein
 - a. Fats: Digestion, Transport
 - b. Fatty Acids: Oxidation, Saturated Fats, Unsaturated Fats, Ketone Bodies

- G. Oxidative Phosphorylation
 - a. Electron Transport Chain: Substrates, Products, Function
 - b. NADH, NADPH, Flavoproteins, Cytochromes
 - c. ATP Synthase, Chemiosmosis
 - d. Net Results
 - e. Regulation
 - f. Mitochondria: Apoptosis, Oxidative Stress
- H. Hormonal Regulation: High Level Integration, Tissue Specific Metabolism, Obesity

2A: Cell Biology

- A. Plasma Membrane
 - a. Composition: Phospholipids, Steroids, Waxes, Proteins
 - i. Receptors
 - b. Solute transport: Thermodynamics, Osmosis, Passive, Active, Na/K Pump, Channels
 - c. Membrane Potential
 - d. Exocytosis, Endocytosis

3A: Nervous and Endocrine Systems

- A. Biosignalling: Gated Ion Channels, Voltage and Ligand Gated, Receptor Enzymes, G protein-coupled receptors
- B. Lipids: Structure, Steroids, Terpenes, Terpenoids

Chemical and Physical Foundations of Biological Systems

5A: Solution Chemistry and Acid/Base

- A. Brønsted-Lowry Definitions, Auto-Ionization of Water, Conjugates
- B. Weak Acids/Bases: Salts, pH Calculations
- C. Constants: K_a , K_b , K_w
- D. Buffers: Common Systems, Titration Curves
- E. Ions: Common Names and Charges, Hydration and Hydronium

5C: Separation and Purifications

- A. Extraction
- B. Distillation
- C. Chromatography: Column, HPLC, Paper, TLC
- D. Peptides: Electrophoresis, Quantitative Analysis, Size-Exclusion, Ion-Exchange, Affinity

5D: Biological Molecules

- A. Nucleotides and Nucleosides: Composition, Purines, Pyrimidines, DNA, Double-Helix, Chemistry, Other Functions
- B. Amino Acids and Peptides
 - a. Amino Acids: Configuration, Dipolar, Acid/Base, Hydrophobic/Hydrophilic
 - b. Peptides: Sulfur Linkage, Polypeptides, 1^o - 4^o Structure, Isoelectric Point
- C. 3D Protein Structure: Conformational Stability, Hydrophobic Interactions, Solvation and Entropy, 4^o Structure, Folding and Denaturing
- D. Non-Enzymatic Protein Function: Binding, Immunoglobulins, Motors
- E. Lipids: Storage, Triacyl Glycerols, Saponification, Phospholipids, Phosphatids, Sphingolipids, Waxes, Fat-Soluble Vitamins, Steroids, Prostaglandins
- F. Cyclic Molecules: Phenols, Hydroquinones, Ubiquinones, 2e⁻ Redox Centers, Aromatic Heterocycles

5E: Thermodynamics and Kinetics

- A. Enzymes
 - a. Reaction Types
 - b. Mechanisms: Active Site, Induced-fit, Cofactors, Coenzymes, Vitamins
 - c. Kinetics: Catalysis, Michaelis-Menten, Cooperativity, Environmental Effects
 - d. Inhibition and Regulation
- B. Bioenergetics: ΔG , K_{eq} , Phosphorylation, ATP, ATP Group Transfers, Redox, Soluble Electron Carriers, Flavoproteins

Chemistry

Biological and Biochemical Foundations of Living Systems

1D: Metabolism

- A. Bioenergetics
 - a. ΔG , K_{eq}
 - b. Concentration, Le Chatelier's Principle
 - c. Exo- and Endo-thermic, Spontaneity
 - d. ATP hydrolysis, $\Delta G < 0$
 - e. Redox: Half-reactions, Soluble Electron Carriers, Flavoproteins

2A: Cell Biology

- A. Plasma Membrane: Osmosis, Osmotic Pressure, Colligative Properties

3A: Nervous and Endocrine Systems

- A. Electrochemistry: Concentration cell, direction of flow, Nernst Equation

3B: Physiology

- A. Respiratory System: Henry's Law

Chemical and Physical Foundations of Biological Systems

4B: Gas Phase

- A. Absolute Temp, Kelvin Scale, Pressure, Mercury Barometers, 22.4 L/mol @ STP
- B. Ideal Gas: Ideal Gas Law, Boyle's Law, Charles's Law, Avogadro's Law
- C. Kinetic Molecular Theory of Gases
- D. Real Gases: Qualitative, Quantitative, Van der Waals's Equation
- E. Partial Pressure, Mole Fraction, Dalton's Law

4C: Electrochemistry and Circuits

- A. Electrochemistry
 - a. Electrolytic Cell: Electrolysis, Anodes and Cathodes, Electrolytes, Faraday's Law, Electron Flow
 - b. Galvanic Cells: Half-reactions, Potential, Electron Flow
 - c. Concentration Cell
 - d. Batteries: EMF, Voltage, Lead-Storage, Nickel-Cadmium

4E: Atomic Nucleus, Periodic Table, Stoichiometry

- A. Atomic Nuclei: Atomic Number and Weight, Nucleons, Nuclear Forces, Radioactive Decay, Mass Spectrometer
- B. Electronic Structure
 - a. Hydrogen Atoms, Bohr Model, Effective Nuclear Charge
 - b. Quantum Numbers
 - c. Ground vs. Excited States
 - d. Pauli Exclusion Principle
 - e. Paramagnetic and Diamagnetic Elements

- f. Photoelectric Effect
 - g. Heisenberg Uncertainty Principle
- C. The Periodic Table
 - a. Alkali Metals, Alkaline Earth Metals, Halogens, Noble Gases, Transition Metals
 - b. Representative Elements
 - c. Metals and Non-Metals
 - d. Oxygen Group
 - e. Valence Electrons
 - f. Ionization Energy, Electron Affinity, Electronegativity, Atomic and Ionic Radius
- D. Stoichiometry: Molecular Weight, Molecular and Empirical Formula, Metric Units, Percent Mass, Avogadro's Number, Density, Oxidation, Disproportionation Reactions, Chemical Equations, Yields, Limiting Reagents

5A: Solutions and Acid/Base

- A. Acid/Base
 - a. Brønsted-Lowry, Auto-ionization of Water, Conjugate Acids and Bases
 - b. Strong Acids, Weak Acids
 - c. Weak Acids: Dissociation, Salts, Hydrolysis, pH Calculations
 - d. K_a , K_b , K_w
 - e. Buffers: Concepts, Titration Curves
- B. Ions and Solutions
 - a. Anions, Cations, Familiar Ions, Hydration, Hydronium, Units of Concentration, K_{sp} , Common-Ion Effect, Complex Ions
- C. Titration: Indicators, Neutralization, Titration Curves, Redox Titration

5B: Covalent Bonds

- A. Lewis Dot Formulas: Resonance, Formal Charge, Lewis Acids and Bases
- B. Partial Ionic Bonds: Electronegativity, Dipole Moment
- C. Sigma and Pi Bonds
 - a. Hybrid Orbitals, VSEPR, Resonance
 - b. Structural Formulas involving H, C, N, O, F, S, P, Si, Cl
- D. Double and Triple Bonds: Bond Length, Bond Energy, Rigidity
- E. Liquids: Intermolecular Forces, H-bonding, Dipoles, Van der Waals, London Dispersion

5E: Thermodynamics and Kinetics

- A. Thermochemistry and Thermodynamics
 - a. Zeroth Law, First and Second Laws
 - b. PV Diagrams: Work
 - c. Entropy: Disorder, Phases
 - d. Calorimetry: Heat Capacity, Specific Heat
 - e. Conduction, Convection, Radiation
 - f. Hess's Law, Enthalpy, Bond Dissociation Energy
 - g. Free Energy, Spontaneity
 - h. Phase Changes: Phase Diagram, Heat of Fusion and Vaporization
- B. Kinetics and Equilibrium
 - a. Rate Law, Rate Constants, Reaction Order, Rate-Determining Step
 - b. Temperature and Rate: Activation Energy, Transition State, Reaction Profiles, Arrhenius Equation
 - c. Kinetic vs. Thermodynamic Control
 - d. Catalysts
 - e. Reversible Reactions: Law of Mass Action, K_{eq} and ΔG , Le Chatelier's Principle

Organic Chemistry

Biological and Biochemical Foundations of Living Systems

1A: Proteins

- A. Amino Acids: configuration, dipolar ions, acidic/basic, hydrophobic/hydrophilic
- B. Structure
 - a. Protein Structure: Primary, Secondary, Tertiary, Quaternary
 - b. Protein Stability: Folding, Denaturing, Hydrophobic interactions, Solvation and Entropy
 - c. Separation Techniques: Isoelectric Point, Electrophoresis

1D: Metabolism

- A. Carbohydrates: Classification, Configuration, Hydrolysis of Glycosides, Monomers and Polymers

2A: Cell Biology

- A. Plasma Membrane: Composition: Phospholipids, Steroids, Waxes, Proteins

3A: Nervous and Endocrine Systems

- A. Lipids: Structure, Steroids, Terpenes, Terpenoids

Chemical and Physical Foundations of Biological Systems

4D: Light and Sound

- A. Molecular Structure and Absorption Spectra
 - a. IR, UV-Vis, Proton NMR

5C: Separation and Purifications

- A. Extraction
- B. Distillation
- C. Chromatography: Column, HPLC, Paper, TLC
- D. Peptides: Electrophoresis, Quantitative Analysis, Size-Exclusion, Ion-Exchange, Affinity
- E. Racemic Mixtures, Separation of Enantiomers

5D: Biological Molecules

- A. Amino Acids and Peptides
 - a. Amino Acids: Configuration, Dipolar, Acid/Base, Hydrophobic/Hydrophilic
 - b. Peptides: Sulfur Linkage, Polypeptides, 1^o - 4^o Structure, Isoelectric Point
- B. Lipids: Storage, Triacyl Glycerols, Saponification, Phospholipids, Phosphatids, Sphingolipids, Waxes, Fat-Soluble Vitamins, Steroids, Prostaglandins
- C. Carbohydrates: Classification, Configuration, Cyclic Conformation
 - a. Hydrolysis of Glycosides
 - b. Keto-Enol Tautomers
- D. Carbonyl Compounds
 - a. Nomenclature and Physical Properties of Aldehydes and Ketones

- b. Nucleophilic Addition to Carbonyl Carbon: Acetal, Ketal, Imine, Enamine, Hydrides, Cyanohydrin
 - c. Oxidation of Aldehydes
 - d. Enolates: Tautomerism, Aldol Condensation, Retro-Aldol, Kinetic and Thermodynamic Enolate
 - e. Steric Hindrance of Carbonyl Bond
 - f. Acidity of α hydrogens, Carbanions
- E. Alcohols
 - a. Nomenclature, Physical Properties
 - b. Reactions: Oxidation, S_N1 , S_N2 , Protection, Mesylates, Tosylates
- F. Carboxylic Acids
 - a. Nomenclature, Physical Properties
 - b. Reactions: Amides, Lactam, Esters, Lactones, Anhydrides, Reduction, Decarboxylation, Nucleophilic Acyl Substitution
- G. Carboxylic Acid Derivatives
 - a. Nomenclature, Physical Properties
 - b. Reactions: Nucleophilic Substitution, Transesterification, Amide Hydrolysis
 - c. Reactivity, Steric Effects, Electronic Effects, Strain, β lactams
- H. Cyclic Molecules: Phenols, Hydroquinones, Ubiquinones, $2e^-$ Redox Centers, Aromatic Heterocycles

Physics

Chemical and Physical Foundations of Biological Systems

4A: Kinematics

- A. Translational Motion: Units, Vectors, Velocity, Acceleration
- B. Force: Newton's Laws, Friction, Center of Mass
- C. Equilibrium: Vector Analysis, Torque
- D. Work: Mechanical Advantage, Work Energy Theorem, Conservative Forces
- E. Energy: Kinetic, Potential (Gravity, Spring), Conservation, Power, Units
- F. Periodic Motion
 - a. Amplitude, Frequency, Phase
 - b. Transverse and Longitudinal Waves: Wavelength, Speed

4B: Fluids

- A. Liquids: Density, Specific Gravity, Buoyancy, Pressure, Viscosity, Continuity, Turbulence, Surface Tension, Bernoulli's Equation, Venturi Effect, Pitot Tube
- B. Gas Phase
 - a. Temperature in Kelvin, Pressure and Barometer
 - b. Ideal Gases: Boyle's Law, Charles's Law, Avogadro's Law
 - c. Kinetic Molecular Theory: Heat Capacity, Boltzmann's Constant
 - d. Real Gases: Qualitative and Quantitative
 - e. Partial Pressure, Dalton's Law

4C: Electrostatics and Circuits

- A. Electrostatics: Charge, Conservation, Coulomb's Law
 - a. Electric Field: Field Lines, Charge Distribution
 - b. Electrostatic Energy, Potential
- B. Circuits
 - a. Current, EMF, Voltage, Ammeters, Voltmeter
 - b. Resistance: Ohm's Law, Series, Parallel, Resistivity
 - c. Capacitance: Parallel Plate Capacitor, Energy, Series, Parallel, Dielectric
 - d. Conductivity: Metallic, Electrolytic
- C. Magnetism: Field, Lorentz Force

4D: Light and Sound

- A. Sound
 - a. Sound Production
 - b. Pitch, Speed, Intensity, Attenuation
 - c. Doppler Effect
 - d. Resonance
 - e. Ultrasound
 - f. Shock Waves
- B. Light
 - a. Interference, Young Double-Slit, Thin Films, Diffraction Grating, Single-Slit Diffraction, X-ray Diffraction
 - b. Polarization: Linear, Circular
 - c. Speed, Oscillating E and B Fields
 - d. EM Spectrum, Visual Spectrum, Color, Photon Energy
- C. Optics

- a. Reflection, Refraction, Snell's Law, Dispersion
- b. Total Internal Reflection
- c. Mirrors: Curvature, Focal Length, Real and Virtual Images
- d. Lenses: Converging, Diverging, Diopters, Combinations of Lenses
- e. Aberrations
- f. Optical Instruments, the Eye

4E: Nuclear and Electronic Structure

- A. Nucleus: Atomic Number and Weight, Nucleons, Decay
- B. Electronic Structure
 - a. Ground State, Excited State, Bohr Model
 - b. Absorption and Emission Spectra
 - c. Paramagnetism and Diamagnetism
 - d. Heisenberg Uncertainty Principle
 - e. Photoelectric Effect

5E: Thermodynamics and Kinetics

- A. Thermodynamic System: Zeroth Law, First Law, Second Law
 - a. PV Diagram, Work
 - b. Conduction, Convection, Radiation
 - c. Coefficient of Expansion

Psychology

Psychological, Social, and Biological Foundations of Behavior

6A: Sensation

1. Thresholds
2. Weber's Law
3. Signal Detection theory
4. Sensory adaptation

Particular Senses

1. Vision
 - a) Parallel Processing
 - b) Feature detection
2. Hearing and Auditory Processing
3. Auditory processing
4. Somatosensation and Pain
5. Kinesthetic sense

Perception

1. Bottom-up / Top-down processing
2. Perceptual organization – depth, form, motion, constancy
3. Gestalt principles

6B: Consciousness and Thinking

Consciousness

1. States of consciousness
 - a) Alertness
 - b) Sleep
 - i. Stages and cycles of sleep
 - ii. Dreaming
 - iii. Sleep disorders
 - c) Hypnosis
 - d) Meditation
2. Drugs that change conscious perception
 - a) Types of drugs
 - b) Drug addiction

Memory and Attention

1. Selective Attention
2. Divided Attention
3. Memory encoding – process and how to increase it
4. Memory storage
 - a) Types
 - b) Semantic networks
 - c) Spreading activation
5. Memory retrieval, effect of emotion
 - a) Recall
 - b) Recognition
 - c) Relearning
 - d) Retrieval cues
6. Memory loss
 - a) Aging
 - b) Alzheimer's disease
 - c) Korsakoff's syndrome
 - d) Decay
 - e) Interference
 - f) Memory construction and source monitoring

Cognition and Language

1. Cognitive development
 - a) Piaget
 - b) Later adulthood
 - c) Effect of language
 - d) Role of culture, heredity, environmental
2. Problem solving
 - a) Approaches
 - b) Barriers
 - c) Heuristics
 - i. Biases
 - ii. Intuition
 - iii. Emotion
 - iv. Overconfidence
 - v. Belief perseverance
3. Intelligence
 - a) Various definitions and levels of ability
 - b) Effect of heredity, environment
4. Theories of language development
 - a) Learning
 - b) Nativist
 - c) Interactionist

6C: Emotion and Stress

Emotion

1. Cognitive component
2. Physiological component
3. Behavioral component
4. Universal emotions
5. James-Lange theory
6. Cannon-Bard theory
7. Schachter-Singer theory

Stress

1. Stress appraisal
2. Stressors
3. Responses to stress: physiological, emotional, behavioral
4. Stress management

7A: Behavior and Personality

Biology influences behavior

1. Neurotransmitters
2. Endocrine effects
3. Genetic factors
 - a) Temperament
 - b) Interaction between heredity and environment
4. Environment and experience effect behavior

Attitudes and Motivation

1. Influences on motivation
 - a) Instinct
 - b) Arousal
 - c) Drive
 - d) Needs
2. Link between motivation and behavior
 - a) Drive Reduction Theory
 - b) Incentive Theory
 - c) Cognitive Theories
 - d) Need-based Theories
3. Specific behaviors explained by theories
 - a) Eating, Sex
 - b) Drug use
 - c) Others
4. Regulation of motivation: biological factors, cultural factors
5. Components of attitudes
 - a) Cognitive
 - b) Affective
 - c) Behavioral
6. Cognitive dissonance
7. Behavior and attitude affect each other

Personality

1. Perspectives on Personality
 - a) Psychoanalytic
 - b) Humanistic
 - c) Trait
 - d) Social cognitive
 - e) Biological
 - f) Behaviorist
2. Explaining behavior situationally

Psychological Disorders

1. Psychological disorders
 - a) Biomedical approach
 - b) Biopsychosocial approach
 - c) Classification schemes and types
 - i. Anxiety
 - ii. Somatoform
 - iii. Mood
 - iv. Schizophrenia
 - v. Dissociative
 - vi. Personality
 - d) Incidence and prevalence
2. Psychological disorders as nervous system disorders
 - a) Schizophrenia
 - b) Depression
 - c) Alzheimer's
 - d) Parkinson's

7B: The Presence of Other People

1. Social facilitation
2. Deindividuation
3. Bystander effect
4. Social loafing
5. Peer pressure

7C: Behavior Change and Learning

1. Habituation
2. Classical Conditioning
 - a) Stimuli
 - i. Neutral
 - ii. Conditioned
 - iii. Unconditioned
 - b) Responses
 - i. Conditioned
 - ii. Unconditioned
 - c) Acquisition
 - d) Extinction
 - e) Spontaneous recovery
 - f) Generalization
 - g) Discrimination
3. Operant Conditioning

- a) Shaping
- b) Extinction

- c) Reinforcement
 - i. Positive
 - ii. Negative
 - iii. Primary
 - iv. Conditional
- d) Reinforcement Schedules
 - i. Fixed ratio
 - ii. Variable ratio
 - iii. Fixed interval
 - iv. Variable interval
- e) Punishment
- f) Escape
- g) Avoidance
- 4. Observational learning
 - a) Modeling
 - b) Mirror Neurons
 - c) Vicarious Emotions
- 5. Attitude change
 - a) Elaboration Likelihood Model
 - i. Central and Peripheral route processing
 - b) Social Cognitive theory
 - c) Factors that affect attitude change
 - i. Changing behavior
 - ii. Characteristics of the message and target
 - iii. Social factors

8A: Identity and Interaction

Identity

1. Self-concept
2. Identity
3. Social Identity
4. Self-esteem
5. Self-efficacy
6. Locus of control in self-identity
7. Stages of identity development
 - a) Erikson
 - b) Vygotsky
 - c) Kohlberg
 - d) Freud
8. Social factors on identity development
 - a) Imitation
 - b) Role-taking
 - c) Reference group

8B: Interaction

- 1) Attribution theory
 - a) Fundamental attribution error
 - b) Cultural impact on attribution
- 2) Self-perception shapes perception of others
- 3) Perception of environment affects perception of others
- 4) Prejudice
 - a) Power
 - b) Prestige
 - c) Class
 - d) Emotion
 - e) Cognition
 - f) Discrimination
 - i. How power, prestige, class affect discrimination
- 5) Stereotypes
 - a) Self-fulfilling prophecy
 - b) Stereotype threat
- 6) Interaction between animals
 - a) Signals used by animals

8C: Social behaviors

- 1) Attraction
- 2) Aggression
- 3) Attachment
- 4) Social support

Sociology

Psychological, Social, and Biological Foundations of Behavior

7B: Social Influences on Behavior

1. Peer pressure
2. Group polarization
3. Groupthink: Culture: Assimilation, Multiculturalism, Subculture
4. Socialization
 - a) Norms
 - b) Socializing Agents
 - i. Family
 - ii. Peers
 - iii. Media
 - iv. Workplace
5. Deviance
 - a) Stigma
6. Obedience
 - a) Conformity

8C: Social Interactions

1. Types of Group
 - a) Status
 - b) Roles
 - c) Groups
 - d) Networks
 - e) Organizations
2. Influences on interaction
 - a) Responses to emotional displays
 - i. Gender
 - ii. Culture
3. Manipulating perception by others
 - a) Front stage vs. Back stage
 - b) Dramaturgy
4. Discrimination
 - a) Individual discrimination
 - b) Institutional discrimination
5. Ethnocentrism
 - a) In-group vs. Out-group
 - b) Cultural relativism

9A: Structure of Society

Analyzing social structures

1. Functionalism
2. Conflict theory
3. Symbolic interaction
4. Social constructionism
5. Institutions that shape society
 - a) Education

- b) Family
 - c) Religion
 - d) Government
 - e) Economy
 - f) Health care
6. Culture
- a) Material culture
 - b) Symbolic culture
 - c) Language
 - d) Values
 - e) Beliefs
 - i. Norms
 - f) Rituals
7. Social groups placement within the culture
8. Evolution

9B: Demographics

- 1. Age
 - 2. Gender
 - 3. Race
 - 4. Ethnicity
 - 5. Immigration
 - 6. Sexual orientation
 - 7. Demographic shifts
 - a) Fertility
 - b) Migration
 - c) Mortality
8. Social movements
9. Globalization
10. Urbanization

10A: Social Inequality

1. Spatial Inequality
 - a) Segregation
 - b) Environmental inequality
 - c) Globalization
2. Social Class
 - a) Stratification into classes
 - i. Status
 - ii. Power
 - b) Cultural capital
 - c) Social capital
 - d) Social reproduction
 - e) Privilege
 - f) Prestige
3. Class and race, gender, age
4. Social mobility
 - a) Intergenerational
 - b) Intragenerational
 - c) Downward
 - d) Upward
 - e) Meritocracy
5. Poverty
 - a) Relative
 - b) Absolute
 - c) Segregation
 - d) Isolation
6. Healthcare Disparities
 - a) Inequality in health status
 - i. Race
 - ii. Gender
 - iii. Class
 - b) Unequal access to healthcare
 - i. Race
 - ii. Gender
 - iii. Class