

## MCAT Biology Topics Listed by UD Course Number

BIO 151 & BIO 151L	<p>Amino Acids</p> <ul style="list-style-type: none"><li>• Description<ul style="list-style-type: none"><li>○ Absolute configuration at the <math>\alpha</math> position</li><li>○ Amino acids as dipolar ions</li><li>○ Classifications<ul style="list-style-type: none"><li>▪ Acidic or basic</li><li>▪ Hydrophobic or hydrophilic</li></ul></li></ul></li><li>• Reactions<ul style="list-style-type: none"><li>○ Sulfur linkage for cysteine and cysteine</li><li>○ Peptide linkage: polypeptides and proteins</li><li>○ Hydrolysis</li></ul></li></ul> <p>Protein Structure</p> <ul style="list-style-type: none"><li>• Structure<ul style="list-style-type: none"><li>○ 1° structure of proteins</li><li>○ 2° structure of proteins</li><li>○ 3° structure of proteins; role of proline, cystine, hydrophobic bonding</li><li>○ 4° structure of proteins</li></ul></li><li>• Conformational stability<ul style="list-style-type: none"><li>○ Denaturing and folding</li><li>○ Hydrophobic interactions</li><li>○ Solvation layer (entropy)</li></ul></li><li>• Separation techniques<ul style="list-style-type: none"><li>○ Isoelectric point</li><li>○ Electrophoresis</li></ul></li></ul> <p>Non-Enzymatic Protein Function</p> <ul style="list-style-type: none"><li>• Binding</li><li>• Immune system</li><li>• Motors</li></ul> <p>Enzyme Structure and Function</p> <ul style="list-style-type: none"><li>• Function of enzymes in catalyzing biological reactions</li><li>• Enzyme classification by reaction type</li><li>• Reduction of activation energy</li><li>• Substrates and enzyme specificity</li><li>• Active Site Model</li><li>• Induced-fit Model</li><li>• Mechanism of catalysis<ul style="list-style-type: none"><li>○ Cofactors</li><li>○ Coenzymes</li><li>○ Water-soluble vitamins</li></ul></li><li>• Effects of local conditions on enzyme activity</li></ul> <p>Control of Enzyme Activity</p> <ul style="list-style-type: none"><li>• Kinetics<ul style="list-style-type: none"><li>○ General (catalysis)</li><li>○ Michaelis-Menten</li><li>○ Cooperativity</li></ul></li><li>• Feedback regulation</li></ul>
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	<ul style="list-style-type: none"><li>• Inhibition – types<ul style="list-style-type: none"><li>○ Competitive</li><li>○ Non-competitive</li><li>○ Mixed</li><li>○ Uncompetitive</li></ul></li><li>• Regulatory enzymes<ul style="list-style-type: none"><li>○ Allosteric enzymes</li><li>○ Covalently-modified enzymes</li><li>○ Zymogen</li></ul></li></ul> <p>Nucleic Acid Structure and Function</p> <ul style="list-style-type: none"><li>• Description</li><li>• Nucleotides and nucleosides<ul style="list-style-type: none"><li>○ Sugar phosphate backbone</li><li>○ Pyrimidine, purine residues</li></ul></li><li>• Deoxyribonucleic acid (DNA): double helix, Watson–Crick model of DNA structure</li><li>• Base pairing specificity: A with T, G with C</li><li>• Function in transmission of genetic information</li><li>• DNA denaturation, reannealing, hybridization</li></ul> <p>DNA Replication</p> <ul style="list-style-type: none"><li>• Mechanism of replication: separation of strands, specific coupling of free nucleic acids</li><li>• Semi-conservative nature of replication</li><li>• Specific enzymes involved in replication</li><li>• Origins of replication, multiple origins in eukaryotes</li><li>• Replicating the ends of DNA molecules</li></ul> <p>Repair of DNA</p> <ul style="list-style-type: none"><li>• Repair during replication</li><li>• Repair of mutations</li></ul> <p>Genetic Code</p> <ul style="list-style-type: none"><li>• Central Dogma: DNA → RNA → protein</li><li>• The triplet code</li><li>• Codon-anticodon relationship</li><li>• Degenerate code, wobble pairing</li><li>• Missense, nonsense codons</li><li>• Initiation, termination codons</li><li>• Messenger RNA (mRNA)</li></ul> <p>Transcription</p> <ul style="list-style-type: none"><li>• Transfer RNA (tRNA); ribosomal RNA (rRNA)</li><li>• Mechanism of transcription</li><li>• mRNA processing in eukaryotes, introns, exons</li><li>• Ribozymes, spliceosomes, small nuclear ribonucleoproteins (snRNPs), small nuclear RNA (snRNAs)</li><li>• Functional and evolutionary importance of introns</li></ul> <p>Translation</p>
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	<ul style="list-style-type: none"><li>• Roles of mRNA, tRNA, rRNA</li><li>• Role and structure of ribosomes</li><li>• Initiation, termination co-factors</li><li>• Post-translational modification of proteins</li></ul> <p>Eukaryotic Chromosome Organization</p> <ul style="list-style-type: none"><li>• Chromosomal proteins</li><li>• Single copy vs. repetitive DNA</li><li>• Supercoiling</li><li>• Heterochromatin vs. euchromatin</li><li>• Telomeres, centromeres</li></ul> <p>Control of Gene Expression in Prokaryotes</p> <ul style="list-style-type: none"><li>• Operon Concept, Jacob-Monod Model</li><li>• Gene repression in bacteria</li><li>• Positive control in bacteria</li></ul> <p>Control of Gene Expression in Eukaryotes</p> <ul style="list-style-type: none"><li>• Transcriptional regulation</li><li>• DNA binding proteins, transcription factors</li><li>• Gene amplification and duplication</li><li>• Post-transcriptional control, basic concept of splicing (introns, exons)</li><li>• Cancer as a failure of normal cellular controls, oncogenes, tumor suppressor genes</li><li>• Regulation of chromatin structure</li><li>• DNA methylation</li><li>• Role of non-coding RNAs</li></ul> <p>Recombinant DNA and Biotechnology</p> <ul style="list-style-type: none"><li>• Gene cloning</li><li>• Restriction enzymes</li><li>• DNA libraries</li><li>• Generation of cDNA</li><li>• Hybridization</li><li>• Expressing cloned genes</li><li>• Polymerase Chain Reaction</li><li>• Gel Electrophoresis and Southern Blotting</li><li>• DNA sequencing</li><li>• Analyzing gene expression</li><li>• Determining gene function</li><li>• Stem cells</li><li>• Practical applications of DNA technology: medical applications, human gene therapy, pharmaceuticals, forensic evidence, environmental cleanup, agriculture</li><li>• Safety and ethics of DNA technology</li></ul> <p>Evidence that DNA is Genetic Material</p> <p>Mendelian Concepts</p> <ul style="list-style-type: none"><li>• Phenotype and genotype</li><li>• Gene</li></ul>
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	<ul style="list-style-type: none"><li>• Locus</li><li>• Allele: single and multiple</li><li>• Homozygosity and heterozygosity</li><li>• Wild-type</li><li>• Recessiveness</li><li>• Complete dominance</li><li>• Co-dominance</li><li>• Incomplete dominance, leakage, penetrance, expressivity</li><li>• Hybridization: viability</li><li>• Gene pool</li></ul> <p>Meiosis and Other Factors Affecting Genetic Variability</p> <ul style="list-style-type: none"><li>• Significance of meiosis</li><li>• Important differences between meiosis and mitosis</li><li>• Segregation of genes<ul style="list-style-type: none"><li>○ Independent assortment</li><li>○ Linkage</li><li>○ Recombination<ul style="list-style-type: none"><li>▪ Single crossovers</li><li>▪ Double crossovers</li><li>▪ Synaptonemal complex</li><li>▪ Tetrad</li></ul></li><li>○ Sex-linked characteristics</li><li>○ Very few genes on Y chromosome</li><li>○ Sex determination</li><li>○ Cytoplasmic/extranuclear inheritance</li></ul></li><li>• Mutation<ul style="list-style-type: none"><li>○ General concept of mutation — error in DNA sequence</li><li>○ Types of mutations: random, translation error, transcription error, base substitution, inversion, addition, deletion, translocation, mispairing</li><li>○ Advantageous vs. deleterious mutation</li><li>○ Inborn errors of metabolism</li><li>○ Relationship of mutagens to carcinogens</li></ul></li><li>• Genetic drift</li><li>• Synapsis or crossing-over mechanism for increasing genetic diversity</li></ul> <p>Analytic Methods</p> <ul style="list-style-type: none"><li>• Hardy–Weinberg Principle</li><li>• Test cross</li><li>• Gene mapping: crossover frequencies</li><li>• Biometry: statistical methods</li></ul> <p>Evolution</p> <ul style="list-style-type: none"><li>• Natural selection<ul style="list-style-type: none"><li>○ Fitness concept</li><li>○ Selection by differential reproduction</li><li>○ Concepts of natural and group selection</li><li>○ Evolutionary success as increase in percent representation in the gene pool of the next</li></ul></li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ generation</li><li>● Speciation<ul style="list-style-type: none"><li>○ Polymorphism</li><li>○ Adaptation and specialization</li><li>○ Inbreeding</li><li>○ Outbreeding</li><li>○ Bottlenecks</li></ul></li><li>● Evolutionary time as measured by gradual random changes in genome</li></ul> <p>Principles of Bioenergetics</p> <ul style="list-style-type: none"><li>● Bioenergetics/thermodynamics<ul style="list-style-type: none"><li>○ Free energy/<math>K_{eq}</math><ul style="list-style-type: none"><li>■ Equilibrium constant</li><li>■ Relationship of the equilibrium constant and <math>\Delta G^\circ</math></li></ul></li><li>○ Concentration<ul style="list-style-type: none"><li>■ Le Châtelier's Principle</li></ul></li><li>○ Endothermic/exothermic reactions</li><li>○ Free energy: <math>G</math></li><li>○ Spontaneous reactions and <math>\Delta G^\circ</math></li></ul></li><li>● Phosphoryl group transfers and ATP<ul style="list-style-type: none"><li>○ ATP hydrolysis <math>\Delta G \ll 0</math></li><li>○ ATP group transfers</li></ul></li><li>● Biological oxidation-reduction<ul style="list-style-type: none"><li>○ Half-reactions</li><li>○ Soluble electron carriers</li><li>○ Flavoproteins</li></ul></li></ul> <p>Carbohydrates</p> <ul style="list-style-type: none"><li>● Description<ul style="list-style-type: none"><li>○ Nomenclature and classification, common names</li><li>○ Absolute configuration</li><li>○ Cyclic structure and conformations of hexoses</li><li>○ Epimers and anomers</li></ul></li><li>● Hydrolysis of the glycoside linkage</li><li>● Monosaccharides</li><li>● Disaccharides</li><li>● Polysaccharides</li></ul> <p>Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway</p> <ul style="list-style-type: none"><li>● Glycolysis (aerobic), substrates and products<ul style="list-style-type: none"><li>○ Feeder pathways: glycogen, starch metabolism</li></ul></li><li>● Fermentation (anaerobic glycolysis)</li><li>● Gluconeogenesis</li><li>● Pentose phosphate pathway</li><li>● Net molecular and energetic results of respiration processes</li></ul> <p>Principles of Metabolic Regulation</p> <ul style="list-style-type: none"><li>● Regulation of metabolic pathways<ul style="list-style-type: none"><li>○ Maintenance of a dynamic steady state</li></ul></li><li>● Regulation of glycolysis and gluconeogenesis</li></ul>
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	<ul style="list-style-type: none"><li>• Metabolism of glycogen</li><li>• Regulation of glycogen synthesis and breakdown<ul style="list-style-type: none"><li>○ Allosteric and hormonal control</li></ul></li><li>• Analysis of metabolic control</li></ul> <p>Citric Acid Cycle</p> <ul style="list-style-type: none"><li>• Acetyl-CoA production</li><li>• Reactions of the cycle, substrates and products</li><li>• Regulation of the cycle</li><li>• Net molecular and energetic results of respiration processes</li></ul> <p>Metabolism of Fatty Acids and Proteins</p> <ul style="list-style-type: none"><li>• Description of fatty acids</li><li>• Digestion, mobilization, and transport of fats</li><li>• Oxidation of fatty acids<ul style="list-style-type: none"><li>○ Saturated fats</li><li>○ Unsaturated fats</li></ul></li><li>• Ketone bodies</li><li>• Anabolism of fats</li><li>• Non-template synthesis: biosynthesis of lipids and polysaccharides</li><li>• Metabolism of proteins</li></ul> <p>Oxidative Phosphorylation</p> <ul style="list-style-type: none"><li>• Electron transport chain and oxidative phosphorylation, substrates and products, general features of the pathway</li><li>• Electron transfer in mitochondria<ul style="list-style-type: none"><li>○ NADH, NADPH</li><li>○ Flavoproteins</li><li>○ Cytochromes</li></ul></li><li>• ATP synthase, chemiosmotic coupling<ul style="list-style-type: none"><li>○ Proton motive force</li></ul></li><li>• Net molecular and energetic results of respiration processes</li><li>• Regulation of oxidative phosphorylation</li><li>• Mitochondria, apoptosis, oxidative stress</li></ul> <p>Hormonal Regulation and Integration of Metabolism</p> <ul style="list-style-type: none"><li>• Higher level integration of hormone structure and function</li><li>• Tissue specific metabolism</li><li>• Hormonal regulation of fuel metabolism</li><li>• Obesity and regulation of body mass</li></ul> <p>Plasma Membrane</p> <ul style="list-style-type: none"><li>• General function in cell containment</li><li>• Composition of membranes<ul style="list-style-type: none"><li>○ Lipid components<ul style="list-style-type: none"><li>▪ Phospholipids (and phosphatids)</li><li>▪ Steroids</li><li>▪ Waxes</li></ul></li><li>○ Protein components</li><li>○ Fluid mosaic model</li></ul></li><li>• Membrane dynamics</li></ul>
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	<ul style="list-style-type: none"><li>• Solute transport across membranes<ul style="list-style-type: none"><li>○ Thermodynamic considerations</li><li>○ Osmosis<ul style="list-style-type: none"><li>▪ Colligative properties, osmotic pressure</li></ul></li><li>○ Passive transport</li><li>○ Active transport<ul style="list-style-type: none"><li>▪ Sodium/potassium pump</li></ul></li></ul></li><li>• Membrane channels</li><li>• Membrane potential</li><li>• Membrane receptors</li><li>• Exocytosis and endocytosis</li><li>• Intercellular junctions<ul style="list-style-type: none"><li>○ Gap junctions</li><li>○ Tight junctions</li><li>○ Desmosomes</li></ul></li></ul> <p>Membrane-Bound Organelles and Defining Characteristics of Eukaryotic Cells</p> <ul style="list-style-type: none"><li>• Defining characteristics of eukaryotic cells: membrane bound nucleus, presence of organelles,</li><li>• mitotic division</li><li>• Nucleus<ul style="list-style-type: none"><li>○ Compartmentalization, storage of genetic information</li><li>○ Nucleolus: location and function</li><li>○ Nuclear envelope, nuclear pores</li></ul></li><li>• Mitochondria<ul style="list-style-type: none"><li>○ Site of ATP production</li><li>○ Inner and outer membrane structure</li><li>○ Self-replication</li></ul></li><li>• Lysosomes: membrane-bound vesicles containing hydrolytic enzymes</li><li>• Endoplasmic reticulum<ul style="list-style-type: none"><li>○ Rough and smooth components</li><li>○ Rough endoplasmic reticulum site of ribosomes</li><li>○ Double membrane structure</li><li>○ Role in membrane biosynthesis</li><li>○ Role in biosynthesis of secreted proteins</li></ul></li><li>• Golgi apparatus: general structure and role in packaging and secretion</li><li>• Peroxisomes: organelles that collect peroxides</li></ul> <p>Cytoskeleton</p> <ul style="list-style-type: none"><li>• General function in cell support and movement</li><li>• Microfilaments: composition and role in cleavage and contractility</li><li>• Microtubules: composition and role in support and transport</li><li>• Intermediate filaments, role in support</li><li>• Composition and function of cilia and flagella</li><li>• Centrioles, microtubule organizing centers</li></ul> <p>Tissues Formed From Eukaryotic Cells</p> <ul style="list-style-type: none"><li>• Epithelial cells</li><li>• Connective tissue cells</li></ul> <p>Cell Theory</p>
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	<ul style="list-style-type: none"><li>• History and development</li><li>• Impact on biology</li></ul> <p>Classification and Structure of Prokaryotic Cells</p> <ul style="list-style-type: none"><li>• Prokaryotic domains<ul style="list-style-type: none"><li>○ Archaea</li><li>○ Bacteria</li></ul></li><li>• Major classifications of bacteria by shape<ul style="list-style-type: none"><li>○ Bacilli (rod-shaped)</li><li>○ Spirilli (spiral shaped)</li><li>○ Cocci (spherical)</li></ul></li><li>• Lack of nuclear membrane and mitotic apparatus</li><li>• Lack of typical eukaryotic organelles</li><li>• Presence of cell wall in bacteria</li><li>• Flagellar propulsion, mechanism</li></ul> <p>Growth and Physiology of Prokaryotic Cells</p> <ul style="list-style-type: none"><li>• Reproduction by fission</li><li>• High degree of genetic adaptability, acquisition of antibiotic resistance</li><li>• Exponential growth</li><li>• Existence of anaerobic and aerobic variants</li><li>• Parasitic and symbiotic</li><li>• Chemotaxis</li></ul> <p>Genetics of Prokaryotic Cells</p> <ul style="list-style-type: none"><li>• Existence of plasmids, extragenomic DNA</li><li>• Transformation: incorporation into bacterial genome of DNA fragments from external medium</li><li>• Conjugation</li><li>• Transposons (also present in eukaryotic cells)</li></ul> <p>Virus Structure</p> <ul style="list-style-type: none"><li>• General structural characteristics (nucleic acid and protein, enveloped and nonenveloped)</li><li>• Lack organelles and nucleus</li><li>• Structural aspects of typical bacteriophage</li><li>• Genomic content--RNA or DNA</li><li>• Size relative to bacteria and eukaryotic cells</li></ul> <p>Viral Life Cycle</p> <ul style="list-style-type: none"><li>• Self-replicating biological units that must reproduce within specific host cell</li><li>• Generalized phage and animal virus life cycles<ul style="list-style-type: none"><li>○ Attachment to host, penetration of cell membrane or cell wall, and entry of viral genetic material</li><li>○ Use of host synthetic mechanism to replicate viral components</li><li>○ Self-assembly and release of new viral particles</li></ul></li><li>• Transduction: transfer of genetic material by viruses</li><li>• Retrovirus life cycle: integration into host DNA, reverse transcriptase,</li></ul>
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	<ul style="list-style-type: none"><li>HIV</li><li>• Prions and viroids: subviral particles</li></ul> <p>Mitosis</p> <ul style="list-style-type: none"><li>• Mitotic process: prophase, metaphase, anaphase, telophase, interphase</li><li>• Mitotic structures<ul style="list-style-type: none"><li>○ Centrioles, asters, spindles</li><li>○ Chromatids, centromeres, kinetochores</li><li>○ Nuclear membrane breakdown and reorganization</li><li>○ Mechanisms of chromosome movement</li></ul></li><li>• Phases of cell cycle: G0, G1, S, G2, M</li><li>• Growth arrest</li><li>• Control of cell cycle</li><li>• Loss of cell cycle controls in cancer cells</li></ul> <p>Biosignalling</p> <ul style="list-style-type: none"><li>• Oncogenes, apoptosis</li></ul> <p>Nerve Cell</p> <ul style="list-style-type: none"><li>• Cell body: site of nucleus, organelles</li><li>• Dendrites: branched extensions of cell body</li><li>• Axon: structure and function</li><li>• Myelin sheath, Schwann cells, insulation of axon</li><li>• Nodes of Ranvier: propagation of nerve impulse along axon</li><li>• Synapse: site of impulse propagation between cells</li><li>• Synaptic activity: transmitter molecules</li><li>• Resting potential: electrochemical gradient</li><li>• Action potential<ul style="list-style-type: none"><li>○ Threshold, all-or-none</li><li>○ Sodium/potassium pump</li></ul></li><li>• Excitatory and inhibitory nerve fibers: summation, frequency of firing</li><li>• Glial cells, neuroglia</li></ul> <p>Biosignalling</p> <ul style="list-style-type: none"><li>• Gated ion channels<ul style="list-style-type: none"><li>○ Voltage gated</li><li>○ Ligand gated</li></ul></li><li>• Receptor enzymes</li><li>• G protein-coupled receptors</li></ul> <p>Lipids</p> <ul style="list-style-type: none"><li>• Description; structure<ul style="list-style-type: none"><li>○ Steroids</li></ul></li><li>• Terpenes and terpenoids</li></ul> <p>Nucleotides and Nucleic Acids</p> <ul style="list-style-type: none"><li>• Nucleotides and nucleosides: composition<ul style="list-style-type: none"><li>○ Sugar phosphate backbone</li><li>○ Pyrimidine, purine residues</li></ul></li><li>• Deoxyribonucleic acid: DNA, double helix</li><li>• Chemistry</li></ul>
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	<ul style="list-style-type: none"> <li>• Other functions</li> </ul> <p>Enzymes</p> <ul style="list-style-type: none"> <li>• Classification by reaction type</li> <li>• Mechanism             <ul style="list-style-type: none"> <li>○ Substrates and enzyme specificity</li> <li>○ Active site model</li> <li>○ Induced-fit model</li> <li>○ Cofactors, coenzymes and vitamins</li> </ul> </li> <li>• Kinetics             <ul style="list-style-type: none"> <li>○ General (catalysis)</li> <li>○ Michaelis-Menten</li> <li>○ Cooperativity</li> <li>○ Effects of local conditions on enzyme activity</li> </ul> </li> <li>• Inhibition</li> <li>• Regulatory enzymes             <ul style="list-style-type: none"> <li>○ Allosteric</li> <li>○ Covalently modified</li> </ul> </li> </ul>
<p>BIO152 &amp; BIO 152L</p>	<p>Mendelian Concepts</p> <ul style="list-style-type: none"> <li>• Phenotype and genotype</li> <li>• Gene</li> <li>• Locus</li> <li>• Allele: single and multiple</li> <li>• Homozygosity and heterozygosity</li> <li>• Wild-type</li> <li>• Recessiveness</li> <li>• Complete dominance</li> <li>• Co-dominance</li> <li>• Incomplete dominance, leakage, penetrance, expressivity</li> <li>• Hybridization: viability</li> <li>• Gene pool</li> </ul> <p>Meiosis and Other Factors Affecting Genetic Variability</p> <ul style="list-style-type: none"> <li>• Significance of meiosis</li> <li>• Important differences between meiosis and mitosis</li> <li>• Segregation of genes             <ul style="list-style-type: none"> <li>○ Independent assortment</li> <li>○ Linkage</li> <li>○ Recombination                 <ul style="list-style-type: none"> <li>▪ Single crossovers</li> <li>▪ Double crossovers</li> <li>▪ Synaptonemal complex</li> <li>▪ Tetrad</li> </ul> </li> <li>○ Sex-linked characteristics</li> <li>○ Very few genes on Y chromosome</li> <li>○ Sex determination</li> <li>○ Cytoplasmic/extranuclear inheritance</li> </ul> </li> <li>• Mutation             <ul style="list-style-type: none"> <li>○ General concept of mutation — error in DNA sequence</li> </ul> </li> </ul>

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	<ul style="list-style-type: none"><li>○ Types of mutations: random, translation error, transcription error, base substitution, inversion, addition, deletion, translocation, mispairing</li><li>○ Advantageous vs. deleterious mutation</li><li>○ Inborn errors of metabolism</li><li>○ Relationship of mutagens to carcinogens</li><li>● Genetic drift</li><li>● Synapsis or crossing-over mechanism for increasing genetic diversity</li></ul> <p>Analytic Methods</p> <ul style="list-style-type: none"><li>● Hardy–Weinberg Principle</li><li>● Test cross</li><li>● Gene mapping: crossover frequencies</li><li>● Biometry: statistical methods</li></ul> <p>Evolution</p> <ul style="list-style-type: none"><li>● Natural selection<ul style="list-style-type: none"><li>○ Fitness concept</li><li>○ Selection by differential reproduction</li><li>○ Concepts of natural and group selection</li><li>○ Evolutionary success as increase in percent representation in the gene pool of the next generation</li></ul></li><li>● Speciation<ul style="list-style-type: none"><li>○ Polymorphism</li><li>○ Adaptation and specialization</li><li>○ Inbreeding</li><li>○ Outbreeding</li><li>○ Bottlenecks</li></ul></li><li>● Evolutionary time as measured by gradual random changes in genome</li></ul> <p>Reproductive System</p> <ul style="list-style-type: none"><li>● Gametogenesis by meiosis</li><li>● Ovum and sperm<ul style="list-style-type: none"><li>○ Differences in formation</li><li>○ Differences in morphology</li><li>○ Relative contribution to next generation</li></ul></li><li>● Reproductive sequence: fertilization, implantation, development, birth</li></ul> <p>Embryogenesis</p> <ul style="list-style-type: none"><li>● Stages of early development (order and general features of each)<ul style="list-style-type: none"><li>○ Fertilization</li><li>○ Cleavage</li><li>○ Blastula formation</li><li>○ Gastrulation<ul style="list-style-type: none"><li>▪ First cell movements</li><li>▪ Formation of primary germ layers (endoderm, mesoderm, ectoderm)</li></ul></li><li>○ Neurulation</li></ul></li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Major structures arising out of primary germ layers</li><li>• Neural crest</li><li>• Environment–gene interaction in development</li></ul> <p>Mechanisms of Development</p> <ul style="list-style-type: none"><li>• Cell specialization<ul style="list-style-type: none"><li>○ Determination</li><li>○ Differentiation</li><li>○ Tissue types</li></ul></li><li>• Cell–cell communication in development</li><li>• Cell migration</li><li>• Pluripotency: stem cells</li><li>• Gene regulation in development</li><li>• Programmed cell death</li><li>• Existence of regenerative capacity in various species</li><li>• Senescence and aging</li></ul> <p>Nervous System: Structure and Function (BIO 152)</p> <ul style="list-style-type: none"><li>• Major Functions<ul style="list-style-type: none"><li>○ High level control and integration of body systems</li><li>○ Adaptive capability to external influences</li></ul></li><li>• Organization of vertebrate nervous system</li><li>• Sensor and effector neurons</li><li>• Sympathetic and parasympathetic nervous systems: antagonistic control</li><li>• Reflexes<ul style="list-style-type: none"><li>○ Feedback loop, reflex arc</li><li>○ Role of spinal cord and supraspinal circuits</li></ul></li><li>• Integration with endocrine system: feedback control</li></ul> <p>Endocrine System: Hormones and Their Sources</p> <ul style="list-style-type: none"><li>• Function of endocrine system: specific chemical control at cell, tissue, and organ level</li><li>• Definitions of endocrine gland, hormone</li><li>• Major endocrine glands: names, locations, products</li><li>• Major types of hormones</li><li>• Neuroendocrinology — relation between neurons and hormonal systems</li></ul> <p>Endocrine System: Mechanisms of Hormone Action</p> <ul style="list-style-type: none"><li>• Cellular mechanisms of hormone action</li><li>• Transport of hormones: blood supply</li><li>• Specificity of hormones: target tissue</li><li>• Integration with nervous system: feedback control regulation by second messengers</li></ul> <p>Respiratory System</p> <ul style="list-style-type: none"><li>• General function<ul style="list-style-type: none"><li>○ Gas exchange, thermoregulation</li><li>○ Protection against disease: particulate matter</li></ul></li><li>• Structure of lungs and alveoli</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Breathing mechanisms<ul style="list-style-type: none"><li>○ Diaphragm, rib cage, differential pressure</li><li>○ Resiliency and surface tension effects</li></ul></li><li>• Thermoregulation: nasal and tracheal capillary beds; evaporation, panting</li><li>• Particulate filtration: nasal hairs, mucus/cilia system in lungs</li><li>• Alveolar gas exchange<ul style="list-style-type: none"><li>○ Diffusion, differential partial pressure</li><li>○ Henry's Law</li></ul></li><li>• pH control</li><li>• Regulation by nervous control<ul style="list-style-type: none"><li>○ CO<sub>2</sub> sensitivity</li></ul></li></ul> <p>Circulatory System</p> <ul style="list-style-type: none"><li>• Functions: circulation of oxygen, nutrients, hormones, ions and fluids, removal of metabolic waste</li><li>• Role in thermoregulation</li><li>• Four-chambered heart: structure and function</li><li>• Endothelial cells</li><li>• Systolic and diastolic pressure</li><li>• Pulmonary and systemic circulation</li><li>• Arterial and venous systems (arteries, arterioles, venules, veins)<ul style="list-style-type: none"><li>○ Structural and functional differences</li><li>○ Pressure and flow characteristics</li></ul></li><li>• Capillary beds<ul style="list-style-type: none"><li>○ Mechanisms of gas and solute exchange</li><li>○ Mechanism of heat exchange</li><li>○ Source of peripheral resistance</li></ul></li><li>• Composition of blood<ul style="list-style-type: none"><li>○ Plasma, chemicals, blood cells</li><li>○ Erythrocyte production and destruction; spleen, bone marrow</li><li>○ Regulation of plasma volume</li></ul></li><li>• Coagulation, clotting mechanisms</li><li>• Oxygen transport by blood<ul style="list-style-type: none"><li>○ Hemoglobin, hematocrit</li><li>○ Oxygen content</li><li>○ Oxygen affinity</li><li>○ Oxygen transport by blood; modification of oxygen affinity</li></ul></li><li>• Carbon dioxide transport and level in blood</li><li>• Nervous and endocrine control</li></ul> <p>Lymphatic System</p> <ul style="list-style-type: none"><li>• Structure of lymphatic system</li><li>• Major functions<ul style="list-style-type: none"><li>○ Equalization of fluid distribution</li><li>○ Transport of proteins and large glycerides</li><li>○ Production of lymphocytes involved in immune reactions</li><li>○ Return of materials to the blood</li></ul></li></ul>
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MCAT Biology Topics Listed by UD Course Number

<p>BIO 301</p>	<p>Mendelian Concepts</p> <ul style="list-style-type: none"> <li>• Phenotype and genotype</li> <li>• Gene</li> <li>• Locus</li> <li>• Allele: single and multiple</li> <li>• Homozygosity and heterozygosity</li> <li>• Wild-type</li> <li>• Recessiveness</li> <li>• Complete dominance</li> <li>• Co-dominance</li> <li>• Incomplete dominance, leakage, penetrance, expressivity</li> <li>• Hybridization: viability</li> <li>• Gene pool</li> </ul>
<p>BIO 312 &amp; BIO 312L</p>	<p>Amino Acids</p> <ul style="list-style-type: none"> <li>• Description <ul style="list-style-type: none"> <li>○ Absolute configuration at the <math>\alpha</math> position</li> <li>○ Amino acids as dipolar ions</li> <li>○ Classifications <ul style="list-style-type: none"> <li>▪ Acidic or basic</li> <li>▪ Hydrophobic or hydrophilic</li> </ul> </li> </ul> </li> <li>• Reactions <ul style="list-style-type: none"> <li>○ Sulfur linkage for cysteine and cysteine</li> <li>○ Peptide linkage: polypeptides and proteins</li> <li>○ Hydrolysis</li> </ul> </li> </ul> <p>Protein Structure</p> <ul style="list-style-type: none"> <li>• Structure <ul style="list-style-type: none"> <li>○ 1° structure of proteins</li> <li>○ 2° structure of proteins</li> <li>○ 3° structure of proteins; role of proline, cystine, hydrophobic bonding</li> <li>○ 4° structure of proteins</li> </ul> </li> <li>• Conformational stability <ul style="list-style-type: none"> <li>○ Denaturing and folding</li> <li>○ Hydrophobic interactions</li> <li>○ Solvation layer (entropy)</li> </ul> </li> <li>• Separation techniques <ul style="list-style-type: none"> <li>○ Isoelectric point</li> <li>○ Electrophoresis</li> </ul> </li> </ul> <p>Non-Enzymatic Protein Function</p> <ul style="list-style-type: none"> <li>• Binding</li> <li>• Immune system</li> <li>• Motors</li> </ul> <p>Nucleic Acid Structure and Function</p> <ul style="list-style-type: none"> <li>• Description</li> <li>• Nucleotides and nucleosides <ul style="list-style-type: none"> <li>○ Sugar phosphate backbone</li> </ul> </li> </ul>

## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Pyrimidine, purine residues</li><li>● Deoxyribonucleic acid (DNA): double helix, Watson–Crick model of DNA structure</li><li>● Base pairing specificity: A with T, G with C</li><li>● Function in transmission of genetic information</li><li>● DNA denaturation, reannealing, hybridization</li></ul> <p>DNA Replication</p> <ul style="list-style-type: none"><li>● Mechanism of replication: separation of strands, specific coupling of free nucleic acids</li><li>● Semi-conservative nature of replication</li><li>● Specific enzymes involved in replication</li><li>● Origins of replication, multiple origins in eukaryotes</li><li>● Replicating the ends of DNA molecules</li></ul> <p>Repair of DNA</p> <ul style="list-style-type: none"><li>● Repair during replication</li><li>● Repair of mutations</li></ul> <p>Genetic Code</p> <ul style="list-style-type: none"><li>● Central Dogma: DNA → RNA → protein</li><li>● The triplet code</li><li>● Codon-anticodon relationship</li><li>● Degenerate code, wobble pairing</li><li>● Missense, nonsense codons</li><li>● Initiation, termination codons</li><li>● Messenger RNA (mRNA)</li></ul> <p>Transcription</p> <ul style="list-style-type: none"><li>● Transfer RNA (tRNA); ribosomal RNA (rRNA)</li><li>● Mechanism of transcription</li><li>● mRNA processing in eukaryotes, introns, exons</li><li>● Ribozymes, spliceosomes, small nuclear ribonucleoproteins (snRNPs), small nuclear RNA (snRNAs)</li><li>● Functional and evolutionary importance of introns</li></ul> <p>Translation</p> <ul style="list-style-type: none"><li>● Roles of mRNA, tRNA, rRNA</li><li>● Role and structure of ribosomes</li><li>● Initiation, termination co-factors</li><li>● Post-translational modification of proteins</li></ul> <p>Eukaryotic Chromosome Organization</p> <ul style="list-style-type: none"><li>● Chromosomal proteins</li><li>● Single copy vs. repetitive DNA</li><li>● Supercoiling</li><li>● Heterochromatin vs. euchromatin</li><li>● Telomeres, centromeres</li></ul> <p>Control of Gene Expression in Prokaryotes</p> <ul style="list-style-type: none"><li>● Operon Concept, Jacob-Monod Model</li><li>● Gene repression in bacteria</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Positive control in bacteria</li></ul> <p>Control of Gene Expression in Eukaryotes</p> <ul style="list-style-type: none"><li>• Transcriptional regulation</li><li>• DNA binding proteins, transcription factors</li><li>• Gene amplification and duplication</li><li>• Post-transcriptional control, basic concept of splicing (introns, exons)</li><li>• Cancer as a failure of normal cellular controls, oncogenes, tumor suppressor genes</li><li>• Regulation of chromatin structure</li><li>• DNA methylation</li><li>• Role of non-coding RNAs</li></ul> <p>Recombinant DNA and Biotechnology</p> <ul style="list-style-type: none"><li>• Gene cloning</li><li>• Restriction enzymes</li><li>• DNA libraries</li><li>• Generation of cDNA</li><li>• Hybridization</li><li>• Expressing cloned genes</li><li>• Polymerase Chain Reaction</li><li>• Gel Electrophoresis and Southern Blotting</li><li>• DNA sequencing</li><li>• Analyzing gene expression</li><li>• Determining gene function</li><li>• Stem cells</li><li>• Practical applications of DNA technology: medical applications, human gene therapy, pharmaceuticals, forensic evidence, environmental cleanup, agriculture</li><li>• Safety and ethics of DNA technology</li></ul> <p>Evidence that DNA is Genetic Material</p> <p>Mendelian Concepts</p> <ul style="list-style-type: none"><li>• Phenotype and genotype</li><li>• Gene</li><li>• Locus</li><li>• Allele: single and multiple</li><li>• Homozygosity and heterozygosity</li><li>• Wild-type</li><li>• Recessiveness</li><li>• Complete dominance</li><li>• Co-dominance</li><li>• Incomplete dominance, leakage, penetrance, expressivity</li><li>• Hybridization: viability</li><li>• Gene pool</li></ul> <p>Meiosis and Other Factors Affecting Genetic Variability</p> <ul style="list-style-type: none"><li>• Significance of meiosis</li><li>• Important differences between meiosis and mitosis</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Segregation of genes<ul style="list-style-type: none"><li>○ Independent assortment</li><li>○ Linkage</li><li>○ Recombination<ul style="list-style-type: none"><li>▪ Single crossovers</li><li>▪ Double crossovers</li><li>▪ Synaptonemal complex</li><li>▪ Tetrad</li></ul></li><li>○ Sex-linked characteristics</li><li>○ Very few genes on Y chromosome</li><li>○ Sex determination</li><li>○ Cytoplasmic/extranuclear inheritance</li></ul></li><li>• Mutation<ul style="list-style-type: none"><li>○ General concept of mutation — error in DNA sequence</li><li>○ Types of mutations: random, translation error, transcription error, base substitution, inversion, addition, deletion, translocation, mispairing</li><li>○ Advantageous vs. deleterious mutation</li><li>○ Inborn errors of metabolism</li><li>○ Relationship of mutagens to carcinogens</li></ul></li><li>• Genetic drift</li><li>• Synapsis or crossing-over mechanism for increasing genetic diversity</li></ul> <p>Analytic Methods</p> <ul style="list-style-type: none"><li>• Hardy–Weinberg Principle</li><li>• Test cross</li><li>• Gene mapping: crossover frequencies</li><li>• Biometry: statistical methods</li></ul> <p>Evolution</p> <ul style="list-style-type: none"><li>• Natural selection<ul style="list-style-type: none"><li>○ Fitness concept</li><li>○ Selection by differential reproduction</li><li>○ Concepts of natural and group selection</li><li>○ Evolutionary success as increase in percent representation in the gene pool of the next generation</li></ul></li><li>• Speciation<ul style="list-style-type: none"><li>○ Polymorphism</li><li>○ Adaptation and specialization</li><li>○ Inbreeding</li><li>○ Outbreeding</li><li>○ Bottlenecks</li></ul></li><li>• Evolutionary time as measured by gradual random changes in genome</li></ul> <p>Genetics of Prokaryotic Cells (BIO 312L)</p> <ul style="list-style-type: none"><li>• Existence of plasmids, extragenomic DNA</li><li>• Transformation: incorporation into bacterial genome of DNA fragments from external medium</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>• Conjugation</li> <li>• Transposons (also present in eukaryotic cells)</li> </ul> <p>Mitosis</p> <ul style="list-style-type: none"> <li>• Mitotic process: prophase, metaphase, anaphase, telophase, interphase</li> <li>• Mitotic structures             <ul style="list-style-type: none"> <li>○ Centrioles, asters, spindles</li> <li>○ Chromatids, centromeres, kinetochores</li> <li>○ Nuclear membrane breakdown and reorganization</li> <li>○ Mechanisms of chromosome movement</li> </ul> </li> <li>• Phases of cell cycle: G<sub>0</sub>, G<sub>1</sub>, S, G<sub>2</sub>, M</li> <li>• Growth arrest</li> <li>• Control of cell cycle</li> <li>• Loss of cell cycle controls in cancer cells</li> </ul> <p>Biosignalling</p> <ul style="list-style-type: none"> <li>• Gated ion channels             <ul style="list-style-type: none"> <li>○ Voltage gated</li> <li>○ Ligand gated</li> </ul> </li> <li>• Receptor enzymes</li> <li>• G protein-coupled receptors</li> </ul> <p>Nucleotides and Nucleic Acids</p> <ul style="list-style-type: none"> <li>• Nucleotides and nucleosides: composition             <ul style="list-style-type: none"> <li>○ Sugar phosphate backbone</li> <li>○ Pyrimidine, purine residues</li> </ul> </li> <li>• Deoxyribonucleic acid: DNA, double helix</li> <li>• Chemistry</li> <li>• Other functions</li> </ul> <p>Enzymes</p> <ul style="list-style-type: none"> <li>• Classification by reaction type</li> <li>• Mechanism             <ul style="list-style-type: none"> <li>○ Substrates and enzyme specificity</li> <li>○ Active site model</li> <li>○ Induced-fit model</li> <li>○ Cofactors, coenzymes and vitamins</li> </ul> </li> <li>• Kinetics             <ul style="list-style-type: none"> <li>○ General (catalysis)</li> <li>○ Michaelis-Menten</li> <li>○ Cooperativity</li> <li>○ Effects of local conditions on enzyme activity</li> </ul> </li> <li>• Inhibition</li> <li>• Regulatory enzymes             <ul style="list-style-type: none"> <li>○ Allosteric</li> </ul> </li> <li>• Covalently modified</li> </ul>
BIO 403 & BIO 403L	<p>Amino Acids</p> <ul style="list-style-type: none"> <li>• Description             <ul style="list-style-type: none"> <li>○ Absolute configuration at the <math>\alpha</math> position</li> </ul> </li> </ul>

## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Amino acids as dipolar ions</li><li>○ Classifications<ul style="list-style-type: none"><li>▪ Acidic or basic</li><li>▪ Hydrophobic or hydrophilic</li></ul></li><li>● Reactions<ul style="list-style-type: none"><li>○ Sulfur linkage for cysteine and cysteine</li><li>○ Peptide linkage: polypeptides and proteins</li><li>○ Hydrolysis</li></ul></li></ul> <p>Protein Structure</p> <ul style="list-style-type: none"><li>● Structure<ul style="list-style-type: none"><li>○ 1° structure of proteins</li><li>○ 2° structure of proteins</li><li>○ 3° structure of proteins; role of proline, cystine, hydrophobic bonding</li><li>○ 4° structure of proteins</li></ul></li><li>● Conformational stability<ul style="list-style-type: none"><li>○ Denaturing and folding</li><li>○ Hydrophobic interactions</li><li>○ Solvation layer (entropy)</li></ul></li><li>● Separation techniques<ul style="list-style-type: none"><li>○ Isoelectric point</li><li>○ Electrophoresis</li></ul></li></ul> <p>Non-Enzymatic Protein Function</p> <ul style="list-style-type: none"><li>● Binding</li><li>● Immune system</li><li>● Motors</li></ul> <p>Analytic Methods</p> <ul style="list-style-type: none"><li>● Hardy–Weinberg Principle</li><li>● Test cross</li><li>● Gene mapping: crossover frequencies</li><li>● Biometry: statistical methods</li><li>●</li></ul> <p>Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway</p> <ul style="list-style-type: none"><li>● Glycolysis (aerobic), substrates and products<ul style="list-style-type: none"><li>○ Feeder pathways: glycogen, starch metabolism</li></ul></li><li>● Fermentation (anaerobic glycolysis)</li><li>● Gluconeogenesis</li><li>● Pentose phosphate pathway</li><li>● Net molecular and energetic results of respiration processes</li></ul> <p>Citric Acid Cycle</p> <ul style="list-style-type: none"><li>● Acetyl-CoA production</li><li>● Reactions of the cycle, substrates and products</li><li>● Regulation of the cycle</li><li>● Net molecular and energetic results of respiration processes</li></ul> <p>Metabolism of Fatty Acids and Proteins</p> <ul style="list-style-type: none"><li>● Description of fatty acids</li><li>● Digestion, mobilization, and transport of fats</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Oxidation of fatty acids<ul style="list-style-type: none"><li>○ Saturated fats</li><li>○ Unsaturated fats</li></ul></li><li>• Ketone bodies</li><li>• Anabolism of fats</li><li>• Non-template synthesis: biosynthesis of lipids and polysaccharides (BIO)</li><li>• Metabolism of proteins</li></ul> <p>Oxidative Phosphorylation</p> <ul style="list-style-type: none"><li>• Electron transport chain and oxidative phosphorylation, substrates and products, general features of the pathway</li><li>• Electron transfer in mitochondria<ul style="list-style-type: none"><li>○ NADH, NADPH</li><li>○ Flavoproteins</li><li>○ Cytochromes</li></ul></li><li>• ATP synthase, chemiosmotic coupling<ul style="list-style-type: none"><li>○ Proton motive force</li></ul></li><li>• Net molecular and energetic results of respiration processes</li><li>• Regulation of oxidative phosphorylation</li><li>• Mitochondria, apoptosis, oxidative stress</li></ul> <p>Hormonal Regulation and Integration of Metabolism</p> <ul style="list-style-type: none"><li>• Higher level integration of hormone structure and function</li><li>• Tissue specific metabolism</li><li>• Hormonal regulation of fuel metabolism</li><li>• Obesity and regulation of body mass</li></ul> <p>Plasma Membrane</p> <ul style="list-style-type: none"><li>• General function in cell containment</li><li>• Composition of membranes<ul style="list-style-type: none"><li>○ Lipid components<ul style="list-style-type: none"><li>▪ Phospholipids (and phosphatids)</li><li>▪ Steroids</li><li>▪ Waxes</li></ul></li><li>○ Protein components</li><li>○ Fluid mosaic model</li></ul></li><li>• Membrane dynamics</li><li>• Solute transport across membranes<ul style="list-style-type: none"><li>○ Thermodynamic considerations</li><li>○ Osmosis<ul style="list-style-type: none"><li>▪ Colligative properties, osmotic pressure</li></ul></li><li>○ Passive transport</li><li>○ Active transport<ul style="list-style-type: none"><li>▪ Sodium/potassium pump</li></ul></li></ul></li><li>• Membrane channels</li><li>• Membrane potential</li><li>• Membrane receptors</li><li>• Exocytosis and endocytosis</li><li>• Intercellular junctions</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Gap junctions</li><li>○ Tight junctions</li><li>○ Desmosomes</li></ul> <p>Membrane-Bound Organelles and Defining Characteristics of Eukaryotic Cells</p> <ul style="list-style-type: none"><li>● Defining characteristics of eukaryotic cells: membrane bound nucleus, presence of organelles,</li><li>● mitotic division</li><li>● Nucleus<ul style="list-style-type: none"><li>○ Compartmentalization, storage of genetic information</li><li>○ Nucleolus: location and function</li><li>○ Nuclear envelope, nuclear pores</li></ul></li><li>● Mitochondria<ul style="list-style-type: none"><li>○ Site of ATP production</li><li>○ Inner and outer membrane structure</li><li>○ Self-replication</li></ul></li><li>● Lysosomes: membrane-bound vesicles containing hydrolytic enzymes</li><li>● Endoplasmic reticulum<ul style="list-style-type: none"><li>○ Rough and smooth components</li><li>○ Rough endoplasmic reticulum site of ribosomes</li><li>○ Double membrane structure</li><li>○ Role in membrane biosynthesis</li><li>○ Role in biosynthesis of secreted proteins</li></ul></li><li>● Golgi apparatus: general structure and role in packaging and secretion</li><li>● Peroxisomes: organelles that collect peroxides</li></ul> <p>Genetics of Prokaryotic Cells (BIO 312L)</p> <ul style="list-style-type: none"><li>● Existence of plasmids, extragenomic DNA</li><li>● Transformation: incorporation into bacterial genome of DNA fragments from external medium</li><li>● Conjugation</li><li>● Transposons (also present in eukaryotic cells)</li></ul> <p>Biosignalling</p> <ul style="list-style-type: none"><li>● Oncogenes, apoptosis</li></ul> <p>Reproductive System</p> <ul style="list-style-type: none"><li>● Gametogenesis by meiosis</li><li>● Ovum and sperm<ul style="list-style-type: none"><li>○ Differences in formation</li><li>○ Differences in morphology</li><li>○ Relative contribution to next generation</li></ul></li><li>● Reproductive sequence: fertilization, implantation, development, birth</li></ul> <p>Nerve Cell</p> <ul style="list-style-type: none"><li>● Cell body: site of nucleus, organelles</li><li>● Dendrites: branched extensions of cell body</li><li>● Axon: structure and function</li><li>● Myelin sheath, Schwann cells, insulation of axon</li><li>● Nodes of Ranvier: propagation of nerve impulse along axon</li><li>● Synapse: site of impulse propagation between cells</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Synaptic activity: transmitter molecules</li><li>• Resting potential: electrochemical gradient</li><li>• Action potential<ul style="list-style-type: none"><li>○ Threshold, all-or-none</li><li>○ Sodium/potassium pump</li></ul></li><li>• Excitatory and inhibitory nerve fibers: summation, frequency of firing</li><li>• Glial cells, neuroglia</li></ul> <p>Electrochemistry</p> <ul style="list-style-type: none"><li>• Concentration cell: direction of electron flow, Nernst equation</li></ul> <p>Lipids</p> <ul style="list-style-type: none"><li>• Description; structure<ul style="list-style-type: none"><li>○ Steroids</li></ul></li><li>• Terpenes and terpenoids</li></ul> <p>Endocrine System: Hormones and Their Sources</p> <ul style="list-style-type: none"><li>• Function of endocrine system: specific chemical control at cell, tissue, and organ level</li><li>• Definitions of endocrine gland, hormone</li><li>• Major endocrine glands: names, locations, products</li><li>• Major types of hormones</li><li>• Neuroendocrinology — relation between neurons and hormonal systems</li></ul> <p>Endocrine System: Mechanisms of Hormone Action</p> <ul style="list-style-type: none"><li>• Cellular mechanisms of hormone action</li><li>• Transport of hormones: blood supply</li><li>• Specificity of hormones: target tissue</li><li>• Integration with nervous system: feedback control regulation by second messengers</li></ul> <p>Respiratory System</p> <ul style="list-style-type: none"><li>• General function<ul style="list-style-type: none"><li>○ Gas exchange, thermoregulation</li><li>○ Protection against disease: particulate matter</li></ul></li><li>• Structure of lungs and alveoli</li><li>• Breathing mechanisms<ul style="list-style-type: none"><li>○ Diaphragm, rib cage, differential pressure</li><li>○ Resiliency and surface tension effects</li></ul></li><li>• Thermoregulation: nasal and tracheal capillary beds; evaporation, panting</li><li>• Particulate filtration: nasal hairs, mucus/cilia system in lungs</li><li>• Alveolar gas exchange<ul style="list-style-type: none"><li>○ Diffusion, differential partial pressure</li><li>○ Henry's Law</li></ul></li><li>• pH control</li><li>• Regulation by nervous control</li><li>• CO<sub>2</sub> sensitivity</li></ul> <p>Circulatory System</p> <ul style="list-style-type: none"><li>• Functions: circulation of oxygen, nutrients, hormones, ions and fluids, removal of metabolic</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<p>waste</p> <ul style="list-style-type: none"> <li>• Role in thermoregulation</li> <li>• Four-chambered heart: structure and function</li> <li>• Endothelial cells</li> <li>• Systolic and diastolic pressure</li> <li>• Pulmonary and systemic circulation</li> <li>• Arterial and venous systems (arteries, arterioles, venules, veins) <ul style="list-style-type: none"> <li>○ Structural and functional differences</li> <li>○ Pressure and flow characteristics</li> </ul> </li> <li>• Capillary beds <ul style="list-style-type: none"> <li>○ Mechanisms of gas and solute exchange</li> <li>○ Mechanism of heat exchange</li> <li>○ Source of peripheral resistance</li> </ul> </li> <li>• Composition of blood <ul style="list-style-type: none"> <li>○ Plasma, chemicals, blood cells</li> <li>○ Erythrocyte production and destruction; spleen, bone marrow</li> <li>○ Regulation of plasma volume</li> </ul> </li> <li>• Coagulation, clotting mechanisms</li> <li>• Oxygen transport by blood <ul style="list-style-type: none"> <li>○ Hemoglobin, hematocrit</li> <li>○ Oxygen content</li> <li>○ Oxygen affinity</li> <li>○ Oxygen transport by blood; modification of oxygen affinity</li> </ul> </li> <li>• Carbon dioxide transport and level in blood</li> <li>• Nervous and endocrine control</li> </ul> <p>Lymphatic System</p> <ul style="list-style-type: none"> <li>• Structure of lymphatic system</li> <li>• Major functions <ul style="list-style-type: none"> <li>○ Equalization of fluid distribution</li> <li>○ Transport of proteins and large glycerides</li> <li>○ Production of lymphocytes involved in immune reactions</li> </ul> </li> <li>• Return of materials to the blood</li> </ul> <p>Digestive System</p> <ul style="list-style-type: none"> <li>• Ingestion <ul style="list-style-type: none"> <li>○ Saliva as lubrication and source of enzymes</li> <li>○ Ingestion, esophagus, transport function</li> </ul> </li> <li>• Stomach <ul style="list-style-type: none"> <li>○ Storage and churning of food</li> <li>○ Low pH, gastric juice, mucal protection against self-destruction</li> <li>○ Production of digestive enzymes, site of digestion</li> <li>○ Structure (gross)</li> </ul> </li> <li>• Liver <ul style="list-style-type: none"> <li>○ Structural relationship of liver within gastrointestinal system</li> <li>○ Production of bile</li> <li>○ Role in blood glucose regulation, detoxification</li> </ul> </li> <li>• Bile</li> </ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>○ Storage in gall bladder</li> <li>○ Function</li> <li>● Pancreas <ul style="list-style-type: none"> <li>○ Production of enzymes</li> <li>○ Transport of enzymes to small intestine</li> </ul> </li> <li>● Small Intestine <ul style="list-style-type: none"> <li>○ Absorption of food molecules and water</li> <li>○ Function and structure of villi</li> <li>○ Production of enzymes, site of digestion</li> <li>○ Neutralization of stomach acid</li> <li>○ Structure (anatomic subdivisions)</li> </ul> </li> <li>● Large Intestine <ul style="list-style-type: none"> <li>○ Absorption of water</li> <li>○ Bacterial flora</li> <li>○ Structure (gross)</li> </ul> </li> <li>● Rectum: storage and elimination of waste, feces</li> <li>● Muscular control <ul style="list-style-type: none"> <li>○ Peristalsis</li> </ul> </li> <li>● Endocrine control <ul style="list-style-type: none"> <li>○ Hormones</li> <li>○ Target tissues</li> </ul> </li> <li>● Nervous control: the enteric nervous system</li> </ul> <p>Excretory System</p> <ul style="list-style-type: none"> <li>● Roles in homeostasis <ul style="list-style-type: none"> <li>○ Blood pressure</li> <li>○ Osmoregulation</li> <li>○ Acid-base balance</li> <li>○ Removal of soluble nitrogenous waste</li> </ul> </li> <li>● Kidney structure <ul style="list-style-type: none"> <li>○ Cortex</li> <li>○ Medulla</li> </ul> </li> <li>● Nephron structure <ul style="list-style-type: none"> <li>○ Glomerulus</li> <li>○ Bowman's capsule</li> <li>○ Proximal tubule</li> <li>○ Loop of Henle</li> <li>○ Distal tubule</li> <li>○ Collecting duct</li> </ul> </li> <li>● Formation of urine <ul style="list-style-type: none"> <li>○ Glomerular filtration</li> <li>○ Secretion and reabsorption of solutes</li> <li>○ Concentration of urine</li> <li>○ Counter-current multiplier mechanism</li> </ul> </li> <li>● Storage and elimination: ureter, bladder, urethra</li> <li>● Osmoregulation: capillary reabsorption of H<sub>2</sub>O, amino acids, glucose, ions</li> <li>● Muscular control: sphincter muscle</li> </ul>
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## MCAT Biology Topics Listed by UD Course Number

	<p>Reproductive System</p> <ul style="list-style-type: none"><li>• Male and female reproductive structures and their functions<ul style="list-style-type: none"><li>○ Gonads</li><li>○ Genitalia</li><li>○ Differences between male and female structures</li></ul></li><li>• Hormonal control of reproduction<ul style="list-style-type: none"><li>○ Male and female sexual development</li><li>○ Female reproductive cycle</li><li>○ Pregnancy, parturition, lactation</li></ul></li><li>• Integration with nervous control</li></ul> <p>Muscle System</p> <ul style="list-style-type: none"><li>• Important functions<ul style="list-style-type: none"><li>○ Support: mobility</li><li>○ Peripheral circulatory assistance</li><li>○ Thermoregulation (shivering reflex)</li></ul></li><li>• Structure of three basic muscle types: striated, smooth, cardiac</li><li>• Muscle structure and control of contraction<ul style="list-style-type: none"><li>○ T-tubule system</li><li>○ Contractile apparatus</li><li>○ Sarcoplasmic reticulum</li><li>○ Fiber type</li><li>○ Contractile velocity of different muscle types</li></ul></li><li>• Regulation of cardiac muscle contraction</li><li>• Oxygen debt: fatigue</li><li>• Nervous control<ul style="list-style-type: none"><li>○ Motor neurons</li><li>○ Neuromuscular junction, motor end plates</li><li>○ Sympathetic and parasympathetic innervation</li><li>○ Voluntary and involuntary muscles</li></ul></li></ul> <p>Specialized Cell-Muscle Cell</p> <ul style="list-style-type: none"><li>• Structural characteristics of striated, smooth, and cardiac muscle</li><li>• Abundant mitochondria in red muscle cells: ATP source</li><li>• Organization of contractile elements: actin and myosin filaments, crossbridges, sliding filament model</li><li>• Sarcomeres: "I" and "A" bands, "M" and "Z" lines, "H" zone</li><li>• Presence of troponin and tropomyosin</li><li>• Calcium regulation of contraction</li></ul> <p>Skin System</p> <ul style="list-style-type: none"><li>• Structure<ul style="list-style-type: none"><li>○ Layer differentiation, cell types</li><li>○ Relative impermeability to water</li></ul></li><li>• Functions in homeostasis and osmoregulation</li><li>• Functions in thermoregulation<ul style="list-style-type: none"><li>○ Hair, erectile musculature</li><li>○ Fat layer for insulation</li><li>○ Sweat glands, location in dermis</li><li>○ Vasoconstriction and vasodilation in surface capillaries</li></ul></li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Physical protection<ul style="list-style-type: none"><li>○ Nails, calluses, hair</li><li>○ Protection against abrasion, disease organisms</li></ul></li><li>• Hormonal control: sweating, vasodilation, and vasoconstriction</li></ul> <p>Circulatory System</p> <ul style="list-style-type: none"><li>• Arterial and venous systems; pressure and flow characteristics</li></ul> <p>Specialized Cell - Nerve Cell (BIO 403)</p> <ul style="list-style-type: none"><li>• Myelin sheath, Schwann cells, insulation of axon</li><li>• Nodes of Ranvier: propagation of nerve impulse along axon</li></ul> <p>Enzymes</p> <ul style="list-style-type: none"><li>• Classification by reaction type</li><li>• Mechanism<ul style="list-style-type: none"><li>○ Substrates and enzyme specificity</li><li>○ Active site model</li><li>○ Induced-fit model</li><li>○ Cofactors, coenzymes and vitamins</li></ul></li><li>• Kinetics<ul style="list-style-type: none"><li>○ General (catalysis)</li><li>○ Michaelis-Menten</li><li>○ Cooperativity</li><li>○ Effects of local conditions on enzyme activity</li></ul></li><li>• Inhibition</li><li>• Regulatory enzymes<ul style="list-style-type: none"><li>○ Allosteric</li><li>○ Covalently modified</li></ul></li></ul> <p>Sensory Processing</p> <ul style="list-style-type: none"><li>• Sensation<ul style="list-style-type: none"><li>○ Thresholds</li><li>○ Weber's Law</li><li>○ Signal detection theory</li><li>○ Sensory adaptation</li></ul></li><li>• Sensory receptors<ul style="list-style-type: none"><li>○ Sensory pathways</li></ul></li><li>• Types of sensory receptors</li></ul> <p>Vision</p> <ul style="list-style-type: none"><li>• Structure and function of the eye</li><li>• Visual processing<ul style="list-style-type: none"><li>○ Visual pathways in the brain</li><li>○ Parallel processing</li></ul></li><li>• Feature detection</li></ul> <p>Hearing</p> <ul style="list-style-type: none"><li>• Auditory processing<ul style="list-style-type: none"><li>○ Auditory pathways in the brain</li></ul></li><li>• Sensory reception by hair cells</li></ul> <p>Other Senses</p> <ul style="list-style-type: none"><li>• Somatosensation<ul style="list-style-type: none"><li>○ Pain perception</li></ul></li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Taste<ul style="list-style-type: none"><li>○ Taste buds/chemoreceptors that detect specific chemicals</li></ul></li><li>• Smell<ul style="list-style-type: none"><li>○ Olfactory cells/chemoreceptors that detect specific chemicals</li><li>○ Pheromones</li><li>○ Olfactory pathways in the brain</li></ul></li><li>• Kinesthetic sense</li><li>• Vestibular sense</li></ul> <p>Cognition</p> <ul style="list-style-type: none"><li>• Information-processing model</li><li>• Cognitive development<ul style="list-style-type: none"><li>○ Piaget's stages of cognitive development</li><li>○ Cognitive changes in late adulthood</li><li>○ Role of culture in cognitive development</li><li>○ Influence of heredity and environment on cognitive development</li></ul></li><li>• Biological factors that affect cognition</li><li>• Problem solving and decision making<ul style="list-style-type: none"><li>○ Types of problem solving</li><li>○ Barriers to effective problem solving</li><li>○ Approaches to problem solving</li><li>○ Heuristics, biases, intuition, and emotion<ul style="list-style-type: none"><li>▪ Overconfidence and belief perseverance</li></ul></li></ul></li><li>• Intellectual functioning<ul style="list-style-type: none"><li>○ Multiple definitions of intelligence</li><li>○ Influence of heredity and environment on intelligence</li></ul></li><li>• Variations in intellectual ability</li></ul> <p>Consciousness</p> <ul style="list-style-type: none"><li>• States of consciousness<ul style="list-style-type: none"><li>○ Alertness</li><li>○ Sleep<ul style="list-style-type: none"><li>▪ Stages of sleep</li><li>▪ Sleep cycles and changes to sleep cycles</li><li>▪ Sleep and circadian rhythms</li><li>▪ Dreaming</li><li>▪ Sleep disorders</li></ul></li><li>○ Hypnosis and meditation</li></ul></li><li>• Consciousness altering drugs<ul style="list-style-type: none"><li>○ Types of consciousness altering drugs and their effects on the nervous system and behavior</li></ul></li><li>• Drug addiction and the reward pathway in the brain</li></ul> <p>Memory</p> <ul style="list-style-type: none"><li>• Encoding<ul style="list-style-type: none"><li>○ Process of encoding information</li><li>○ Processes that aid in encoding memories</li></ul></li><li>• Storage</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>○ Types of memory storage (e.g., sensory, working, long-term)</li> <li>○ Semantic networks and spreading activation</li> <li>● Retrieval             <ul style="list-style-type: none"> <li>○ Recall, recognition, and relearning</li> <li>○ Retrieval cues</li> <li>○ The role of emotion in retrieving memories</li> </ul> </li> <li>● Forgetting             <ul style="list-style-type: none"> <li>○ Aging and memory</li> <li>○ Memory dysfunctions (e.g., Alzheimer's disease, Korsakoff's syndrome)</li> <li>○ Decay</li> <li>○ Interference</li> <li>○ Memory construction and source monitoring</li> </ul> </li> <li>● Changes in synaptic connections underlie memory and learning             <ul style="list-style-type: none"> <li>○ Neural plasticity</li> <li>○ Memory and learning</li> </ul> </li> <li>● Long-term potentiation</li> </ul> <p>Language</p> <ul style="list-style-type: none"> <li>● Theories of language development (e.g., learning, Nativist, Interactionist)</li> <li>● Influence of language on cognition</li> <li>● Different brain areas control language and speech</li> </ul> <p>Emotion</p> <ul style="list-style-type: none"> <li>● Three components of emotion (i.e., cognitive, physiological, behavioral)</li> <li>● Universal emotions (e.g., fear, anger, happiness, surprise, joy, disgust, sadness)</li> <li>● Adaptive role of emotion</li> <li>● Theories of emotion             <ul style="list-style-type: none"> <li>○ James-Lange theory</li> <li>○ Cannon-Bard theory</li> <li>○ Schachter-Singer theory</li> </ul> </li> <li>● The role of biological processes in perceiving emotion             <ul style="list-style-type: none"> <li>○ Generation and experience of emotions involve many brain regions</li> <li>○ The role of the limbic system in emotion</li> <li>○ Emotional experiences can be stored as memories that can be recalled by similar circumstances</li> <li>○ Prefrontal cortex is critical for emotional experience, and is also important in                 <ul style="list-style-type: none"> <li>○ temperament and decision making</li> <li>○ Emotion and the autonomic nervous system</li> </ul> </li> </ul> </li> <li>● Physiological markers of emotion (signatures of emotion)</li> </ul> <p>Stress</p> <ul style="list-style-type: none"> <li>● The nature of stress             <ul style="list-style-type: none"> <li>○ Appraisal</li> </ul> </li> </ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>○ Different types of stressors (e.g., cataclysmic events, personal, etc.)</li> <li>○ Effects of stress on psychological functions</li> <li>● Stress outcomes/response to stressors             <ul style="list-style-type: none"> <li>○ Physiological</li> <li>○ Emotional</li> <li>○ Behavioral</li> </ul> </li> <li>● Managing stress (e.g., exercise, relaxation techniques, spirituality, etc.)</li> </ul> <p>Biological Bases of Behavior</p> <ul style="list-style-type: none"> <li>● The nervous system             <ul style="list-style-type: none"> <li>○ Neurons                 <ul style="list-style-type: none"> <li>▪ The reflex arc</li> </ul> </li> <li>○ Neurotransmitters</li> <li>○ Peripheral nervous system</li> <li>○ Central nervous system                 <ul style="list-style-type: none"> <li>▪ The brain                     <ul style="list-style-type: none"> <li>○ The brainstem</li> <li>○ The cerebellum</li> <li>○ The diencephalon (BIO)</li> <li>○ The cerebrum</li> <li>○ Control of voluntary movement in the cerebral cortex</li> <li>○ Information processing in the cerebral cortex</li> <li>○ Lateralization of cortical functions</li> <li>○ Methods of studying the brain</li> </ul> </li> </ul> </li> </ul> </li> <li>● Neurons communicate and influence behavior (PSY)</li> <li>● Influence of neurotransmitters on behavior (PSY)</li> <li>● The endocrine system             <ul style="list-style-type: none"> <li>○ Components of the endocrine system</li> <li>○ Effects of the endocrine system on behavior</li> </ul> </li> <li>● Behavioral genetics             <ul style="list-style-type: none"> <li>○ Genes, temperament, and heredity</li> <li>○ Adaptive value of traits and behaviors</li> <li>○ Interaction between heredity and environmental influences</li> </ul> </li> <li>● Genetic and environmental factors contribute to the development of behaviors             <ul style="list-style-type: none"> <li>○ Experience and behavior (PSY)</li> <li>○ Regulatory genes and behavior (BIO)</li> <li>○ Genetically based behavioral variation in natural populations</li> </ul> </li> <li>● Human physiological development (PSY)             <ul style="list-style-type: none"> <li>○ Prenatal development</li> <li>○ Motor development</li> </ul> </li> <li>● Developmental changes in adolescence</li> </ul>
BIO 411 & BIO 411L	<p>Amino Acids</p> <ul style="list-style-type: none"> <li>● Description</li> </ul>

## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Absolute configuration at the <math>\alpha</math> position</li><li>○ Amino acids as dipolar ions</li><li>○ Classifications<ul style="list-style-type: none"><li>▪ Acidic or basic</li><li>▪ Hydrophobic or hydrophilic</li></ul></li><li>● Reactions<ul style="list-style-type: none"><li>○ Sulfur linkage for cysteine and cysteine</li><li>○ Peptide linkage: polypeptides and proteins</li><li>○ Hydrolysis</li></ul></li></ul> <p>Protein Structure</p> <ul style="list-style-type: none"><li>● Structure<ul style="list-style-type: none"><li>○ 1° structure of proteins</li><li>○ 2° structure of proteins</li><li>○ 3° structure of proteins; role of proline, cystine, hydrophobic bonding</li><li>○ 4° structure of proteins</li></ul></li><li>● Conformational stability<ul style="list-style-type: none"><li>○ Denaturing and folding</li><li>○ Hydrophobic interactions</li><li>○ Solvation layer (entropy)</li></ul></li><li>● Separation techniques<ul style="list-style-type: none"><li>○ Isoelectric point</li><li>○ Electrophoresis</li></ul></li></ul> <p>Non-Enzymatic Protein Function</p> <ul style="list-style-type: none"><li>● Binding</li><li>● Immune system</li><li>● Motors</li></ul> <p>Enzyme Structure and Function</p> <ul style="list-style-type: none"><li>● Function of enzymes in catalyzing biological reactions</li><li>● Enzyme classification by reaction type</li><li>● Reduction of activation energy</li><li>● Substrates and enzyme specificity</li><li>● Active Site Model</li><li>● Induced-fit Model</li><li>● Mechanism of catalysis<ul style="list-style-type: none"><li>○ Cofactors</li><li>○ Coenzymes</li><li>○ Water-soluble vitamins</li></ul></li><li>● Effects of local conditions on enzyme activity</li></ul> <p>Control of Enzyme Activity</p> <ul style="list-style-type: none"><li>● Kinetics<ul style="list-style-type: none"><li>○ General (catalysis)</li><li>○ Michaelis-Menten</li><li>○ Cooperativity</li></ul></li><li>● Feedback regulation</li><li>● Inhibition – types<ul style="list-style-type: none"><li>○ Competitive</li></ul></li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Non-competitive</li><li>○ Mixed</li><li>○ Uncompetitive</li><li>● Regulatory enzymes<ul style="list-style-type: none"><li>○ Allosteric enzymes</li><li>○ Covalently-modified enzymes</li><li>○ Zymogen</li></ul></li></ul> <p>Repair of DNA</p> <ul style="list-style-type: none"><li>● Repair during replication</li><li>● Repair of mutations</li></ul> <p>Genetic Code</p> <ul style="list-style-type: none"><li>● Central Dogma: DNA → RNA → protein</li><li>● The triplet code</li><li>● Codon-anticodon relationship</li><li>● Degenerate code, wobble pairing</li><li>● Missense, nonsense codons</li><li>● Initiation, termination codons</li><li>● Messenger RNA (mRNA)</li></ul> <p>Control of Gene Expression in Prokaryotes</p> <ul style="list-style-type: none"><li>● Operon Concept, Jacob-Monod Model</li><li>● Gene repression in bacteria</li><li>● Positive control in bacteria</li></ul> <p>Control of Gene Expression in Eukaryotes</p> <ul style="list-style-type: none"><li>● Transcriptional regulation</li><li>● DNA binding proteins, transcription factors</li><li>● Gene amplification and duplication</li><li>● Post-transcriptional control, basic concept of splicing (introns, exons)</li><li>● Cancer as a failure of normal cellular controls, oncogenes, tumor suppressor genes</li><li>● Regulation of chromatin structure</li><li>● DNA methylation</li><li>● Role of non-coding RNAs</li></ul> <p>Recombinant DNA and Biotechnology</p> <ul style="list-style-type: none"><li>● Gene cloning</li><li>● Restriction enzymes</li><li>● DNA libraries</li><li>● Generation of cDNA</li><li>● Hybridization</li><li>● Expressing cloned genes</li><li>● Polymerase Chain Reaction</li><li>● Gel Electrophoresis and Southern Blotting</li><li>● DNA sequencing</li><li>● Analyzing gene expression</li><li>● Determining gene function</li><li>● Stem cells</li><li>● Practical applications of DNA technology: medical applications,</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<p>human gene therapy, pharmaceuticals, forensic evidence, environmental cleanup, agriculture</p> <ul style="list-style-type: none"><li>• Safety and ethics of DNA technology</li></ul> <p>Analytic Methods (BIO 411L)</p> <ul style="list-style-type: none"><li>• Hardy–Weinberg Principle</li><li>• Test cross</li><li>• Gene mapping: crossover frequencies</li><li>• Biometry: statistical methods</li></ul> <p>Principles of Bioenergetics</p> <ul style="list-style-type: none"><li>• Bioenergetics/thermodynamics<ul style="list-style-type: none"><li>○ Free energy/Keq<ul style="list-style-type: none"><li>▪ Equilibrium constant</li><li>▪ Relationship of the equilibrium constant and <math>\Delta G^\circ</math></li></ul></li><li>○ Concentration<ul style="list-style-type: none"><li>▪ Le Châtelier's Principle</li></ul></li><li>○ Endothermic/exothermic reactions</li><li>○ Free energy: G</li><li>○ Spontaneous reactions and <math>\Delta G^\circ</math></li></ul></li><li>• Phosphoryl group transfers and ATP<ul style="list-style-type: none"><li>○ ATP hydrolysis <math>\Delta G \ll 0</math></li><li>○ ATP group transfers</li></ul></li><li>• Biological oxidation-reduction<ul style="list-style-type: none"><li>○ Half-reactions</li><li>○ Soluble electron carriers</li><li>○ Flavoproteins</li></ul></li></ul> <p>Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway</p> <ul style="list-style-type: none"><li>• Glycolysis (aerobic), substrates and products<ul style="list-style-type: none"><li>○ Feeder pathways: glycogen, starch metabolism</li></ul></li><li>• Fermentation (anaerobic glycolysis)</li><li>• Gluconeogenesis</li><li>• Pentose phosphate pathway</li><li>• Net molecular and energetic results of respiration processes</li></ul> <p>Principles of Metabolic Regulation</p> <ul style="list-style-type: none"><li>• Regulation of metabolic pathways<ul style="list-style-type: none"><li>○ Maintenance of a dynamic steady state</li></ul></li><li>• Regulation of glycolysis and gluconeogenesis</li><li>• Metabolism of glycogen</li><li>• Regulation of glycogen synthesis and breakdown<ul style="list-style-type: none"><li>○ Allosteric and hormonal control</li></ul></li><li>• Analysis of metabolic control</li></ul> <p>Citric Acid Cycle</p> <ul style="list-style-type: none"><li>• Acetyl-CoA production</li><li>• Reactions of the cycle, substrates and products</li><li>• Regulation of the cycle</li><li>• Net molecular and energetic results of respiration processes</li></ul> <p>Metabolism of Fatty Acids and Proteins</p>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Description of fatty acids</li><li>• Digestion, mobilization, and transport of fats</li><li>• Oxidation of fatty acids<ul style="list-style-type: none"><li>○ Saturated fats</li><li>○ Unsaturated fats</li></ul></li><li>• Ketone bodies</li><li>• Anabolism of fats</li><li>• Non-template synthesis: biosynthesis of lipids and polysaccharides</li><li>• Metabolism of proteins</li></ul> <p>Oxidative Phosphorylation</p> <ul style="list-style-type: none"><li>• Electron transport chain and oxidative phosphorylation, substrates and products, general features of the pathway</li><li>• Electron transfer in mitochondria<ul style="list-style-type: none"><li>○ NADH, NADPH</li><li>○ Flavoproteins</li><li>○ Cytochromes</li></ul></li><li>• ATP synthase, chemiosmotic coupling<ul style="list-style-type: none"><li>○ Proton motive force</li></ul></li><li>• Net molecular and energetic results of respiration processes</li><li>• Regulation of oxidative phosphorylation</li><li>• Mitochondria, apoptosis, oxidative stress</li></ul> <p>Plasma Membrane</p> <ul style="list-style-type: none"><li>• General function in cell containment</li><li>• Composition of membranes<ul style="list-style-type: none"><li>○ Lipid components<ul style="list-style-type: none"><li>▪ Phospholipids (and phosphatids)</li><li>▪ Steroids</li><li>▪ Waxes</li></ul></li><li>○ Protein components</li><li>○ Fluid mosaic model</li></ul></li><li>• Membrane dynamics</li><li>• Solute transport across membranes<ul style="list-style-type: none"><li>○ Thermodynamic considerations</li><li>○ Osmosis<ul style="list-style-type: none"><li>▪ Colligative properties, osmotic pressure</li></ul></li><li>○ Passive transport</li><li>○ Active transport<ul style="list-style-type: none"><li>▪ Sodium/potassium pump</li></ul></li></ul></li><li>• Membrane channels</li><li>• Membrane potential</li><li>• Membrane receptors</li><li>• Exocytosis and endocytosis</li><li>• Intercellular junctions<ul style="list-style-type: none"><li>○ Gap junctions</li><li>○ Tight junctions</li><li>○ Desmosomes</li></ul></li></ul> <p>Cell Theory</p>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• History and development</li><li>• Impact on biology</li></ul> <p>Classification and Structure of Prokaryotic Cells</p> <ul style="list-style-type: none"><li>• Prokaryotic domains<ul style="list-style-type: none"><li>○ Archaea</li><li>○ Bacteria</li></ul></li><li>• Major classifications of bacteria by shape<ul style="list-style-type: none"><li>○ Bacilli (rod-shaped)</li><li>○ Spirilli (spiral shaped)</li><li>○ Cocci (spherical)</li></ul></li><li>• Lack of nuclear membrane and mitotic apparatus</li><li>• Lack of typical eukaryotic organelles</li><li>• Presence of cell wall in bacteria</li><li>• Flagellar propulsion, mechanism</li></ul> <p>Growth and Physiology of Prokaryotic Cells</p> <ul style="list-style-type: none"><li>• Reproduction by fission</li><li>• High degree of genetic adaptability, acquisition of antibiotic resistance</li><li>• Exponential growth</li><li>• Existence of anaerobic and aerobic variants</li><li>• Parasitic and symbiotic</li><li>• Chemotaxis</li></ul> <p>Genetics of Prokaryotic Cells</p> <ul style="list-style-type: none"><li>• Existence of plasmids, extragenomic DNA</li><li>• Transformation: incorporation into bacterial genome of DNA fragments from external medium</li><li>• Conjugation</li><li>• Transposons (also present in eukaryotic cells)</li></ul> <p>Virus Structure</p> <ul style="list-style-type: none"><li>• General structural characteristics (nucleic acid and protein, enveloped and nonenveloped)</li><li>• Lack organelles and nucleus</li><li>• Structural aspects of typical bacteriophage</li><li>• Genomic content--RNA or DNA</li><li>• Size relative to bacteria and eukaryotic cells</li></ul> <p>Viral Life Cycle</p> <ul style="list-style-type: none"><li>• Self-replicating biological units that must reproduce within specific host cell</li><li>• Generalized phage and animal virus life cycles<ul style="list-style-type: none"><li>○ Attachment to host, penetration of cell membrane or cell wall, and entry of viral genetic material</li><li>○ Use of host synthetic mechanism to replicate viral components</li><li>○ Self-assembly and release of new viral particles</li></ul></li><li>• Transduction: transfer of genetic material by viruses</li><li>• Retrovirus life cycle: integration into host DNA, reverse transcriptase,</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>HIV<ul style="list-style-type: none"><li>• Prions and viroids: subviral particles</li></ul></li><li>Biosignalling<ul style="list-style-type: none"><li>• Oncogenes, apoptosis</li></ul></li><li>Lipids<ul style="list-style-type: none"><li>• Description; structure<ul style="list-style-type: none"><li>○ Steroids</li></ul></li><li>• Terpenes and terpenoids</li></ul></li><li>Immune System<ul style="list-style-type: none"><li>• Innate (non-specific) vs. adaptive (specific) immunity</li><li>• Adaptive immune system cells<ul style="list-style-type: none"><li>○ T-lymphocytes</li><li>○ B-lymphocytes</li></ul></li><li>• Innate immune system cells<ul style="list-style-type: none"><li>○ Macrophages</li><li>○ Phagocytes</li></ul></li><li>• Concept of antigen and antibody</li><li>• Antigen presentation</li><li>• Clonal selection</li><li>• Antigen-antibody recognition</li><li>• Structure of antibody molecule</li><li>• Recognition of self vs. non-self, autoimmune diseases</li><li>• Major histocompatibility complex</li></ul></li><li>Gas Phase<ul style="list-style-type: none"><li>• Absolute temperature, (K) Kelvin Scale</li><li>• Pressure, simple mercury barometer</li><li>• Molar volume at 0°C and 1 atm = 22.4 L/mol</li><li>• Ideal gas<ul style="list-style-type: none"><li>○ Definition</li><li>○ Ideal Gas Law: <math>PV = nRT</math></li><li>○ Boyle's Law: <math>PV = \text{constant}</math></li><li>○ Charles' Law: <math>V/T = \text{constant}</math></li><li>○ Avogadro's Law: <math>V/n = \text{constant}</math></li></ul></li><li>• Kinetic Molecular Theory of Gases<ul style="list-style-type: none"><li>○ Heat capacity at constant volume and at constant pressure</li><li>○ Boltzmann's Constant</li></ul></li><li>• Deviation of real gas behavior from Ideal Gas Law<ul style="list-style-type: none"><li>○ Qualitative</li><li>○ Quantitative (Van der Waals' Equation)</li></ul></li><li>• Partial pressure, mole fraction</li><li>• Dalton's Law relating partial pressure to composition</li></ul></li><li>Enzymes<ul style="list-style-type: none"><li>• Classification by reaction type</li><li>• Mechanism<ul style="list-style-type: none"><li>○ Substrates and enzyme specificity</li><li>○ Active site model</li><li>○ Induced-fit model</li></ul></li></ul></li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>○ Cofactors, coenzymes and vitamins</li> <li>• Kinetics             <ul style="list-style-type: none"> <li>○ General (catalysis)</li> <li>○ Michaelis-Menten</li> <li>○ Cooperativity</li> <li>○ Effects of local conditions on enzyme activity</li> </ul> </li> <li>• Inhibition</li> <li>• Regulatory enzymes             <ul style="list-style-type: none"> <li>○ Allosteric</li> <li>○ Covalently modified</li> </ul> </li> </ul> <p>Rate Processes in Chemical Reactions - Kinetics and Equilibrium</p> <ul style="list-style-type: none"> <li>• Reaction rate</li> <li>• Dependence of reaction rate upon concentration of reactants             <ul style="list-style-type: none"> <li>○ Rate law, rate constant</li> <li>○ Reaction order</li> </ul> </li> <li>• Rate-determining step</li> <li>• Dependence of reaction rate upon temperature             <ul style="list-style-type: none"> <li>○ Activation energy                 <ul style="list-style-type: none"> <li>▪ Activated complex or transition state</li> <li>▪ Interpretation of energy profiles showing energies of reactants, products, activation energy, and <math>\Delta H</math> for the reaction</li> </ul> </li> <li>○ Use of the Arrhenius Equation</li> </ul> </li> <li>• Kinetic control versus thermodynamic control of a reaction</li> <li>• Catalysts</li> <li>• Equilibrium in reversible chemical reactions             <ul style="list-style-type: none"> <li>○ Law of Mass Action</li> <li>○ Equilibrium Constant</li> <li>○ Application of Le Châtelier's Principle</li> <li>○ Relationship of the equilibrium constant and <math>\Delta G^\circ</math></li> </ul> </li> </ul>
BIO 415	<p>Nerve Cell</p> <ul style="list-style-type: none"> <li>• Cell body: site of nucleus, organelles</li> <li>• Dendrites: branched extensions of cell body</li> <li>• Axon: structure and function</li> <li>• Myelin sheath, Schwann cells, insulation of axon</li> <li>• Nodes of Ranvier: propagation of nerve impulse along axon</li> <li>• Synapse: site of impulse propagation between cells</li> <li>• Synaptic activity: transmitter molecules</li> <li>• Resting potential: electrochemical gradient</li> <li>• Action potential             <ul style="list-style-type: none"> <li>○ Threshold, all-or-none</li> <li>○ Sodium/potassium pump</li> </ul> </li> <li>• Excitatory and inhibitory nerve fibers: summation, frequency of firing</li> <li>• Glial cells, neuroglia</li> </ul> <p>Specialized Cell - Nerve Cell</p> <ul style="list-style-type: none"> <li>• Myelin sheath, Schwann cells, insulation of axon</li> <li>• Nodes of Ranvier: propagation of nerve impulse along axon</li> </ul>

## MCAT Biology Topics Listed by UD Course Number

	<p>Sensory Processing</p> <ul style="list-style-type: none"><li>• Sensation<ul style="list-style-type: none"><li>○ Thresholds</li><li>○ Weber's Law</li><li>○ Signal detection theory</li><li>○ Sensory adaptation</li></ul></li><li>• Sensory receptors<ul style="list-style-type: none"><li>○ Sensory pathways</li></ul></li><li>• Types of sensory receptors</li></ul> <p>Vision</p> <ul style="list-style-type: none"><li>• Structure and function of the eye</li><li>• Visual processing<ul style="list-style-type: none"><li>○ Visual pathways in the brain</li><li>○ Parallel processing</li></ul></li><li>• Feature detection</li></ul> <p>Hearing</p> <ul style="list-style-type: none"><li>• Auditory processing<ul style="list-style-type: none"><li>○ Auditory pathways in the brain</li></ul></li><li>• Sensory reception by hair cells</li></ul> <p>Other Senses</p> <ul style="list-style-type: none"><li>• Somatosensation<ul style="list-style-type: none"><li>○ Pain perception</li></ul></li><li>• Taste<ul style="list-style-type: none"><li>○ Taste buds/chemoreceptors that detect specific chemicals</li></ul></li><li>• Smell<ul style="list-style-type: none"><li>○ Olfactory cells/chemoreceptors that detect specific chemicals</li><li>○ Pheromones</li><li>○ Olfactory pathways in the brain</li></ul></li><li>• Kinesthetic sense</li><li>• Vestibular sense</li></ul> <p>Cognition</p> <ul style="list-style-type: none"><li>• Information-processing model</li><li>• Cognitive development<ul style="list-style-type: none"><li>○ Piaget's stages of cognitive development</li><li>○ Cognitive changes in late adulthood</li><li>○ Role of culture in cognitive development</li><li>○ Influence of heredity and environment on cognitive development</li></ul></li><li>• Biological factors that affect cognition</li><li>• Problem solving and decision making<ul style="list-style-type: none"><li>○ Types of problem solving</li><li>○ Barriers to effective problem solving</li><li>○ Approaches to problem solving</li><li>○ Heuristics, biases, intuition, and emotion<ul style="list-style-type: none"><li>▪ Overconfidence and belief perseverance</li></ul></li></ul></li><li>• Intellectual functioning<ul style="list-style-type: none"><li>○ Multiple definitions of intelligence</li></ul></li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Influence of heredity and environment on intelligence</li><li>● Variations in intellectual ability</li></ul> <p>Consciousness</p> <ul style="list-style-type: none"><li>● States of consciousness<ul style="list-style-type: none"><li>○ Alertness (PSY, BIO)</li><li>○ Sleep<ul style="list-style-type: none"><li>▪ Stages of sleep</li><li>▪ Sleep cycles and changes to sleep cycles</li><li>▪ Sleep and circadian rhythms</li><li>▪ Dreaming</li><li>▪ Sleep disorders</li></ul></li><li>○ Hypnosis and meditation</li></ul></li><li>● Consciousness altering drugs<ul style="list-style-type: none"><li>○ Types of consciousness altering drugs and their effects on the nervous system and behavior</li></ul></li><li>● Drug addiction and the reward pathway in the brain</li></ul> <p>Memory</p> <ul style="list-style-type: none"><li>● Encoding<ul style="list-style-type: none"><li>○ Process of encoding information</li><li>○ Processes that aid in encoding memories</li></ul></li><li>● Storage<ul style="list-style-type: none"><li>○ Types of memory storage (e.g., sensory, working, long-term)</li><li>○ Semantic networks and spreading activation</li></ul></li><li>● Retrieval<ul style="list-style-type: none"><li>○ Recall, recognition, and relearning</li><li>○ Retrieval cues</li><li>○ The role of emotion in retrieving memories</li></ul></li><li>● Forgetting<ul style="list-style-type: none"><li>○ Aging and memory</li><li>○ Memory dysfunctions (e.g., Alzheimer's disease, Korsakoff's syndrome)</li><li>○ Decay</li><li>○ Interference</li><li>○ Memory construction and source monitoring</li></ul></li><li>● Changes in synaptic connections underlie memory and learning<ul style="list-style-type: none"><li>○ Neural plasticity</li><li>○ Memory and learning</li></ul></li><li>● Long-term potentiation</li></ul> <p>Language</p> <ul style="list-style-type: none"><li>● Theories of language development (e.g., learning, Nativist, Interactionist)</li><li>● Influence of language on cognition</li><li>● Different brain areas control language and speech</li></ul> <p>Emotion</p> <ul style="list-style-type: none"><li>● Three components of emotion (i.e., cognitive, physiological, behavioral)</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Universal emotions (e.g., fear, anger, happiness, surprise, joy, disgust, sadness)</li><li>• Adaptive role of emotion</li><li>• Theories of emotion<ul style="list-style-type: none"><li>○ James-Lange theory</li><li>○ Cannon-Bard theory</li><li>○ Schachter-Singer theory</li></ul></li><li>• The role of biological processes in perceiving emotion<ul style="list-style-type: none"><li>○ Generation and experience of emotions involve many brain regions</li><li>○ The role of the limbic system in emotion</li><li>○ Emotional experiences can be stored as memories that can be recalled by similar circumstances</li><li>○ Prefrontal cortex is critical for emotional experience, and is also important in<ul style="list-style-type: none"><li>○ temperament and decision making</li><li>○ Emotion and the autonomic nervous system</li></ul></li></ul></li><li>• Physiological markers of emotion (signatures of emotion)</li></ul> <p>Stress</p> <ul style="list-style-type: none"><li>• The nature of stress<ul style="list-style-type: none"><li>○ Appraisal</li><li>○ Different types of stressors (e.g., cataclysmic events, personal, etc.)</li><li>○ Effects of stress on psychological functions</li></ul></li><li>• Stress outcomes/response to stressors<ul style="list-style-type: none"><li>○ Physiological</li><li>○ Emotional</li><li>○ Behavioral</li></ul></li><li>• Managing stress (e.g., exercise, relaxation techniques, spirituality, etc.)</li></ul> <p>Biological Bases of Behavior</p> <ul style="list-style-type: none"><li>• The nervous system<ul style="list-style-type: none"><li>○ Neurons<ul style="list-style-type: none"><li>▪ The reflex arc</li></ul></li><li>○ Neurotransmitters</li><li>○ Peripheral nervous system</li><li>○ Central nervous system<ul style="list-style-type: none"><li>▪ The brain<ul style="list-style-type: none"><li>○ The brainstem</li><li>○ The cerebellum</li><li>○ The diencephalon (BIO)</li><li>○ The cerebrum</li><li>○ Control of voluntary movement in the cerebral cortex</li><li>○ Information processing in the cerebral cortex</li><li>○ Lateralization of cortical functions</li></ul></li></ul></li></ul></li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>○ Methods of studying the brain</li> <li>● Neurons communicate and influence behavior (PSY)</li> <li>● Influence of neurotransmitters on behavior (PSY)</li> <li>● The endocrine system             <ul style="list-style-type: none"> <li>○ Components of the endocrine system</li> <li>○ Effects of the endocrine system on behavior</li> </ul> </li> <li>● Behavioral genetics             <ul style="list-style-type: none"> <li>○ Genes, temperament, and heredity</li> <li>○ Adaptive value of traits and behaviors</li> <li>○ Interaction between heredity and environmental influences</li> </ul> </li> <li>● Genetic and environmental factors contribute to the development of behaviors             <ul style="list-style-type: none"> <li>○ Experience and behavior (PSY)</li> <li>○ Regulatory genes and behavior (BIO)</li> <li>○ Genetically based behavioral variation in natural populations</li> </ul> </li> <li>● Human physiological development (PSY)             <ul style="list-style-type: none"> <li>○ Prenatal development</li> <li>○ Motor development</li> </ul> </li> <li>● Developmental changes in adolescence</li> </ul> <p>Associative Learning</p> <ul style="list-style-type: none"> <li>● Classical conditioning             <ul style="list-style-type: none"> <li>○ Neutral, conditioned, and unconditioned stimuli</li> <li>○ Conditioned and unconditioned response</li> <li>○ Processes: acquisition, extinction, spontaneous recovery, generalization, discrimination</li> </ul> </li> <li>● Operant conditioning             <ul style="list-style-type: none"> <li>○ Processes of shaping and extinction</li> <li>○ Types of reinforcement: positive, negative, primary, conditional</li> <li>○ Reinforcement schedules: fixed-ratio, variable-ratio, fixed-interval, variable-interval</li> <li>○ Punishment</li> <li>○ Escape and avoidance learning</li> </ul> </li> <li>● Cognitive processes that affect associative learning</li> <li>● Biological factors that affect associative learning             <ul style="list-style-type: none"> <li>○ Innate behaviors are developmentally fixed</li> <li>○ Learned behaviors are modified based on experiences</li> <li>○ Development of learned behaviors</li> </ul> </li> </ul>
BIO 427	<p>Non-Enzymatic Protein Function</p> <ul style="list-style-type: none"> <li>● Binding</li> <li>● Immune system</li> <li>● Motors</li> </ul> <p>Immune System</p> <ul style="list-style-type: none"> <li>● Innate (non-specific) vs. adaptive (specific) immunity</li> <li>● Adaptive immune system cells             <ul style="list-style-type: none"> <li>○ T-lymphocytes</li> <li>○ B-lymphocytes</li> </ul> </li> </ul>



MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>• Innate immune system cells             <ul style="list-style-type: none"> <li>○ Macrophages</li> <li>○ Phagocytes</li> </ul> </li> <li>• Concept of antigen and antibody</li> <li>• Antigen presentation</li> <li>• Clonal selection</li> <li>• Antigen-antibody recognition</li> <li>• Structure of antibody molecule</li> <li>• Recognition of self vs. non-self, autoimmune diseases</li> <li>• Major histocompatibility complex</li> </ul>
BIO 440	<p>Amino Acids</p> <ul style="list-style-type: none"> <li>• Description             <ul style="list-style-type: none"> <li>○ Absolute configuration at the <math>\alpha</math> position</li> <li>○ Amino acids as dipolar ions</li> <li>○ Classifications                 <ul style="list-style-type: none"> <li>▪ Acidic or basic</li> <li>▪ Hydrophobic or hydrophilic</li> </ul> </li> </ul> </li> <li>• Reactions             <ul style="list-style-type: none"> <li>○ Sulfur linkage for cysteine and cysteine</li> <li>○ Peptide linkage: polypeptides and proteins</li> <li>○ Hydrolysis</li> </ul> </li> </ul> <p>Protein Structure</p> <ul style="list-style-type: none"> <li>• Structure             <ul style="list-style-type: none"> <li>○ 1° structure of proteins</li> <li>○ 2° structure of proteins</li> <li>○ 3° structure of proteins; role of proline, cystine, hydrophobic bonding</li> <li>○ 4° structure of proteins</li> </ul> </li> <li>• Conformational stability             <ul style="list-style-type: none"> <li>○ Denaturing and folding</li> <li>○ Hydrophobic interactions</li> <li>○ Solvation layer (entropy)</li> </ul> </li> <li>• Separation techniques             <ul style="list-style-type: none"> <li>○ Isoelectric point</li> <li>○ Electrophoresis</li> </ul> </li> </ul> <p>DNA Replication</p> <ul style="list-style-type: none"> <li>• Mechanism of replication: separation of strands, specific coupling of free nucleic acids</li> <li>• Semi-conservative nature of replication</li> <li>• Specific enzymes involved in replication</li> <li>• Origins of replication, multiple origins in eukaryotes</li> <li>• Replicating the ends of DNA molecules</li> </ul> <p>Repair of DNA</p> <ul style="list-style-type: none"> <li>• Repair during replication</li> <li>• Repair of mutations</li> </ul> <p>Plasma Membrane</p>

## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• General function in cell containment</li><li>• Composition of membranes<ul style="list-style-type: none"><li>○ Lipid components<ul style="list-style-type: none"><li>▪ Phospholipids (and phosphatids)</li><li>▪ Steroids</li><li>▪ Waxes</li></ul></li><li>○ Protein components</li><li>○ Fluid mosaic model</li></ul></li><li>• Membrane dynamics</li><li>• Solute transport across membranes<ul style="list-style-type: none"><li>○ Thermodynamic considerations</li><li>○ Osmosis<ul style="list-style-type: none"><li>▪ Colligative properties, osmotic pressure</li></ul></li><li>○ Passive transport</li><li>○ Active transport<ul style="list-style-type: none"><li>▪ Sodium/potassium pump</li></ul></li></ul></li><li>• Membrane channels</li><li>• Membrane potential</li><li>• Membrane receptors</li><li>• Exocytosis and endocytosis</li><li>• Intercellular junctions<ul style="list-style-type: none"><li>○ Gap junctions</li><li>○ Tight junctions</li><li>○ Desmosomes</li></ul></li></ul> <p>Membrane-Bound Organelles and Defining Characteristics of Eukaryotic Cells</p> <ul style="list-style-type: none"><li>• Defining characteristics of eukaryotic cells: membrane bound nucleus, presence of organelles,</li><li>• mitotic division</li><li>• Nucleus<ul style="list-style-type: none"><li>○ Compartmentalization, storage of genetic information</li><li>○ Nucleolus: location and function</li><li>○ Nuclear envelope, nuclear pores</li></ul></li><li>• Mitochondria<ul style="list-style-type: none"><li>○ Site of ATP production</li><li>○ Inner and outer membrane structure</li><li>○ Self-replication</li></ul></li><li>• Lysosomes: membrane-bound vesicles containing hydrolytic enzymes</li><li>• Endoplasmic reticulum<ul style="list-style-type: none"><li>○ Rough and smooth components</li><li>○ Rough endoplasmic reticulum site of ribosomes</li><li>○ Double membrane structure</li><li>○ Role in membrane biosynthesis</li><li>○ Role in biosynthesis of secreted proteins</li></ul></li><li>• Golgi apparatus: general structure and role in packaging and secretion</li><li>• Peroxisomes: organelles that collect peroxides</li></ul> <p>Cytoskeleton</p> <ul style="list-style-type: none"><li>• General function in cell support and movement</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>• Microfilaments: composition and role in cleavage and contractility</li> <li>• Microtubules: composition and role in support and transport</li> <li>• Intermediate filaments, role in support</li> <li>• Composition and function of cilia and flagella</li> <li>• Centrioles, microtubule organizing centers</li> </ul> <p>Tissues Formed From Eukaryotic Cells</p> <ul style="list-style-type: none"> <li>• Epithelial cells</li> <li>• Connective tissue cells</li> </ul> <p>Cell Theory</p> <ul style="list-style-type: none"> <li>• History and development</li> <li>• Impact on biology</li> </ul> <p>Mitosis</p> <ul style="list-style-type: none"> <li>• Mitotic process: prophase, metaphase, anaphase, telophase, interphase</li> <li>• Mitotic structures             <ul style="list-style-type: none"> <li>○ Centrioles, asters, spindles</li> <li>○ Chromatids, centromeres, kinetochores</li> <li>○ Nuclear membrane breakdown and reorganization</li> <li>○ Mechanisms of chromosome movement</li> </ul> </li> <li>• Phases of cell cycle: G<sub>0</sub>, G<sub>1</sub>, S, G<sub>2</sub>, M</li> <li>• Growth arrest</li> <li>• Control of cell cycle</li> <li>• Loss of cell cycle controls in cancer cells</li> </ul> <p>Biosignalling</p> <ul style="list-style-type: none"> <li>• Oncogenes, apoptosis</li> </ul> <p>Biosignalling</p> <ul style="list-style-type: none"> <li>• Gated ion channels             <ul style="list-style-type: none"> <li>○ Voltage gated</li> <li>○ Ligand gated</li> </ul> </li> <li>• Receptor enzymes</li> <li>• G protein-coupled receptors</li> </ul> <p>Specialized Cell-Muscle Cell</p> <ul style="list-style-type: none"> <li>• Structural characteristics of striated, smooth, and cardiac muscle</li> <li>• Abundant mitochondria in red muscle cells: ATP source</li> <li>• Organization of contractile elements: actin and myosin filaments, crossbridges, sliding filament model</li> <li>• Sarcomeres: "I" and "A" bands, "M" and "Z" lines, "H" zone</li> <li>• Presence of troponin and tropomyosin</li> <li>• Calcium regulation of contraction</li> </ul>
BIO 442	<p>Eukaryotic Chromosome Organization</p> <ul style="list-style-type: none"> <li>• Chromosomal proteins</li> <li>• Single copy vs. repetitive DNA</li> <li>• Supercoiling</li> <li>• Heterochromatin vs. euchromatin</li> <li>• Telomeres, centromeres</li> </ul> <p>Tissues Formed From Eukaryotic Cells</p>

MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>• Epithelial cells</li> <li>• Connective tissue cells</li> </ul> <p>Mitosis</p> <ul style="list-style-type: none"> <li>• Mitotic process: prophase, metaphase, anaphase, telophase, interphase</li> <li>• Mitotic structures             <ul style="list-style-type: none"> <li>○ Centrioles, asters, spindles</li> <li>○ Chromatids, centromeres, kinetochores</li> <li>○ Nuclear membrane breakdown and reorganization</li> <li>○ Mechanisms of chromosome movement</li> </ul> </li> <li>• Phases of cell cycle: G0, G1, S, G2, M</li> <li>• Growth arrest</li> <li>• Control of cell cycle</li> <li>• Loss of cell cycle controls in cancer cells</li> </ul> <p>Embryogenesis</p> <ul style="list-style-type: none"> <li>• Stages of early development (order and general features of each)             <ul style="list-style-type: none"> <li>○ Fertilization</li> <li>○ Cleavage</li> <li>○ Blastula formation</li> <li>○ Gastrulation                 <ul style="list-style-type: none"> <li>▪ First cell movements</li> <li>▪ Formation of primary germ layers (endoderm, mesoderm, ectoderm)</li> </ul> </li> <li>○ Neurulation</li> </ul> </li> <li>• Major structures arising out of primary germ layers</li> <li>• Neural crest</li> <li>• Environment–gene interaction in development</li> </ul> <p>Mechanisms of Development</p> <ul style="list-style-type: none"> <li>• Cell specialization             <ul style="list-style-type: none"> <li>○ Determination</li> <li>○ Differentiation</li> <li>○ Tissue types</li> </ul> </li> <li>• Cell–cell communication in development</li> <li>• Cell migration</li> <li>• Pluripotency: stem cells</li> <li>• Gene regulation in development</li> <li>• Programmed cell death</li> <li>• Existence of regenerative capacity in various species</li> <li>• Senescence and aging</li> </ul>
BIO 462	<p>Protein Structure</p> <ul style="list-style-type: none"> <li>• Structure             <ul style="list-style-type: none"> <li>○ 1° structure of proteins</li> <li>○ 2° structure of proteins</li> <li>○ 3° structure of proteins; role of proline, cystine, hydrophobic bonding</li> <li>○ 4° structure of proteins</li> </ul> </li> <li>• Conformational stability</li> </ul>

## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Denaturing and folding</li><li>○ Hydrophobic interactions</li><li>○ Solvation layer (entropy)</li><li>● Separation techniques<ul style="list-style-type: none"><li>○ Isoelectric point</li><li>○ Electrophoresis</li></ul></li></ul> <p>Enzyme Structure and Function</p> <ul style="list-style-type: none"><li>● Function of enzymes in catalyzing biological reactions</li><li>● Enzyme classification by reaction type</li><li>● Reduction of activation energy</li><li>● Substrates and enzyme specificity</li><li>● Active Site Model</li><li>● Induced-fit Model</li><li>● Mechanism of catalysis<ul style="list-style-type: none"><li>○ Cofactors</li><li>○ Coenzymes</li><li>○ Water-soluble vitamins</li></ul></li><li>● Effects of local conditions on enzyme activity</li></ul> <p>Control of Enzyme Activity</p> <ul style="list-style-type: none"><li>● Kinetics<ul style="list-style-type: none"><li>○ General (catalysis)</li><li>○ Michaelis-Menten</li><li>○ Cooperativity</li></ul></li><li>● Feedback regulation</li><li>● Inhibition – types<ul style="list-style-type: none"><li>○ Competitive</li><li>○ Non-competitive</li><li>○ Mixed</li><li>○ Uncompetitive</li></ul></li><li>● Regulatory enzymes<ul style="list-style-type: none"><li>○ Allosteric enzymes</li><li>○ Covalently-modified enzymes</li><li>○ Zymogen</li></ul></li></ul> <p>Nucleic Acid Structure and Function</p> <ul style="list-style-type: none"><li>● Description</li><li>● Nucleotides and nucleosides<ul style="list-style-type: none"><li>○ Sugar phosphate backbone</li><li>○ Pyrimidine, purine residues</li></ul></li><li>● Deoxyribonucleic acid (DNA): double helix, Watson–Crick model of DNA structure</li><li>● Base pairing specificity: A with T, G with C</li><li>● Function in transmission of genetic information</li><li>● DNA denaturation, reannealing, hybridization</li></ul> <p>DNA Replication</p> <ul style="list-style-type: none"><li>● Mechanism of replication: separation of strands, specific coupling of free nucleic acids</li><li>● Semi-conservative nature of replication</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Specific enzymes involved in replication</li><li>• Origins of replication, multiple origins in eukaryotes</li><li>• Replicating the ends of DNA molecules</li></ul> <p>Repair of DNA</p> <ul style="list-style-type: none"><li>• Repair during replication</li><li>• Repair of mutations</li></ul> <p>Genetic Code</p> <ul style="list-style-type: none"><li>• Central Dogma: DNA → RNA → protein</li><li>• The triplet code</li><li>• Codon-anticodon relationship</li><li>• Degenerate code, wobble pairing</li><li>• Missense, nonsense codons</li><li>• Initiation, termination codons</li><li>• Messenger RNA (mRNA)</li></ul> <p>Transcription</p> <ul style="list-style-type: none"><li>• Transfer RNA (tRNA); ribosomal RNA (rRNA)</li><li>• Mechanism of transcription</li><li>• mRNA processing in eukaryotes, introns, exons</li><li>• Ribozymes, spliceosomes, small nuclear ribonucleoproteins (snRNPs), small nuclear RNA (snRNAs)</li><li>• Functional and evolutionary importance of introns</li></ul> <p>Translation</p> <ul style="list-style-type: none"><li>• Roles of mRNA, tRNA, rRNA</li><li>• Role and structure of ribosomes</li><li>• Initiation, termination co-factors</li><li>• Post-translational modification of proteins</li></ul> <p>Eukaryotic Chromosome Organization</p> <ul style="list-style-type: none"><li>• Chromosomal proteins</li><li>• Single copy vs. repetitive DNA</li><li>• Supercoiling</li><li>• Heterochromatin vs. euchromatin</li><li>• Telomeres, centromeres</li></ul> <p>Control of Gene Expression in Prokaryotes</p> <ul style="list-style-type: none"><li>• Operon Concept, Jacob-Monod Model</li><li>• Gene repression in bacteria</li><li>• Positive control in bacteria</li></ul> <p>Control of Gene Expression in Eukaryotes</p> <ul style="list-style-type: none"><li>• Transcriptional regulation</li><li>• DNA binding proteins, transcription factors</li><li>• Gene amplification and duplication</li><li>• Post-transcriptional control, basic concept of splicing (introns, exons)</li><li>• Cancer as a failure of normal cellular controls, oncogenes, tumor suppressor genes</li><li>• Regulation of chromatin structure</li><li>• DNA methylation</li></ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>• Role of non-coding RNAs</li> </ul>
BIO 470	<p>DNA Replication</p> <ul style="list-style-type: none"> <li>• Mechanism of replication: separation of strands, specific coupling of free nucleic acids</li> <li>• Semi-conservative nature of replication</li> <li>• Specific enzymes involved in replication</li> <li>• Origins of replication, multiple origins in eukaryotes</li> <li>• Replicating the ends of DNA molecules</li> </ul>
BIO 475 & 475L	<p>Analytic Methods (BIO 475L)</p> <ul style="list-style-type: none"> <li>• Hardy–Weinberg Principle</li> <li>• Test cross</li> <li>• Gene mapping: crossover frequencies</li> <li>• Biometry: statistical methods</li> </ul> <p>Reproductive System</p> <ul style="list-style-type: none"> <li>• Gametogenesis by meiosis</li> <li>• Ovum and sperm <ul style="list-style-type: none"> <li>○ Differences in formation</li> <li>○ Differences in morphology</li> <li>○ Relative contribution to next generation</li> </ul> </li> <li>• Reproductive sequence: fertilization, implantation, development, birth</li> </ul> <p>Endocrine System: Hormones and Their Sources</p> <ul style="list-style-type: none"> <li>• Function of endocrine system: specific chemical control at cell, tissue, and organ level</li> <li>• Definitions of endocrine gland, hormone</li> <li>• Major endocrine glands: names, locations, products</li> <li>• Major types of hormones</li> <li>• Neuroendocrinology — relation between neurons and hormonal systems</li> </ul> <p>Endocrine System: Mechanisms of Hormone Action</p> <ul style="list-style-type: none"> <li>• Cellular mechanisms of hormone action</li> <li>• Transport of hormones: blood supply</li> <li>• Specificity of hormones: target tissue</li> <li>• Integration with nervous system: feedback control regulation by second messengers</li> </ul> <p>Respiratory System</p> <ul style="list-style-type: none"> <li>• General function <ul style="list-style-type: none"> <li>○ Gas exchange, thermoregulation</li> <li>○ Protection against disease: particulate matter</li> </ul> </li> <li>• Structure of lungs and alveoli</li> <li>• Breathing mechanisms <ul style="list-style-type: none"> <li>○ Diaphragm, rib cage, differential pressure</li> <li>○ Resiliency and surface tension effects</li> </ul> </li> <li>• Thermoregulation: nasal and tracheal capillary beds; evaporation,</li> </ul>

MCAT Biology Topics Listed by UD Course Number

	<p>panting</p> <ul style="list-style-type: none"> <li>• Particulate filtration: nasal hairs, mucus/cilia system in lungs</li> <li>• Alveolar gas exchange             <ul style="list-style-type: none"> <li>○ Diffusion, differential partial pressure</li> <li>○ Henry's Law</li> </ul> </li> <li>• pH control</li> <li>• Regulation by nervous control</li> <li>• CO<sub>2</sub> sensitivity</li> </ul> <p>Circulatory System</p> <ul style="list-style-type: none"> <li>• Functions: circulation of oxygen, nutrients, hormones, ions and fluids, removal of metabolic waste</li> <li>• Role in thermoregulation</li> <li>• Four-chambered heart: structure and function</li> <li>• Endothelial cells</li> <li>• Systolic and diastolic pressure</li> <li>• Pulmonary and systemic circulation</li> <li>• Arterial and venous systems (arteries, arterioles, venules, veins)             <ul style="list-style-type: none"> <li>○ Structural and functional differences</li> <li>○ Pressure and flow characteristics</li> </ul> </li> <li>• Capillary beds             <ul style="list-style-type: none"> <li>○ Mechanisms of gas and solute exchange</li> <li>○ Mechanism of heat exchange</li> <li>○ Source of peripheral resistance</li> </ul> </li> <li>• Composition of blood             <ul style="list-style-type: none"> <li>○ Plasma, chemicals, blood cells</li> <li>○ Erythrocyte production and destruction; spleen, bone marrow</li> <li>○ Regulation of plasma volume</li> </ul> </li> <li>• Coagulation, clotting mechanisms</li> <li>• Oxygen transport by blood             <ul style="list-style-type: none"> <li>○ Hemoglobin, hematocrit</li> <li>○ Oxygen content</li> <li>○ Oxygen affinity</li> <li>○ Oxygen transport by blood; modification of oxygen affinity</li> </ul> </li> <li>• Carbon dioxide transport and level in blood</li> <li>• Nervous and endocrine control</li> </ul> <p>Digestive System</p> <ul style="list-style-type: none"> <li>• Ingestion             <ul style="list-style-type: none"> <li>○ Saliva as lubrication and source of enzymes</li> <li>○ Ingestion, esophagus, transport function</li> </ul> </li> <li>• Stomach             <ul style="list-style-type: none"> <li>○ Storage and churning of food</li> <li>○ Low pH, gastric juice, mucal protection against self-destruction</li> <li>○ Production of digestive enzymes, site of digestion</li> <li>○ Structure (gross)</li> </ul> </li> <li>• Liver</li> </ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"> <li>○ Structural relationship of liver within gastrointestinal system</li> <li>○ Production of bile</li> <li>○ Role in blood glucose regulation, detoxification</li> <li>● Bile             <ul style="list-style-type: none"> <li>○ Storage in gall bladder</li> <li>○ Function</li> </ul> </li> <li>● Pancreas             <ul style="list-style-type: none"> <li>○ Production of enzymes</li> <li>○ Transport of enzymes to small intestine</li> </ul> </li> <li>● Small Intestine             <ul style="list-style-type: none"> <li>○ Absorption of food molecules and water</li> <li>○ Function and structure of villi</li> <li>○ Production of enzymes, site of digestion</li> <li>○ Neutralization of stomach acid</li> <li>○ Structure (anatomic subdivisions)</li> </ul> </li> <li>● Large Intestine             <ul style="list-style-type: none"> <li>○ Absorption of water</li> <li>○ Bacterial flora</li> <li>○ Structure (gross)</li> </ul> </li> <li>● Rectum: storage and elimination of waste, feces</li> <li>● Muscular control             <ul style="list-style-type: none"> <li>○ Peristalsis</li> </ul> </li> <li>● Endocrine control             <ul style="list-style-type: none"> <li>○ Hormones</li> <li>○ Target tissues</li> </ul> </li> <li>● Nervous control: the enteric nervous system</li> </ul> <p>Excretory System</p> <ul style="list-style-type: none"> <li>● Roles in homeostasis             <ul style="list-style-type: none"> <li>○ Blood pressure</li> <li>○ Osmoregulation</li> <li>○ Acid-base balance</li> <li>○ Removal of soluble nitrogenous waste</li> </ul> </li> <li>● Kidney structure             <ul style="list-style-type: none"> <li>○ Cortex</li> <li>○ Medulla</li> </ul> </li> <li>● Nephron structure             <ul style="list-style-type: none"> <li>○ Glomerulus</li> <li>○ Bowman's capsule</li> <li>○ Proximal tubule</li> <li>○ Loop of Henle</li> <li>○ Distal tubule</li> <li>○ Collecting duct</li> </ul> </li> <li>● Formation of urine             <ul style="list-style-type: none"> <li>○ Glomerular filtration</li> <li>○ Secretion and reabsorption of solutes</li> <li>○ Concentration of urine</li> <li>○ Counter-current multiplier mechanism</li> </ul> </li> </ul>
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MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>• Storage and elimination: ureter, bladder, urethra</li><li>• Osmoregulation: capillary reabsorption of H<sub>2</sub>O, amino acids, glucose, ions</li><li>• Muscular control: sphincter muscle</li></ul> <p>Reproductive System</p> <ul style="list-style-type: none"><li>• Male and female reproductive structures and their functions<ul style="list-style-type: none"><li>○ Gonads</li><li>○ Genitalia</li><li>○ Differences between male and female structures</li></ul></li><li>• Hormonal control of reproduction<ul style="list-style-type: none"><li>○ Male and female sexual development</li><li>○ Female reproductive cycle</li><li>○ Pregnancy, parturition, lactation</li></ul></li><li>• Integration with nervous control</li></ul> <p>Muscle System</p> <ul style="list-style-type: none"><li>• Important functions<ul style="list-style-type: none"><li>○ Support: mobility</li><li>○ Peripheral circulatory assistance</li><li>○ Thermoregulation (shivering reflex)</li></ul></li><li>• Structure of three basic muscle types: striated, smooth, cardiac</li><li>• Muscle structure and control of contraction<ul style="list-style-type: none"><li>○ T-tubule system</li><li>○ Contractile apparatus</li><li>○ Sarcoplasmic reticulum</li><li>○ Fiber type</li><li>○ Contractile velocity of different muscle types</li></ul></li><li>• Regulation of cardiac muscle contraction</li><li>• Oxygen debt: fatigue</li><li>• Nervous control<ul style="list-style-type: none"><li>○ Motor neurons</li><li>○ Neuromuscular junction, motor end plates</li><li>○ Sympathetic and parasympathetic innervation</li><li>○ Voluntary and involuntary muscles</li></ul></li></ul> <p>Specialized Cell-Muscle Cell</p> <ul style="list-style-type: none"><li>• Structural characteristics of striated, smooth, and cardiac muscle</li><li>• Abundant mitochondria in red muscle cells: ATP source</li><li>• Organization of contractile elements: actin and myosin filaments, crossbridges, sliding filament model</li><li>• Sarcomeres: "I" and "A" bands, "M" and "Z" lines, "H" zone</li><li>• Presence of troponin and tropomyosin</li><li>• Calcium regulation of contraction</li></ul> <p>Skeletal System</p> <ul style="list-style-type: none"><li>• Functions<ul style="list-style-type: none"><li>○ Structural rigidity and support</li><li>○ Calcium storage</li><li>○ Physical protection</li></ul></li><li>• Skeletal structure</li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Specialization of bone types, structures</li><li>○ Joint structures</li><li>○ Endoskeleton vs. exoskeleton</li><li>● Bone structure<ul style="list-style-type: none"><li>○ Calcium/protein matrix</li><li>○ Cellular composition of bone</li></ul></li><li>● Cartilage: structure and function</li><li>● Ligaments, tendons</li><li>● Endocrine control</li></ul> <p>Skin System</p> <ul style="list-style-type: none"><li>● Structure<ul style="list-style-type: none"><li>○ Layer differentiation, cell types</li><li>○ Relative impermeability to water</li></ul></li><li>● Functions in homeostasis and osmoregulation</li><li>● Functions in thermoregulation<ul style="list-style-type: none"><li>○ Hair, erectile musculature</li><li>○ Fat layer for insulation</li><li>○ Sweat glands, location in dermis</li><li>○ Vasoconstriction and vasodilation in surface capillaries</li></ul></li><li>● Physical protection<ul style="list-style-type: none"><li>○ Nails, calluses, hair</li><li>○ Protection against abrasion, disease organisms</li></ul></li><li>● Hormonal control: sweating, vasodilation, and vasoconstriction</li></ul> <p>Biological Bases of Behavior</p> <ul style="list-style-type: none"><li>● The nervous system<ul style="list-style-type: none"><li>○ Neurons<ul style="list-style-type: none"><li>▪ The reflex arc</li></ul></li><li>○ Neurotransmitters</li><li>○ Peripheral nervous system</li><li>○ Central nervous system<ul style="list-style-type: none"><li>▪ The brain<ul style="list-style-type: none"><li>○ The brainstem</li><li>○ The cerebellum</li><li>○ The diencephalon (BIO)</li><li>○ The cerebrum</li><li>○ Control of voluntary movement in the cerebral cortex</li><li>○ Information processing in the cerebral cortex</li><li>○ Lateralization of cortical functions</li><li>○ Methods of studying the brain</li></ul></li></ul></li></ul></li><li>● Neurons communicate and influence behavior (PSY)</li><li>● Influence of neurotransmitters on behavior (PSY)</li><li>● The endocrine system<ul style="list-style-type: none"><li>○ Components of the endocrine system</li><li>○ Effects of the endocrine system on behavior</li></ul></li><li>● Behavioral genetics<ul style="list-style-type: none"><li>○ Genes, temperament, and heredity</li></ul></li></ul>
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## MCAT Biology Topics Listed by UD Course Number

	<ul style="list-style-type: none"><li>○ Adaptive value of traits and behaviors</li><li>○ Interaction between heredity and environmental influences</li><li>● Genetic and environmental factors contribute to the development of behaviors<ul style="list-style-type: none"><li>○ Experience and behavior (PSY)</li><li>○ Regulatory genes and behavior (BIO)</li><li>○ Genetically based behavioral variation in natural populations</li></ul></li><li>● Human physiological development (PSY)<ul style="list-style-type: none"><li>○ Prenatal development</li><li>○ Motor development</li></ul></li><li>● Developmental changes in adolescence</li></ul>
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