Section 1: Biological and Biochemical Foundations of Living Systems

□ **Foundational Concept 1: Biomolecules have unique properties that determine how they contribute to the structure and function of cells and how they participate in the processes necessary to maintain life.**			
	□ Amino Acids (BC, OC)	□ Description	□ Absolute configuration at the α position □ Amino acids as dipolar ions □ Classifications □ Acidic or basic □ Hydrophobic or hydrophilic
		□ Reactions	□ Sulfur linkage for cysteine and cysteine □ Peptide linkage: polypeptides and proteins □ Hydrolysis
	□ Protein Structure (BIO, BC, OC)	□ Structure	□ 1° structure of proteins □ 2° structure of proteins □ 3° structure of proteins; role of proline, cystine, hydrophobic bonding □ 4° structure of proteins (BIO, BC)
		□ Conformational stability	□ Denaturing and folding □ Hydrophobic interactions □ Solvation layer (entropy) (BC)

□ **1A. Structure and function of proteins and their constituent amino acids**		□ Separation techniques	□ Isoelectric point □ Electrophoresis
	□ Non-Enzymatic Protein Function (BIO, BC)	□ Binding (BC)	
		□ Immune system	
		□ Motors	
	□ Enzyme Structure and Function (BIO, BC)	□ Function of enzymes in catalyzing biological reactions	
		□ Enzyme classification by reaction type	
		□ Reduction of activation energy	
		□ Substrates and enzyme specificity	
		□ Active Site Model	
		□ Induced-fit Model	
		□ Mechanism of catalysis	□ Cofactors □ Coenzymes □ Water-soluble vitamins
		□ Effects of local conditions on enzyme activity	
	□ Control of Enzyme Activity (BIO, BC)	□ Kinetics	□ General (catalysis) □ Michaelis–Menten □ Cooperativity
		□ Feedback regulation	
		□ Inhibition – types	□ Competitive □ Non-competitive □ Mixed (BC) □ Uncompetitive (BC)

		□ Regulatory enzymes	□ Allosteric enzymes □ Covalently-modified enzymes □ Zymogen
	□ Nucleic Acid Structure and Function (BIO, BC)	□ Description	
		□ Nucleotides and nucleosides	□ Sugar phosphate backbone □ Pyrimidine, purine residues
		□ Deoxyribonucleic acid (DNA): double helix, Watson–Crick model of DNA structure	
		□ Base pairing specificity: A with T, G with C	
		□ Function in transmission of genetic information (BIO)	
		□ DNA denaturation, reannealing, hybridization	
	□ DNA Replication (BIO)	□ Mechanism of replication: separation of strands, specific coupling of free nucleic acids	
		□ Semi-conservative nature of replication	
		□ Specific enzymes involved in replication	
		□ Origins of replication, multiple origins in eukaryotes	
		□ Replicating the ends of DNA molecules	
	□ Repair of DNA (BIO)	□ Repair during replication	
		□ Repair of mutation	
	□ Genetic Code (BIO)	□ Central Dogma: DNA → RNA → protein	
		□ The triplet code	
		□ Codon–anticodon relationship	
		□ Degenerate code, wobble pairing	

□ **1B. Transmission of genetic information from the gene to the protein**		□ Missense, nonsense codons
		□ Initiation, termination codons
		□ Messenger RNA (mRNA)
	□ Transcription (BIO)	□ Transfer RNA (tRNA); ribosomal RNA (rRNA)
		□ Mechanism of transcription
		□ mRNA processing in eukaryotes, introns, exons
		□ Ribozymes, spliceosomes, small nuclear ribonucleoproteins (snRNPs), small nuclear RNAs (snRNAs)
		□ Functional and evolutionary importance of introns
	□ Translation (BIO)	□ Roles of mRNA, tRNA, rRNA
		□ Role and structure of ribosomes
		□ Initiation, termination co-factors
		□ Post-translational modification of proteins
	□ Eukaryotic Chromosome Organization (BIO)	□ Chromosomal proteins
		□ Single copy vs. repetitive DNA
		□ Supercoiling
		□ Heterochromatin vs. euchromatin
		□ Telomeres, centromeres
	□ Control of Gene Expression in Prokaryotes (BIO)	□ Operon Concept, Jacob–Monod Model
		□ Gene repression in bacteria
		□ Positive control in bacteria
		□ Transcriptional regulation

	□ Control of Gene Expression in Eukaryotes (BIO)	□ DNA binding proteins, transcription factors
		□ Gene amplification and duplication
		□ Post-transcriptional control, basic concept of splicing (introns, exons)
		□ Cancer as a failure of normal cellular controls, oncogenes, tumor suppressor genes
		□ Regulation of chromatin structure
		□ DNA methylation
		□ Role of non-coding RNAs
	□ Recombinant DNA and Biotechnology (BIO)	□ Gene cloning
		□ Restriction enzymes
		□ DNA libraries
		□ Generation of cDNA
		□ Hybridization
		□ Expressing cloned genes
		□ Polymerase chain reaction
		□ Gel electrophoresis and Southern blotting
		□ DNA sequencing
		□ Analyzing gene expression
		□ Determining gene function
		□ Stem cells
		□ Practical applications of DNA technology: medical applications, human gene therapy, pharmaceuticals, forensic evidence, environmental cleanup, agriculture
		□ Safety and ethics of DNA technology

	□ Mendelian Concepts (BIO)	□ Phenotype and genotype
		□ Gene
		□ Locus
		□ Allele: single and multiple
		□ Homozygosity and heterozygosity
		□ Wild-type
		□ Recessiveness
		□ Complete dominance
		□ Co-dominance
		□ Incomplete dominance, leakage, penetrance, expressivity
		□ Hybridization: viability
		□ Gene pool
	□ Meiosis and Other Factors Affecting Genetic Variability (BIO)	□ Significance of meiosis
		□ Important differences between meiosis and mitosis

□ **1C. Transmission of heritable information from generation to generation and the processes that increase genetic diversity**		□ Segregation of genes	□ Independent assortment □ Linkage □ Recombination □ Single crossovers □ Double crossovers □ Synaptonemal complex □ Tetrad □ Sex-linked characteristics □ Very few genes on Y chromosome □ Sex determination □ Cytoplasmic/extranuclear inheritance
		□ Mutation	□ General concept of mutation — error in DNA sequence □ Types of mutations: random, translation error, transcription error, base substitution, inversion, addition, deletion, translocation, mispairing □ Advantageous vs. deleterious mutation □ Inborn errors of metabolism □ Relationship of mutagens to carcinogens
		□ Genetic drift	
		□ Synapsis or crossing-over mechanism for increasing genetic diversity	

	□ Analytic Methods (BIO)	□ Hardy–Weinberg Principle	
		□ Testcross (Backcross; concepts of parental, F1, and F2 generations)	
		□ Gene mapping: crossover frequencies	
		□ Biometry: statistical methods	
	□ Evolution (BIO)	□ Natural selection	□ Fitness concept □ Selection by differential reproduction □ Concepts of natural and group selection □ Evolutionary success as increase in percent representation in the gene pool of the next generation
		□ Speciation	□ Polymorphism □ Adaptation and specialization □ Inbreeding □ Outbreeding □ Bottlenecks
		□ Evolutionary time as measured by gradual random changes in genome	

	□ Principles of Bioenergetics (BC, GC)	□ Bioenergetics/thermodynamics	□ Free energy/Keq □ Equilibrium constant □ Relationship of the equilibrium constant and ΔG° □ Concentration □ Le Châtelier's Principle □ Endothermic/ exothermic reactions □ Free energy: G □ Spontaneous reactions and ΔG°
		□ Phosphoryl group transfers and ATP	□ ATP hydrolysis ΔG << 0 □ ATP group transfers
		□ Biological oxidation-reduction	□ Half-reactions □ Soluble electron carriers □ Flavoproteins
	□ Carbohydrates (BC, OC)	□ Description	□ Nomenclature and classification, common names □ Absolute configuration □ Cyclic structure and conformations of hexoses □ Epimers and anomers
		□ Hydrolysis of the glycoside linkage	
		□ Monosaccharides	
		□ Disaccharides	

□ **1D. Principles of bioenergetics and fuel molecule metabolism**		□ Polysaccharides	
	□ Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway (BIO, BC)	□ Glycolysis (aerobic), substrates and products	□ Feeder pathways: glycogen, starch metabolism
		□ Fermentation (anaerobic glycolysis)	
		□ Gluconeogenesis (BC)	
		□ Pentose phosphate pathway (BC)	
		□ Net molecular and energetic results of respiration processes	
	□ Principles of Metabolic Regulation (BC)	□ Regulation of metabolic pathways (BIO, BC)	□ Maintenance of a dynamic steady state
		□ Regulation of glycolysis and gluconeogenesis	
		□ Metabolism of glycogen	
		□ Regulation of glycogen synthesis and breakdown	□ Allosteric and hormonal control
		□ Analysis of metabolic control	
	□ Citric Acid Cycle (BIO, BC)	□ Acetyl-CoA production (BC)	
		□ Reactions of the cycle, substrates and products	
		□ Regulation of the cycle	
		□ Net molecular and energetic results of respiration processes	
	□ Metabolism of Fatty Acids and Proteins (BIO, BC)	□ Description of fatty acids (BC)	
		□ Digestion, mobilization, and transport of fats	
		□ Oxidation of fatty acids	□ Saturated fats □ Unsaturated fats
		□ Ketone bodies (BC)	

		□ Anabolism of fats (BIO)	
		□ Non-template synthesis: biosynthesis of lipids and polysaccharides (BIO)	
		□ Metabolism of proteins (BIO)	
	□ Oxidative Phosphorylation (BIO, BC)	□ Electron transport chain and oxidative phosphorylation, substrates and products, general features of the pathway	
		□ Electron transfer in mitochondria	□ NADH, NADPH □ Flavoproteins □ Cytochromes
		□ ATP synthase, chemiosmotic coupling	□ Proton motive force
		□ Net molecular and energetic results of respiration processes	
		□ Regulation of oxidative phosphorylation	
		□ Mitochondria, apoptosis, oxidative stress (BC)	
	□ Hormonal Regulation and Integration of Metabolism (BC)	□ Higher level integration of hormone structure and function	
		□ Tissue specific metabolism	
		□ Hormonal regulation of fuel metabolism	
		□ Obesity and regulation of body mass	
□ Foundational Concept 2: Highly-organized assemblies of molecules, cells, and organs interact to carry out the functions of living organisms.			
		□ General function in cell containment	

	□ Plasma Membrane (BIO, BC)	□ Composition of membranes	□ Lipid components (BIO, BC, OC) □ Phospholipids (and phosphatids) □ Steroids □ Waxes □ Protein components □ Fluid mosaic model
		□ Membrane dynamics	
		□ Solute transport across membranes	□ Thermodynamic considerations □ Colligative properties; osmotic pressure (GC) □ Osmosis □ Passive transport □ Active transport □ Sodium/potassium pump
		□ Membrane channels	
		□ Membrane potential	
		□ Membrane receptors	
		□ Exocytosis and endocytosis	
		□ Intercellular junctions (BIO)	□ Gap junctions □ Tight junctions □ Desmosomes
		□ Defining characteristics of eukaryotic cells: membrane bound nucleus, presence of organelles, mitotic division	

□ **2A. Assemblies of molecules, cells, and groups of cells within single cellular and multicellular organisms**	□ Membrane-Bound Organelles and Defining Characteristics of Eukaryotic Cells (BIO)	□ Nucleus	□ Compartmentalization, storage of genetic information □ Nucleolus: location and function □ Nuclear envelope, nuclear pores
		□ Mitochondria	□ Site of ATP production □ Inner and outer membrane structure (BIO, BC) □ Self-replication
		□ Lysosomes: membrane-bound vesicles containing hydrolytic enzymes	
		□ Endoplasmic reticulum	□ Rough and smooth components □ Rough endoplasmic reticulum site of ribosomes □ Double membrane structure □ Role in membrane biosynthesis □ Role in biosynthesis of secreted proteins
		□ Golgi apparatus: general structure and role in packaging and secretion	
		□ Peroxisomes: organelles that collect peroxides	
	□ Cytoskeleton (BIO)	□ General function in cell support and movement	
		□ Microfilaments: composition and role in cleavage and contractility	
		□ Microtubules: composition and role in support and transport	
		□ Intermediate filaments, role in support	

		□ Composition and function of cilia and flagella	
		□ Centrioles, microtubule organizing centers	
	□ Tissues Formed From Eukaryotic Cells (BIO)	□ Epithelial cells	
		□ Connective tissue cells	
	□ Cell Theory (BIO)	□ History and development	
		□ Impact on biology	
	□ Classifica-tion and Structure of Prokaryotic Cells (BIO)	□ Prokaryotic domains	□ Archaea □ Bacteria
		□ Major classifications of bacteria by shape	□ Bacilli (rod-shaped) □ Spirilli (spiral-shaped) □ Cocci (spherical)
		□ Lack of nuclear membrane and mitotic apparatus	
		□ Lack of typical eukaryotic organelles	
		□ Presence of cell wall in bacteria	
		□ Flagellar propulsion, mechanism	
□ **2B. The**	□ Growth and Physiology of Prokaryotic Cells (BIO)	□ Reproduction by fission	
		□ High degree of genetic adaptability, acquisition of antibiotic resistance	
		□ Exponential growth	
		□ Existence of anaerobic and aerobic variants	
		□ Parasitic and symbiotic	
		□ Chemotaxis	

structure, growth, physiology, and genetics of prokaryotes and viruses	□ Genetics of Prokaryotic Cells (BIO)	□ Existence of plasmids, extragenomic DNA	
		□ Transformation: incorporation into bacterial genome of DNA fragments from external medium	
		□ Conjugation	
		□ Transposons (also present in eukaryotic cells)	
	□ Virus Structure (BIO)	□ General structural characteristics (nucleic acid and protein, enveloped and nonenveloped)	
		□ Lack organelles and nucleus	
		□ Structural aspects of typical bacteriophage	
		□ Genomic content — RNA or DNA	
		□ Size relative to bacteria and eukaryotic cells	
	□ Viral Life Cycle (BIO)	□ Self-replicating biological units that must reproduce within specific host cell	
		□ Generalized phage and animal virus life cycles	□ Attachment to host, penetration of cell membrane or cell wall, and entry of viral genetic material □ Use of host synthetic mechanism to replicate viral components □ Self-assembly and release of new viral particles
		□ Transduction: transfer of genetic material by viruses	
		□ Retrovirus life cycle: integration into host DNA, reverse transcriptase, HIV	
		□ Prions and viroids: subviral particles	
		□ Mitotic process: prophase, metaphase, anaphase, telophase, interphase	

□ **2C. Processes of cell divi**	□ Mitosis (BIO)	□ Mitotic structures	□ Centrioles, asters, spindles □ Chromatids, centromeres, kinetochores □ Nuclear membrane breakdown and reorganization □ Mechanisms of chromosome movement
		□ Phases of cell cycle: G0, G1, S, G2, M	
		□ Growth arrest	
		□ Control of cell cycle	
		□ Loss of cell cycle controls in cancer cells	
	□ Biosignalling (BC)	□ Oncogenes, apoptosis	
	□ Reproductive System (BIO)	□ Gametogenesis by meiosis	
		□ Ovum and sperm	□ Differences in formation □ Differences in morphology □ Relative contribution to next generation
		□ Reproductive sequence: fertilization; implantation; development; birth	

cell division, differentiation, and specialization	□ Embryogenesis (BIO)	□ Stages of early development (order and general features of each)	□ Fertilization
			□ Cleavage
			□ Blastula formation
			□ Gastrulation
			  □ First cell movements
			  □ Formation of primary germ layers (endoderm, mesoderm, ectoderm)
			□ Neurulation

		□ Major structures arising out of primary germ layers	
		□ Neural crest	
		□ Environment–gene interaction in development	
	□ Mechanisms of Development (BIO)	□ Cell specialization	□ Determination □ Differentiation □ Tissue types
		□ Cell–cell communication in development	
		□ Cell migration	
		□ Pluripotency: stem cells	
		□ Gene regulation in development	
		□ Programmed cell death	
		□ Existence of regenerative capacity in various species	
		□ Senescence and aging	
□ Foundational Concept 3: Complex systems of tissues and organs sense the internal and external environments of multicellular organisms, and through integrated functioning, maintain a stable internal environment within an ever-changing external environment.			

□ **3A. Structure and functions of the nervous and endocrine systems and ways in which these sys-**	□ Nervous System: Structure and Function (BIO)	□ Major Functions	□ High level control and integration of body systems □ Adaptive capability to external influences
		□ Organization of vertebrate nervous system	
		□ Sensor and effector neurons	
		□ Sympathetic and parasympathetic nervous systems: antagonistic control	
		□ Reflexes	□ Feedback loop, reflex arc □ Role of spinal cord and supraspinal circuits
		□ Integration with endocrine system: feedback control	
	□ Nerve Cell (BIO)	□ Cell body: site of nucleus, organelles	
		□ Dendrites: branched extensions of cell body	
		□ Axon: structure and function	
		□ Myelin sheath, Schwann cells, insulation of axon	
		□ Nodes of Ranvier: propagation of nerve impulse along axon	
		□ Synapse: site of impulse propagation between cells	
		□ Synaptic activity: transmitter molecules	
		□ Resting potential: electrochemical gradient	
		□ Action potential	□ Threshold, all-or-none □ Sodium/potassium pump
		□ Excitatory and inhibitory nerve fibers: summation, frequency of firing	

tems coordinate the organ systems		□ Glial cells, neuroglia	
	□ Electrochemistry (GC)	□ Concentration cell: direction of electron flow, Nernst equation	
	□ Biosignalling (BC)	□ Gated ion channels	□ Voltage gated □ Ligand gated
		□ Receptor enzymes	
		□ G protein-coupled receptors	
	□ Lipids (BC, OC)	□ Description; structure	□ Steroids □ Terpenes and terpenoids
	□ Endocrine System: Hormones and Their Sources (BIO)	□ Function of endocrine system: specific chemical control at cell, tissue, and organ level	
		□ Definitions of endocrine gland, hormone	
		□ Major endocrine glands: names, locations, products	
		□ Major types of hormones	
		□ Neuroendrocrinology — relation between neurons and hormonal systems	
	□ Endocrine System: Mechanisms of Hormone Action (BIO)	□ Cellular mechanisms of hormone action	
		□ Transport of hormones: blood supply	
		□ Specificity of hormones: target tissue	
		□ Integration with nervous system: feedback control	
		□ Regulation by second messengers	
		□ General function	□ Gas exchange, thermoregulation □ Protection against disease: particulate matter

	□ Respiratory System (BIO)	□ Structure of lungs and alveoli	
		□ Breathing mechanisms	□ Diaphragm, rib cage, differential pressure □ Resiliency and surface tension effects
		□ Thermoregulation: nasal and tracheal capillary beds; evaporation, panting	
		□ Particulate filtration: nasal hairs, mucus/cilia system in lungs	
		□ Alveolar gas exchange	□ Diffusion, differential partial pressure □ Henry's Law (GC)
		□ pH control	
		□ Regulation by nervous control	□ CO2 sensitivity
		□ Functions: circulation of oxygen, nutrients, hormones, ions and fluids, removal of metabolic waste	
		□ Role in thermoregulation	
		□ Four-chambered heart: structure and function	
		□ Endothelial cells	
		□ Systolic and diastolic pressure	
		□ Pulmonary and systemic circulation	
		□ Arterial and venous systems (arteries, arterioles, venules, veins)	□ Structural and functional differences □ Pressure and flow characteristics

	□ Circulatory System (BIO)	□ Capillary beds	□ Mechanisms of gas and solute exchange □ Mechanism of heat exchange □ Source of peripheral resistance
		□ Composition of blood	□ Plasma, chemicals, blood cells □ Erythrocyte production and destruction; spleen, bone marrow □ Regulation of plasma volume
		□ Coagulation, clotting mechanisms	
		□ Oxygen transport by blood	□ Hemoglobin, haematocrit □ Oxygen content □ Oxygen affinity
		□ Carbon dioxide transport and level in blood	
		□ Nervous and endocrine control	
	□ Lymphatic System (BIO)	□ Structure of lymphatic system	
		□ Major functions	□ Equalization of fluid distribution □ Transport of proteins and large glycerides □ Production of lymphocytes involved in immune reactions □ Return of materials to the blood
		□ Innate (non-specific) vs. adaptive (specific) immunity	

	□ Immune System (BIO)	□ Adaptive immune system cells	□ T-lymphocytes □ B-lymphocytes
		□ Innate immune system cells	□ Macrophages □ Phagocytes
		□ Tissues	□ Bone marrow □ Spleen □ Thymus □ Lymph nodes
		□ Concept of antigen and antibody	
		□ Antigen presentation	
		□ Clonal selection	
		□ Antigen-antibody recognition	
		□ Structure of antibody molecule	
		□ Recognition of self vs. non-self, autoimmune diseases	
		□ Major histocompatibility complex	
		□ Ingestion	□ Saliva as lubrication and source of enzymes □ Ingestion; esophagus, transport function

□ **3B. Structure and inte-**	□ Digestive System (BIO)	□ Stomach	□ Storage and churning of food □ Low pH, gastric juice, mucal protection against self-destruction □ Production of digestive enzymes, site of digestion □ Structure (gross)
		□ Liver	□ Structural relationship of liver within gastrointestinal system □ Production of bile □ Role in blood glucose regulation, detoxification
		□ Bile	□ Storage in gall bladder □ Function
		□ Pancreas	□ Production of enzymes □ Transport of enzymes to small intestine
		□ Small Intestine	□ Absorption of food molecules and water □ Function and structure of villi □ Production of enzymes, site of digestion □ Neutralization of stomach acid □ Structure (anatomic subdivisions)

grative functions of the main organ systems		□ Large Intestine	□ Absorption of water □ Bacterial flora □ Structure (gross)
		□ Rectum: storage and elimination of waste, feces	
		□ Muscular control	□ Peristalsis
		□ Endocrine control	□ Hormones □ Target tissues
		□ Nervous control: the enteric nervous system	
	□ Excretory System (BIO)	□ Roles in homeostasis	□ Blood pressure □ Osmoregulation □ Acid–base balance □ Removal of soluble nitrogenous waste
		□ Kidney structure	□ Cortex □ Medulla
		□ Nephron structure	□ Glomerulus □ Bowman’s capsule □ Proximal tubule □ Loop of Henle □ Distal tubule □ Collecting duct

		□ Formation of urine	□ Glomerular filtration □ Secretion and reabsorption of solutes □ Concentration of urine □ Counter-current multiplier mechanism
		□ Storage and elimination: ureter, bladder, urethra	
		□ Osmoregulation: capillary reabsorption of H2O, amino acids, glucose, ions	
		□ Muscular control: sphincter muscle	
	□ Reproductive System (BIO)	□ Male and female reproductive structures and their functions	□ Gonads □ Genitalia □ Differences between male and female structures
		□ Hormonal control of reproduction	□ Male and female sexual development □ Female reproductive cycle □ Pregnancy, parturition, lactation □ Integration with nervous control
		□ Important functions	□ Support: mobility □ Peripheral circulatory assistance □ Thermoregulation (shivering reflex)
		□ Structure of three basic muscle types: striated, smooth, cardiac	

	□ Muscle System (BIO)	□ Muscle structure and control of contraction	□ T-tubule system □ Contractile apparatus □ Sarcoplasmic reticulum □ Fiber type □ Contractile velocity of different muscle types
		□ Regulation of cardiac muscle contraction	
		□ Oxygen debt: fatigue	
		□ Nervous control	□ Motor neurons □ Neuromuscular junction, motor end plates □ Sympathetic and parasympathetic innervation □ Voluntary and involuntary muscles
	□ Specialized Cell - Muscle Cell (BIO)	□ Structural characteristics of striated, smooth, and cardiac muscle	
		□ Abundant mitochondria in red muscle cells: ATP source	
		□ Organization of contractile elements: actin and myosin filaments, crossbridges, sliding filament model	
		□ Sarcomeres: “I” and “A” bands, “M” and “Z” lines, “H” zone	
		□ Presence of troponin and tropomyosin	
		□ Calcium regulation of contraction	
		□ Functions	□ Structural rigidity and support □ Calcium storage □ Physical protection

	□ Skeletal System (BIO)	□ Skeletal structure	□ Specialization of bone types, structures □ Joint structures □ Endoskeleton vs. exoskeleton
		□ Bone structure	□ Calcium/protein matrix □ Cellular composition of bone
		□ Cartilage: structure and function	
		□ Ligaments, tendons	
		□ Endocrine control	
	□ Skin System (BIO)	□ Structure	□ Layer differentiation, cell types □ Relative impermeability to water
		□ Functions in homeostasis and osmoregulation	
		□ Functions in thermoregulation	□ Hair, erectile musculature □ Fat layer for insulation □ Sweat glands, location in dermis □ Vasoconstriction and vasodilation in surface capillaries
		□ Physical protection	□ Nails, calluses, hair □ Protection against abrasion, disease organisms

		□ Hormonal control: sweating, vasodilation, and vasoconstriction

□ **Section 2: Chemical and Physical Foundations of Biological Systems**

□ **Foundational Concept 4: Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes understood in terms of physical principles.**		
□ **4A. Translational motion, forces, work, energy, and equilibrium in living systems**	□ Translational Motion (PHY)	□ Units and dimensions
		□ Vectors, components
		□ Vector addition
		□ Speed, velocity (average and instantaneous)
		□ Acceleration
	□ Force (PHY)	□ Newton's First Law, inertia
		□ Newton's Second Law (F = ma)
		□ Newton's Third Law, forces equal and opposite
		□ Friction, static and kinetic
		□ Center of mass
	□ Equilibrium (PHY)	□ Vector analysis of forces acting on a point object
		□ Torques, lever arms
	□ Work (PHY)	□ Work done by a constant force: $W = Fd\cos\theta$
		□ Mechanical advantage
		□ Work Kinetic Energy Theorem
		□ Conservative forces
		□ Kinetic Energy: $KE = \frac{1}{2} mv^2$; units

	□ Energy of Point Object Systems (PHY)	□ Potential Energy	□ PE = mgh (gravitational, local) □ PE = ½ kx^2 (spring)
		□ Conservation of energy	
		□ Power, units	
	□ Periodic Motion (PHY	□ Amplitude, frequency, phase	
		□ Transverse and longitudinal waves: wavelength and propagation speed	
□ 4B. Importance of fluids for the circulation of blood, gas movement, and gas ex-	□ Fluids (PHY)	□ Density, specific gravity	
		□ Buoyancy, Archimedes' Principle	
		□ Hydrostatic pressure	□ Pascal's Law □ Hydrostatic pressure; P = ρgh (pressure vs. depth)
		□ Viscosity: Poiseuille Flow	
		□ Continuity equation (A·v = constant)	
		□ Concept of turbulence at high velocities	
		□ Surface tension	
		□ Bernoulli's equation	
		□ Venturi effect, pitot tube	
	□ Circulatory System (BIO)	□ Arterial and venous systems; pressure and flow characteristics	
		□ Absolute temperature, (K) Kelvin Scale	
		□ Pressure, simple mercury barometer	
		□ Molar volume at 0°C and 1 atm = 22.4 L/mol	

and gas exchange	□ Gas Phase (GC, PHY)	□ Ideal gas	□ Definition □ Ideal Gas Law: PV = nRT □ Boyle's Law: PV = constant □ Charles' Law: V/T = constant □ Avogadro's Law: V/n = constant
		□ Kinetic Molecular Theory of Gases	□ Heat capacity at constant volume and at constant pressure (PHY) □ Boltzmann's Constant (PHY)
		□ Deviation of real gas behavior from Ideal Gas Law	□ Qualitative □ Quantitative (Van der Waals' Equation)
		□ Partial pressure, mole fraction	
		□ Dalton's Law relating partial pressure to composition	
	□ Electrostatics (PHY)	□ Charge, conductors, charge conservation	
		□ Insulators	
		□ Coulomb's Law	
		□ Electric field E	□ Field lines □ Field due to charge distribution
		□ Electrostatic energy, electric potential at a point in space	
		□ Current I = ΔQ/Δt, sign conventions, units	
		□ Electromotive force, voltage	

□ **4C. Electrochemistry and electrical circuits and their elements**	□ Circuit Elements (PHY)	□ Resistance	□ Ohm's Law: I = V/R □ Resistors in series □ Resistors in parallel □ Resistivity: ρ = R•A / L
		□ Capacitance	□ Parallel plate capacitor □ Energy of charged capacitor □ Capacitors in series □ Capacitors in parallel □ Dielectrics
		□ Conductivity	○ Metallic ○ Electrolytic
		□ Meters	
	□ Magnetism (PHY)	□ Definition of magnetic field	
		□ Motion of charged particles in magnetic fields; Lorentz force	
	□ Electrochemistry (GC)	□ Electrolytic cell	□ Electrolysis □ Anode, cathode □ Electrolyte □ Faraday's Law relating amount of elements deposited (or gas liberated) at an electrode to current □ Electron flow; oxidation, and reduction at the electrodes
		□ Galvanic or Voltaic cells	□ Half-reactions □ Reduction potentials; cell potential □ Direction of electron flow

		□ Concentration cell	
		□ Batteries	□ Electromotive force, Voltage □ Lead-storage batteries □ Nickel-cadmium batteries
	□ Specialized Cell - Nerve Cell (BIO)	□ Myelin sheath, Schwann cells, insulation of axon	
		□ Nodes of Ranvier: propagation of nerve impulse along axon	
	□ Sound (PHY)	□ Production of sound	
		□ Relative speed of sound in solids, liquids, and gases	
		□ Intensity of sound, decibel units, log scale	
		□ Attenuation (Damping)	
		□ Doppler Effect: moving sound source or observer, reflection of sound from a moving object	
		□ Pitch	
		□ Resonance in pipes and strings	
		□ Ultrasound	
		□ Shock waves	
		□ Concept of Interference; Young Double-slit Experiment	
		□ Thin films, diffraction grating, single-slit diffraction	
		□ Other diffraction phenomena, X-ray diffraction	
		□ Polarization of light: linear and circular	

□ **4D. How light and sound interact with matter**	□ Light, Electromagnetic Radiation (PHY)	□ Properties of electromagnetic radiation	□ Velocity equals constant c, in vacuo □ Electromagnetic radiation consists of perpendicularly oscillating electric and magnetic fields; direction of propagation is perpendicular to both
		□ Classification of electromagnetic spectrum, photon energy E = hf	
		□ Visual spectrum, color	
	□ Molecular Structure and Absorption Spectra (OC)	□ Infrared region	□ Intramolecular vibrations and rotations □ Recognizing common characteristic group absorptions, fingerprint region
		□ Visible region (GC)	□ Absorption in visible region gives complementary color (e.g., carotene) □ Effect of structural changes on absorption (e.g., indicators)
		□ Ultraviolet region	□ π-Electron and nonbonding electron transitions □ Conjugated systems
		□ NMR spectroscopy	□ Protons in a magnetic field; equivalent protons □ Spin-spin splitting
		□ Reflection from plane surface: angle of incidence equals angle of reflection	
		□ Refraction, refractive index n; Snell's law: n1 sin θ1 = n2 sin θ2	
		□ Dispersion, change of index of refraction with wavelength	
		□ Conditions for total internal reflection	

	□ Geometrical Optics (PHY)	□ Spherical mirrors	□ Center of curvature □ Focal length □ Real and virtual images
		□ Thin lenses	□ Converging and diverging lenses □ Use of formula 1/p + 1/q = 1/f, with sign conventions □ Lens strength, diopters
		□ Combination of lenses	
		□ Lens aberration	
		□ Optical Instruments, including the human eye	
	□ Atomic Nucleus (PHY, GC)	□ Atomic number, atomic weight	
		□ Neutrons, protons, isotopes	
		□ Nuclear forces, binding energy	
		□ Radioactive decay	□ α, ß, γ decay □ Half-life, exponential decay, semi-log plots
		□ Mass spectrometer	
	□ Electronic Structure (PHY, GC)	□ Orbital structure of hydrogen atom, principal quantum number n, number of electrons per orbital (GC)	
		□ Ground state, excited states	
		□ Absorption and emission line spectra	
		□ Use of Pauli Exclusion Principle	
		□ Paramagnetism and diamagnetism	
		□ Conventional notation for electronic structure (GC)	

□ **4E. Atoms, nuclear decay, electronic structure, and atomic chemical behavior**		□ Bohr atom	
		□ Heisenberg Uncertainty Principle	
		□ Effective nuclear charge (GC)	
		□ Photoelectric effect	
	□ The Periodic Table - Classification of Elements into Groups by Electronic Structure (GC)	□ Alkali metals	
		□ Alkaline earth metals: their chemical characteristics	
		□ Halogens: their chemical characteristics	
		□ Noble gases: their physical and chemical characteristics	
		□ Transition metals	
		□ Representative elements	
		□ Metals and non-metals	
		□ Oxygen group	
	□ The Periodic Table - Variations of Chemical Properties with Group and Row (GC)	□ Valence electrons	
		□ First and second ionization energy	□ Definition □ Prediction from electronic structure for elements in different groups or rows
		□ Electron affinity	□ Definition □ Variation with group and row
		□ Electronegativity	□ Definition □ Comparative values for some representative elements and important groups

		□ Electron shells and the sizes of atoms	
		□ Electron shells and the sizes of ions	
	□ Stoichiom-etry (GC)	□ Molecular weight	
		□ Empirical versus molecular formula	
		□ Metric units commonly used in the context of chemistry	
		□ Description of composition by percent mass	
		□ Mole concept, Avogadro's number NA	
		□ Definition of density	
		□ Oxidation number	□ Common oxidizing and reducing agents □ Disproportionation reactions
		□ Description of reactions by chemical equations	□ Conventions for writing chemical equations □ Balancing equations, including redox equations □ Limiting reactants □ Theoretical yields
□ Foundational Concept 5: The principles that govern chemical interactions and reactions form the basis for a broader understanding of the molecular dynamics of living systems.			
		□ Brønsted–Lowry definition of acid, base	
		□ Ionization of water	□ K_w, its approximate value ($Kw = [H+][OH^-] = 10^{-14}$ at 25°C, 1 atm) □ Definition of pH: pH of pure water
		□ Conjugate acids and bases (e.g., NH_4 + and NH_3)	

<table>
<tr><td rowspan="9">□ 5A. Unique nature of water and its solutions</td><td rowspan="4">□ Acid/Base Equilibria (GC, BC)</td><td colspan="2">□ Strong acids and bases (e.g., nitric, sulfuric)</td></tr>
<tr><td>□ Weak acids and bases (e.g., acetic, benzoic)</td><td>□ Dissociation of weak acids and bases with or without added salt
□ Hydrolysis of salts of weak acids or bases
□ Calculation of pH of solutions of salts of weak acids or bases</td></tr>
<tr><td colspan="2">□ Equilibrium constants K_a and K_b: pK_a, pK_b</td></tr>
<tr><td>□ Buffers</td><td>□ Definition and concepts (common buffer systems)
□ Influence on titration curves</td></tr>
<tr><td rowspan="2">□ Ions in Solutions (GC, BC)</td><td colspan="2">□ Anion, cation: common names, formulas and charges for familiar ions (e.g., NH_4^+ ammonium, PO_4^{3-} phosphate, SO_4^{2-} sulfate)</td></tr>
<tr><td colspan="2">□ Hydration, the hydronium ion</td></tr>
<tr><td rowspan="3">□ Solubility (GC)</td><td colspan="2">□ Units of concentration (e.g., molarity)</td></tr>
<tr><td colspan="2">□ Solubility product constant; the equilibrium expression K_{sp}</td></tr>
<tr><td>□ Common-ion effect, its use in laboratory separations</td><td>□ Complex ion formation
□ Complex ions and solubility
□ Solubility and pH</td></tr>
<tr><td rowspan="4">□ Titration (GC</td><td colspan="2">□ Indicators</td></tr>
<tr><td colspan="2">□ Neutralization</td></tr>
<tr><td colspan="2">□ Interpretation of the titration curves</td></tr>
<tr><td colspan="2">□ Redox titration</td></tr>
</table>

□ **5B. Nature of molecules and intermolecular interactions**	□ Covalent Bond (GC)	□ Lewis Electron Dot formulas	□ Resonance structures □ Formal charge □ Lewis acids and bases
		□ Partial ionic character	□ Role of electronegativity in determining charge distribution □ Dipole Moment
		□ σ and π bonds	□ Hybrid orbitals: sp^3 , sp^2 , sp and respective geometries □ Valence shell electron pair repulsion and the prediction of shapes of molecules (e.g., NH_3, H_2O, CO_2) □ Structural formulas for molecules involving H, C, N, O, F, S, P, Si, Cl □ Delocalized electrons and resonance in ions and molecules
		□ Multiple bonding	□ Effect on bond length and bond energies □ Rigidity in molecular structure

		□ Stereochemistry of covalently bonded molecules (OC)	□ Isomers □ Structural isomers □ Stereoisomers (e.g., diastereomers, enantiomers, cis/trans isomers) □ Conformational isomers □ Polarization of light, specific rotation □ Absolute and relative configuration □ Conventions for writing R and S forms □ Conventions for writing E and Z forms
	□ Liquid Phase - Intermolecular Forces (GC)	□ Hydrogen bonding	
		□ Dipole Interactions	
		□ Van der Waals' Forces (London dispersion forces)	
□ 5C. Separation and purification methods	□ Separations and Purifications (OC, BC)	□ Extraction: distribution of solute between two immiscible solvents	
		□ Distillation	
		□ Chromatography: Basic principles involved in separation process	□ Column chromatography □ Gas-liquid chromatography □ High pressure liquid chromatography □ Paper chromatography □ Thin-layer chromatography
		□ Separation and purification of peptides and proteins (BC)	□ Electrophoresis □ Quantitative analysis □ Chromatography □ Size-exclusion □ Ion-exchange □ Affinity
		□ Racemic mixtures, separation of enantiomers (OC)	

	□ Nucleotides and Nucleic Acids (BC, BIO)	□ Nucleotides and nucleosides: composition	□ Sugar phosphate backbone □ Pyrimidine, purine residues
		□ Deoxyribonucleic acid: DNA; double helix	
		□ Chemistry (BC)	
		□ Other functions (BC)	
	□ Amino Acids, Peptides, Proteins (OC, BC)	□ Amino acids: description	□ Absolute configuration at the α position □ Dipolar ions □ Classification □ Acidic or basic □ Hydrophilic or hydrophobic □ Synthesis of α-amino acids (OC) □ Strecker Synthesis □ Gabriel Synthesis
		□ Peptides and proteins: reactions	□ Sulfur linkage for cysteine and cysteine □ Peptide linkage: polypeptides and proteins □ Hydrolysis (BC)
		□ General Principles	□ Primary structure of proteins □ Secondary structure of proteins □ Tertiary structure of proteins □ Isoelectric point
	□ The Three-Dimensional Protein	□ Conformational stability	□ Hydrophobic interactions □ Solvation layer (entropy)

□ **5D. Structure, function, and reactivity of biologically-relevant molecules**	Protein Structure (BC)	□ Quaternary structure	
		□ Denaturing and Folding	
	□ Non-Enzymatic Protein Function (BC)	□ Binding	
		□ Immune system	
		□ Motor	
	□ Lipids (BC, OC)	□ Description, Types	□ Storage □ Triacyl glycerols □ Free fatty acids: saponification □ Structural □ Phospholipids and phosphatides □ Sphingolipids (BC) □ Waxes □ Signals/cofactors □ Fat-soluble vitamins □ Steroids □ Prostaglandins (BC)
	□ Carbohydrates (OC)	□ Description	□ Nomenclature and classification, common names □ Absolute configuration □ Cyclic structure and conformations of hexoses □ Epimers and anomers
		□ Hydrolysis of the glycoside linkage	
		□ Keto-enol tautomerism of monosaccharides	
		□ Disaccharides (BC)	
		□ Polysaccharides (BC)	
		□ Description	□ Nomenclature □ Physical properties

	□ Aldehydes and Ketones (OC)	□ Important reactions	□ Nucleophilic addition reactions at C=O bond □ Acetal, hemiacetal □ Imine, enamine □ Hydride reagents □ Cyanohydrin □ Oxidation of aldehydes □ Reactions at adjacent positions: enolate chemistry □ Keto-enol tautomerism (α-racemization) □ Aldol condensation, retro-aldol □ Kinetic versus thermodynamic enolate
		□ General principles	□ Effect of substituents on reactivity of C=O; steric hindrance □ Acidity of α-H; carbanions
	□ Alcohols (OC)	□ Description	□ Nomenclature □ Physical properties (acidity, hydrogen bonding)
		□ Important reactions	□ Oxidation □ Substitution reactions: S_N1 or S_N2 □ Protection of alcohols □ Preparation of mesylates and tosylates
		□ Description	□ Nomenclature □ Physical properties

	□ Carboxylic Acids (OC)	□ Important reactions	□ Carboxyl group reactions □ Amides (and lactam), esters (and lactone), anhydride formation □ Reduction □ Decarboxylation □ Reactions at 2-position, substitution
	□ Acid Derivatives (Anhydrides, Amides, Esters) (OC)	□ Description	□ Nomenclature □ Physical properties
		□ Important reactions	□ Nucleophilic substitution □ Transesterification □ Hydrolysis of amides
		□ General principles	□ Relative reactivity of acid derivatives □ Steric effects □ Electronic effects □ Strain (e.g., ß-lactams)
	□ Phenols (OC, BC)	□ Oxidation and reduction (e.g., hydroquinones, ubiquinones): biological 2e– redox centers	
	□ Polycyclic and Heterocyclic Aromatic Compounds (OC, BC)	□ Biological aromatic heterocycles	
		□ Classification by reaction type	
		□ Mechanism	□ Substrates and enzyme specificity □ Active site model □ Induced-fit model □ Cofactors, coenzymes, and vitamins

	□ Enzymes (BC, BIO)	□ Kinetics	□ General (catalysis) □ Michaelis–Menten □ Cooperativity □ Effects of local conditions on enzyme activity
		□ Inhibition	
		□ Regulatory enzymes	□ Allosteric □ Covalently modified
	□ Principles of Bioenergetics (BC)	□ Bioenergetics/ thermodynamics	□ Free energy/K_{eq} □ Concentration
		□ Phosphorylation/ATP	□ ATP hydrolysis $\Delta G << 0$ □ ATP group transfers
		□ Biological oxidation–reduction	□ Half-reactions □ Soluble electron carriers □ Flavoproteins
□ 5E. Principles of chemical thermodynamics and	□ Energy	□ Thermodynamic system – state function	
		□ Zeroth Law – concept of temperature	
		□ First Law − conservation of energy in thermodynamic processes	
		□ PV diagram: work done = area under or enclosed by curve (PHY)	
		□ Second Law – concept of entropy	□ Entropy as a measure of “disorder” □ Relative entropy for gas, liquid, and crystal states
		□ Measurement of heat changes (calorimetry), heat capacity, specific heat	

kinetics	Changes in Chemical Reactions – Thermochemistry, Thermodynamics (GC, PHY)	□ Heat transfer – conduction, convection, radiation (PHY)	
		□ Endothermic/ exothermic reactions (GC)	□ Enthalpy, H, and standard heats of reaction and formation □ Hess' Law of Heat Summation
		□ Bond dissociation energy as related to heats of formation (GC)	
		□ Free energy: G (GC)	
		□ Spontaneous reactions and ΔG° (GC)	
		□ Coefficient of expansion (PHY)	
		□ Heat of fusion, heat of vaporization	
		□ Phase diagram: pressure and temperature	
	□ Rate Processes in Chemical Reactions - Kinetics and Equilibrium (GC)	□ Reaction rate	
		□ Dependence of reaction rate on concentration of reactants	□ Rate law, rate constant □ Reaction order
		□ Rate-determining step	
		□ Dependence of reaction rate upon temperature	□ Activation energy □ Activated complex or transition state □ Interpretation of energy profiles showing energies of reactants, products, activation energy, and ΔH for the reaction □ Use of the Arrhenius Equation
		□ Kinetic control versus thermodynamic control of a reaction	
		□ Catalysts	

		□ Equilibrium in reversible chemical reactions	□ Law of Mass Action □ Equilibrium Constant □ Application of Le Châtelier's Principle
		□ Relationship of the equilibrium constant and ΔG°	

□ **Section 3: Psychological, Social, and Biological Foundations of Behavior**

□ **Foundational Concept 6: Biological, psychological, and sociocultural factors influence the ways that individuals perceive, think about, and react to the world.**			
□ **6A. Sensing the environment**	□ Sensory Processing (PSY, BIO)	□ Sensation	□ Threshold □ Weber's Law (PSY) □ Signal detection theory (PSY) □ Sensory adaptation □ Psychophysics
		□ Sensory receptors	□ Sensory pathways □ Types of sensory receptor
	□ Vision (PSY, BIO)	□ Structure and function of the eye	
		□ Visual processing	□ Visual pathways in the brain □ Parallel processing (PSY) □ Feature detection (PSY)
	□ Hearing (PSY, BIO)	□ Structure and function of the ear	
		□ Auditory processing (e.g., auditory pathways in the brain)	
		□ Sensory reception by hair cells	

	□ Other Senses (PSY, BIO)	□ Somatosensation (e.g., pain perception)	
		□ Taste (e.g., taste buds/chemoreceptors that detect specific chemicals)	
		□ Smell	□ Olfactory cells/ chemoreceptors that detect specific chemicals □ Pheromones (BIO) □ Olfactory pathways in the brain (BIO)
		□ Kinesthetic sense (PSY)	
		□ Vestibular sense	
	□ Perception (PSY)	□ Bottom-up/Top-down processing	
		□ Perceptual organization (e.g., depth, form, motion, constancy)	
		□ Gestalt principles	
	□ Attention (PSY)	□ Selective attention	
		□ Divided attention	
		□ Information-processing model	
		□ Cognitive development	□ Piaget's stages of cognitive development □ Cognitive changes in late adulthood □ Role of culture in cognitive development □ Influence of heredity and environment on cognitive development
		□ Biological factors that affect cognition (PSY, BIO)	

□ **6B. Making sense of the environment**	□ Cognition (PSY)	□ Problem solving and decision making	□ Types of problem solving □ Barriers to effective problem solving □ Approaches to problem solving □ Heuristics and biases (e.g., overconfidence, belief perseverance)
		□ Intellectual functioning	□ Theories of intelligence □ Influence of heredity and environment on intelligence □ Variations in intellectual ability
	□ Consciousness (PSY)	□ States of consciousness	□ Alertness (PSY, BIO) □ Sleep □ Stages of sleep □ Sleep cycles and changes to sleep cycles □ Sleep and circadian rhythms (PSY, BIO) □ Dreaming □ Sleep–wake disorders □ Hypnosis and meditation
		□ Consciousness-altering drugs	□ Types of consciousness-altering drugs and their effects on the nervous system and behaviour □ Drug addiction and the reward pathway in the brain
		□ Encoding	□ Process of encoding information □ Processes that aid in encoding memories

	□ Memory (PSY)	□ Storage	□ Types of memory storage (e.g., sensory, working, long-term) □ Semantic networks and spreading activation
		□ Retrieval	□ Recall, recognition, and relearning □ Retrieval cues □ The role of emotion in retrieving memories (PSY, BIO) □ Processes that aid retrieval
		□ Forgetting	□ Aging and memory □ Memory dysfunctions (e.g., Alzheimer's disease, Korsakoff's syndrome) □ Decay □ Interference □ Memory construction and source monitoring
		□ Changes in synaptic connections underlie memory and learning (PSY, BIO)	□ Neural plasticity □ Memory and learning □ Long-term potentiation
	□ Language (PSY)	□ Theories of language development (e.g., learning, Nativist, Interactionist)	
		□ Influence of language on cognition	
		□ Brain areas that control language and speech (PSY, BIO)	
		□ Three components of emotion (i.e., cognitive, physiological, behavioral)	
		□ Universal emotions (i.e., fear, anger, happiness, surprise, joy, disgust, and sadness)	
		□ Adaptive role of emotion	

□ **6C. Responding to the world**	□ Emotion (PSY)	□ Theories of emotion	□ James–Lange theory □ Cannon–Bard theory □ Schachter–Singer theory
		□ The role of biological processes in perceiving emotion (PSY, BIO)	□ Brain regions involved in the generation and experience of emotions □ The role of the limbic system in emotion □ Emotion and the autonomic nervous system □ Physiological markers of emotion (signatures of emotion)
	□ Stress (PSY)	□ The nature of stress	□ Appraisal □ Different types of stressors (e.g., cataclysmic events, personal) □ Effects of stress on psychological functions
		□ Stress outcomes/response to stressors	□ Physiological (PSY, BIO) □ Emotional □ Behavioral
		□ Managing stress (e.g., exercise, relaxation, spirituality)	
□ **Foundational Concept 7: Biological, psychological, and sociocultural factors influence behavior and behavior change.**			

	□ Biological Bases of Behavior (PSY, BIO)	□ The nervous system	□ Neurons (e.g., the reflex arc) □ Neurotransmitters □ Structure and function of the peripheral nervous system □ Structure and function of the central nervous system □ The brain □ Forebrain □ Midbrain □ Hindbrain □ Lateralization of cortical functions □ Methods used in studying the brain □ The spinal cord
		□ Neuronal communication and its influence on behavior (PSY)	
		□ Influence of neurotransmitters on behavior (PSY)	
		□ The endocrine system	□ Components of the endocrine system □ Effects of the endocrine system on behaviour
		□ Behavioral genetics	□ Genes, temperament, and heredity □ Adaptive value of traits and behaviors □ Interaction between heredity and environmental influences
			□ Genes, temperament, and heredity □ Adaptive value of traits and behaviors □ Interaction between heredity and environmental influences

□ **7A. Individual influences on behavior**		□ Influence of genetic and environmental factors on the development of behaviors	□ Experience and behavior (PSY) □ Regulatory genes and behavior (BIO) □ Genetically based behavioral variation in natural populations
		□ Human physiological development (PSY)	□ Prenatal development □ Motor development □ Developmental changes in adolescence
	□ Personality (PSY)	□ Theories of personality	□ Psychoanalytic perspective □ Humanistic perspective □ Trait perspective □ Social cognitive perspective □ Biological perspective □ Behaviorist perspective
		□ Situational approach to explaining behavior	
		□ Understanding psychological disorders	□ Biomedical vs. biopsychosocial approaches □ Classifying psychological disorders □ Rates of psychological disorders

	□ Psychological Disorders (PSY)	□ Types of psychological disorders	□ Anxiety disorders □ Obsessive–compulsive disorder □ Trauma- and stressor-related disorders □ Somatic symptom and related disorders □ Bipolar and related disorders □ Depressive disorders □ Schizophrenia □ Dissociative disorders □ Personality disorders
		□ Biological bases of nervous system disorders (PSY, BIO)	□ Schizophrenia □ Depression □ Alzheimer's disease □ Parkinson's disease □ Stem cell-based therapy to regenerate neurons in the central nervous system (BIO)
	□ Motivation (PSY)	□ Factors that influence motivation	□ Instinct □ Arousal □ Drives (e.g., negative feedback systems) (PSY, BIO) □ Needs
		□ Theories that explain how motivation affects human behavior	□ Drive reduction theory □ Incentive theory □ Other theories (e.g., cognitive, need-based)

		□ Biological and sociocultural motivators that regulate behavior (e.g., hunger, sex drive, substance addiction)	
	□ Attitudes (PSY)	□ Components of attitudes (i.e., cognitive, affective, and behavioral)	
		□ The link between attitudes and behavior	□ Processes by which behavior influences attitudes (e.g., foot-in-the door phenomenon, role-playing effects) □ Processes by which attitudes influence behaviour □ Cognitive dissonance theory
□ **7B. Social processes that influence human behavior**	□ How the Presence of Others Affects Individual Behavior (PSY)	□ Social facilitation	
		□ Deindividuation	
		□ Bystander effect	
		□ Social loafing	
		□ Social control (SOC)	
		□ Peer pressure (PSY, SOC)	
		□ Conformity (PSY, SOC)	
		□ Obedience (PSY, SOC)	
	□ Group Decision-making Processes (PSY, SOC)	□ Group polarization (PSY)	
		□ Groupthink	
	□ Normative and Non-	□ Social norms (PSY, SOC)	□ Sanctions (SOC) □ Folkways, mores, and taboos (SOC) □ Anomie (SOC)

	normative Behavior (SOC)	□ Deviance	□ Perspectives on deviance (e.g., differential association, labeling theory, strain theory)
		□ Aspects of collective behavior (e.g., fads, mass hysteria, riots)	
	□ Socialization (PSY, SOC)	□ Agents of socialization (e.g., the family, mass media, peers, workplace)	
□ 7C. Attitude and behavior change	□ Associative Learning (PSY)	□ Classical conditioning (PSY, BIO)	□ Neutral, conditioned, and unconditioned stimuli □ Conditioned and unconditioned response □ Processes: acquisition, extinction, spontaneous recovery, generalization, discrimination
		□ Operant conditioning (PSY, BIO)	□ Processes of shaping and extinction □ Types of reinforcement: positive, negative, primary, conditional □ Reinforcement schedules: fixed-ratio, variable-ratio, fixed-interval, variable-interval □ Punishment □ Escape and avoidance learning
		□ The role of cognitive processes in associative learning	
		□ Biological processes that affect associative learning (e.g., biological predispositions, instinctive drift) (PSY, BIO)	
	□ Observational Learning (PSY)	□ Modeling	
		□ Biological processes that affect observational learning	□ Mirror neurons □ Role of the brain in experiencing vicarious emotions

		□ Applications of observational learning to explain individual behavior	
	□ Theories of Attitude and Behavior Change (PSY)	□ Elaboration likelihood model	
		□ Social cognitive theory	
		□ Factors that affect attitude change (e.g., changing behavior, characteristics of the message and target, social factors)	
□ Foundational Concept 8: Psychological, sociocultural, and biological factors influence the way we think about ourselves and others, as well as how we interact with others.			
□ 8A. Self-identity	□ Self-Concept, Self-identity, and Social Identity (PSY, SOC)	□ The role of self-esteem, self-efficacy, and locus of control in self-concept and self-identity (PSY)	
		□ Different types of identities (e.g., race/ethnicity, gender, age, sexual orientation, class)	
	□ Formation of Identity (PSY, SOC)	□ Theories of identity development (e.g., gender, moral, psychosexual, social)	
		□ Influence of social factors on identity formation	□ Influence of individuals (e.g., imitation, looking-glass self, role-taking) □ Influence of groups (e.g., reference group)
		□ Influence of culture and socialization on identity formation	
□ 8B. Social thinking	□ Attributing Behavior to Persons or Situations (PSY)	□ Attributional processes (e.g., fundamental attribution error, role of culture in attributions)	
		□ How self-perceptions shape our perceptions of others	
		□ How perceptions of the environment shape our perceptions of others	
	□ Prejudice and Bias (PSY, SOC)	□ Processes that contribute to prejudice	□ Power, prestige, and class (SOC) □ The role of emotion in prejudice (PSY) □ The role of cognition in prejudice (PSY)
		□ Stereotypes	

		□ Stigma (SOC)	
		□ Ethnocentrism (SOC)	□ Ethnocentrism vs. cultural relativism
	□ Processes Related to Stereotypes (PSY)	□ Self-fulfilling prophecy	
		□ Stereotype threat	
	□ Elements of Social Interaction (PSY, SOC)	□ Status (SOC)	□ Types of status (e.g., achieved, ascribed)
		□ Role	□ Role conflict and role strain (SOC) □ Role exit (SOC)
		□ Groups	□ Primary and secondary groups (SOC) □ In-group vs. out-group □ Group size (e.g., dyads, triads) (SOC)
		□ Networks (SOC)	
		□ Organizations (SOC)	□ Formal organization □ Bureaucracy □ Characteristics of an ideal bureaucracy □ Perspectives on bureaucracy (e.g., iron law of oligarchy, McDonaldization)
	□ Self-pre-	□ Expressing and detecting emotion	□ The role of gender in the expression and detection of emotion □ The role of culture in the expression and detection of emotion

□ **8C. Social interactions**	sentation and Interacting with Others (PSY, SOC)	□ Presentation of self	□ Impression management □ Front stage vs. back stage self (Dramaturgical approach) (SOC)
		□ Verbal and nonverbal communication	
		□ Animal signals and communication (PSY, BIO)	
	□ Social Behavior (PSY)	□ Attraction	
		□ Aggression	
		□ Attachment	
		□ Altruism	
		□ Social support (PSY, SOC)	
		□ Biological explanations of social behavior in animals (PSY, BIO)	□ Foraging behavior (BIO) □ Mating behavior and mate choice □ Applying game theory (BIO) □ Altruism □ Inclusive fitness (BIO)
	□ Discrimination (PSY, SOC)	□ Individual vs. institutional discrimination (SOC)	
		□ The relationship between prejudice and discrimination	
		□ How power, prestige, and class facilitate discrimination (SOC)	
□ **Foundational Concept 9: Cultural and social differences influence well-being.**			
	□ Theoreti-	□ Microsociology vs. macrosociology	
		□ Functionalism	
		□ Conflict theory	

□ **9A. Understanding social structure**	□ Theoretical Approaches (SOC)	□ Symbolic interactionism	
		□ Social constructionism	
		□ Exchange-rational choice	
		□ Feminist theory	
	□ Social Institutions (SOC)	□ Education	□ Hidden curriculum □ Teacher expectancy □ Educational segregation and stratification
		□ Family (PSY, SOC)	□ Forms of kinship (SOC) □ Diversity in family forms □ Marriage and divorce □ Violence in the family (e.g., child abuse, elder abuse, spousal abuse) (SOC)
		□ Religion	□ Religiosity □ Types of religious organizations (e.g., churches, sects, cults) □ Religion and social change (e.g., modernization, secularization, fundamentalism)
		□ Government and economy	□ Power and authority □ Comparative economic and political systems □ Division of labor

		□ Health and medicine	□ Medicalization □ The sick role □ Delivery of health care □ Illness experience □ Social epidemiology
	□ Culture (PSY, SOC)	□ Elements of culture (e.g., beliefs, language, rituals, symbols, values)	
		□ Material vs. symbolic culture (SOC)	
		□ Culture lag (SOC)	
		□ Culture shock (SOC)	
		□ Assimilation (SOC)	
		□ Multiculturalism (SOC)	
		□ Subcultures and countercultures (SOC)	
		□ Mass media and popular culture (SOC)	
		□ Evolution and human culture (PSY, BIO)	
		□ Transmission and diffusion (SOC)	
	□ Demographic Structure of	□ Age	□ Aging and the life course □ Age cohorts (SOC) □ Social significance of aging
		□ Gender	□ Sex versus gender □ The social construction of gender (SOC) □ Gender segregation (SOC)

□ **9B. Demographic characteristics and processes**	Society (PSY, SOC)	□ Race and ethnicity (SOC)	□ The social construction of race □ Racialization □ Racial formation
		□ Immigration status (SOC)	□ Patterns of immigration □ Intersections with race and ethnicity
		□ Sexual orientation	
	□ Demographic Shifts and Social Change (SOC)	□ Theories of demographic change (i.e., Malthusian theory and demographic transition)	
		□ Population growth and decline (e.g., population projections, population pyramids)	
		□ Fertility, migration, and mortality	□ Fertility and mortality rates (e.g., total, crude, age-specific) □ Patterns in fertility and mortality □ Push and pull factors in migration
		□ Social movements	□ Relative deprivation □ Organization of social movements □ Movement strategies and tactics
		□ Globalization	□ Factors contributing to globalization (e.g., communication technology, economic interdependence) □ Perspectives on globalization □ Social changes in globalization (e.g., civil unrest, terrorism)

		□ Urbanization	□ Industrialization and urban growth □ Suburbanization and urban decline □ Gentrification and urban renewal
□ Foundational Concept 10: Social stratification and access to resources influence well-being			
□ 10A. Social inequality	□ Spatial Inequality (SOC)	□ Residential segregation	
		□ Neighborhood safety and violence	
		□ Environmental justice (location and exposure to health risks)	
	□ Social Class (SOC)	□ Aspects of social stratification	□ Social class and socioeconomic status □ Class consciousness and false consciousness □ Cultural capital and social capital □ Social reproduction □ Power, privilege, and prestige □ Intersectionality (e.g., race, gender, age) □ Socioeconomic gradient in health □ Global inequalities
		□ Patterns of social mobility	□ Intergenerational and intragenerational mobility □ Vertical and horizontal mobility □ Meritocracy
		□ Poverty	□ Relative and absolute poverty □ Social exclusion (segregation and isolation)

	□ Health Disparities (SOC) (e.g., class, gender, and race inequalities in health)
	□ Healthcare Disparities (SOC) (e.g., class, gender, and race inequalities in health care)