



Master AAMC MCAT-2015 Topics List

Reorganized and Duplicates Removed

1. Amino Acids

- Absolute configuration at the α position
- Amino acids as dipolar ions
- Classifications (acidic or basic, hydrophobic or hydrophilic)
- Sulfur linkage between two cysteine residues (forming cystine).
- Peptide linkage: polypeptides and proteins
- Hydrolysis
- Synthesis of α -amino acids (Strecker Synthesis, Gabriel Synthesis)
- Isoelectric point

2. Protein Structures

- 1° structure of proteins
- 2° structure of proteins
- 3° structure of proteins; roll of proline, cystine, hydrophobic bonding
- 4° structure of proteins
- Conformational stability (denaturing and folding, hydrophobic interactions, solvation layer [entropy])
- Separation techniques (isoelectric point, electrophoresis)

3. Non-Enzymatic Protein Function

- Binding
- Immune system
- Motors

4. Enzyme Structure and Function

- Function of enzymes in catalyzing biological reactions
- Enzyme classification by reaction type
- Reduction of activation energy
- Substrates and enzyme specificity
- Active Site Model
- Induced-fit Model
- Mechanism of catalysis (cofactors, coenzymes, water-soluble vitamins)
- Cofactors, coenzymes, and vitamins

5. Control of Enzyme Activity

- Kinetics: general (catalysis)
- Kinetics: Michealis-Menten

- Kinetics: Cooperativity
- Kinetics: Effects of local conditions on enzyme activity (pH, temperature, etc.)
- Feedback regulation
- Competitive Inhibition
- Non-competitive Inhibition
- Mixed Inhibition
- Uncompetitive Inhibition
- Regulatory enzymes (allosteric enzymes, covalently-modified enzymes, zymogens)

6. Nucleic Acid Structure and Function

- Description
- Nucleotides and nucleosides (sugar phosphate backbone, pyrimidine, purine residues)
- Deoxyribonucleic acid (DNA): double helix, Watson-Crick model of DNA structure
- Base pairing specificity: A with T, G with C
- Function in transmission of genetic information
- DNA denaturation, reannealing, hybridization
- Chemistry
- Other functions

7. DNA Replication

- Mechanism of replication: separation of strands, specific coupling of free nucleic acids
- Semi-conservative nature of replication
- Specific enzymes involved in replication
- Origins of replication, multiple origins in eukaryotes

8. Repair of DNA

- Repair during replication
- Repair of mutations

9. Genetic Code

- Central Dogma: DNA → RNA → protein
- The triplet code
- Codon- anticodon relationship
- Degenerate code, wobble pairing
- Missense, nonsense codons
- Initiation, termination codons
- Messenger RNA (mRNA)

10. Transcription

- Transfer RNA (tRNA), ribosomal RNA (rRNA)
- Mechanism of transcription
- mRNA processing in eukaryotes, introns, exons
- Ribozymes, spliceosomes, small nuclear ribonucleoproteins (snRNPs), small nuclear RNAs (snRNAs)
- Functional and evolutionary importance of introns

11. Translation

- Roles of mRNA, tRNA, rRNA
- Role and structure of ribosomes
- Initiation, termination co-factors
- Post-translational modification of proteins

12. Eukaryotic Chromosome Organization

- Chromosomal proteins
- Single copy vs. repetitive DNA
- Supercoiling
- Heterochromatin vs. euchromatin
- Telomeres, centromeres

13. Control of Gene Expression in Prokaryotes

- Operon Concept, Jacob-Monod Model
- Gene repression in bacteria
- Positive control in bacteria

14. Control of Gene Expression in Eukaryotes

- Transcriptional regulation
- DNA binding proteins, transcription factors
- Gene amplification and duplication
- Post-transcriptional control, basic concept of slicing (introns, exons)
- Cancer as a failure of normal cellular controls, oncogenes, tumor suppressor genes
- Regulation of chromatic structure
- DNA methylation
- Role of non-coding RNAs

15. Recombinant DNA and Biotechnology

- Gene cloning
- Restriction enzymes
- DNA libraries
- Generation of cDNA
- Hybridization
- Expressing cloned genes
- Polymerase chain reaction
- Gel electrophoresis and Southern blotting
- DNA sequencing
- Analyzing gene function
- Stem cells
- Practical applications of DNA technology: medical applications, human gene therapy, pharmaceuticals, forensic evidence, environmental cleanup, agriculture
- Safety and ethics of DNA technology

16. Evidence that DNA is Genetic Material

17. Mendelian Concepts

- Phenotype and genotype
- Gene
- Locus
- Allele: single and multiple
- Homozygosity and heterozygosity
- Wild-type
- Recessiveness
- Complete dominance
- Co-dominance
- Incomplete dominance, leakage, penetrance, expressivity
- Hybridization: viability
- Gene pool

18. Meiosis and Other Factors Affecting Genetic Variability

- Significance of meiosis
- Important differences between meiosis and mitosis
- Independent assortment
- Linkage
- Recombination (single crossovers, double crossovers, synaptonemal complex, tetrad)
- Sex-linked characteristics
- Very few genes on Y chromosomes
- Sex determination
- Cytoplasmic/extranuclear inheritance
- General concept of mutation—error in DNA sequence
- Types of mutations: random, translation error, transcription error, base substitution, insertion, deletion, translocation, mispairing
- Advantageous vs. deleterious mutation
- Inborn errors of metabolism
- Relationship to mutagens to carcinogens
- Genetic drift
- Synapsis of crossing-over mechanism for increasing genetic diversity

19. Analytic Methods

- Hardy-Weinberg Principle
- Testcross (Backcross: concepts of parental, F1, and F2 generations)
- Gene mapping: crossover frequencies
- Biometry: statistical methods

20. Evolution

- Natural Selection: Fitness concept
- Natural Selection: Selection by differential reproduction
- Natural Selection: Concepts of natural and group selection
- Natural Selection: Evolutionary success as increase in percent representation in the gene pool of the next generation

- Speciation: Polymorphism
- Speciation: Adaptation and specialization
- Speciation: Inbreeding
- Speciation: Outbreeding
- Speciation: Bottlenecks
- Evolutionary time as measured by gradual random changes in genome

21. Principles of Bioenergetics

- Free energy/ K_{eq} (equilibrium constant, relationship of the equilibrium constant and ΔG°)
- Le Châtelier's Principle
- Endothermic/exothermic reactions
- Free energy: G
- Spontaneous reactions and ΔG°
- Phosphoryl group transfers and ATP
- Biological oxidation-reduction (half-reactions, soluble electron carriers, flavoproteins)
- Bioenergetics/thermodynamics (free energy/ K_{eq} , concentration)
- Phosphorylation/ATP (ATP hydrolysis $\Delta G \ll 0$, ATP group transfers)

22. Carbohydrates

- Nomenclature and classification, common names
- Absolute configuration
- Cyclic structure and conformations of hexoses
- Epimers and anomers
- Hydrolysis of the glycoside linkage
- Monosaccharides
- Keto-enol tautomerism of monosaccharides
- Disaccharides
- Polysaccharides

23. Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway

- Glycolysis (aerobic), substrates and products
- Glycolysis feeder pathways: glycogen, starch metabolism
- Fermentation (anaerobic glycolysis)
- Gluconeogenesis
- Pentose phosphate pathway
- Net molecular and energetic results of respiration processes

24. Principles of Metabolic Regulation

- Regulation of metabolic pathways
- Maintenance of the dynamic steady state
- Regulation of glycolysis and gluconeogenesis
- Metabolism of glycogen
- Regulation of glycogen synthesis and breakdown (allosteric and hormonal control)
- Analysis of metabolic control

25. Citric Acid Cycle

- Acetyl-CoA production
- Reactions of the cycle, substrates, and products
- Regulation of the cycle
- Net molecular and energetic results in respiration processes

26. Metabolism of Fatty Acids and Proteins

- Description of fatty acids
- Digestion, mobilization, and transport of fats
- Oxidation of fatty acids (saturated fats, unsaturated fats)
- Ketone bodies
- Anabolism of fats
- Non-template synthesis: biosynthesis of lipids and polysaccharides
- Metabolism of proteins

27. Oxidative Phosphorylation

- Electron transport chain and oxidative phosphorylation, substrates and products, general features of the pathway
- Electron transfer in mitochondria (NADH, NADPH, flavoproteins, cytochromes)
- ATP synthase, chemiosmotic coupling (proton motion force)
- Net molecular and energetic results of respiration processes
- Regulation of oxidative phosphorylation
- Mitochondria, apoptosis, oxidative stress

28. Hormonal Regulation and Integration of Metabolism

- Higher level integration of hormone structure and function
- Tissue specific metabolism
- Hormonal regulation of fuel metabolism
- Obesity and regulation of body mass

29. Plasma Membrane

- General function in cell containment
- Lipid components (phospholipids, and phosphatids, steroids, waxes)
- Protein components
- Fluid mosaic model
- Membrane dynamics
- Solute Transport Across Membranes: Thermodynamics
- Solute Transport Across Membranes: Osmosis (colligative properties; osmotic pressure)
- Solute Transport Across Membranes: Passive transport
- Solute Transport Across Membranes: Active transport (sodium/potassium pump)
- Membrane channels
- Membrane potential
- Membrane receptors
- Exocytosis and endocytosis
- Intercellular junctions (gap junctions, tight junctions, desmosomes)

30. Membrane-Bound Organelles and Defining Characteristics of Eukaryotic Cells

- Defining Characteristics: membrane bound nucleus, presence of organelles, mitotic division
- Nucleus: Compartmentalization, storage of genetic information
- Nucleus: Nucleolus: location and function
- Nucleus: Nuclear envelope, nuclear pores
- Mitochondria: Site of ATP production
- Mitochondria: Inner and outer membrane structure
- Mitochondria: Self-replication
- Lysosomes: membrane-bound vesicles containing hydrolytic enzymes
- Endoplasmic reticulum: Rough smooth components
- Endoplasmic reticulum: Rough endoplasmic reticulum site of ribosomes
- Endoplasmic reticulum: Double membrane structure
- Endoplasmic reticulum: Role in membrane biosynthesis
- Endoplasmic reticulum: Role in biosynthesis of secreted proteins
- Golgi apparatus: general structure and role in packaging and secretion
- Peroxisomes: organelles that collect peroxides

31. Cytoskeleton

- General function in cell support and movement
- Microfilaments: composition and role in cleavage and contractility
- Microtubules: composition and role in support and transport
- Intermediate filaments, role in support
- Composition and function of cilia and flagella
- Centrioles, microtubules organizing centers

32. Tissues Formed From Eukaryotic Cells

- Epithelial cells
- Connective tissue cells

33. Cell Theory

- History and development
- Impact on biology

34. Classification and Structure of Prokaryotic Cells

- Prokaryotic domains (Archaea, Bacteria)
- Major classifications of bacterial by shape (Bacilli [rod shaped], Spirilli [spiral-shaped], Cocci [spherical])
- Lack of nuclear membrane and mitotic apparatus
- Lack of typical eukaryotic organelles
- Presence of cell wall in bacteria
- Flagellar propulsion, mechanism

35. Growth and Physiology of Prokaryotic Cells

- Reproduction by fission
- High degree of genetic adaptability, acquisition of antibiotic resistance
- Exponential growth

- Existence of anaerobic and aerobic variants
- Parasitic and symbiotic
- Chemotaxis

36. Genetics of Prokaryotic Cells

- Existence of plasmids, extragenomic DNA
- Transformation: incorporation into bacterial genome of DNA fragments from external medium
- Conjugation
- Transposons (also present in eukaryotic cells)

37. Virus Structure

- General structural characteristics (nucleic acid and protein, enveloped and nonenveloped)
- Lack organelles and nucleus
- Structural aspects of typical bacteriophage
- Genomic content—RNA or DNA
- Size relative to bacteria and eukaryotic cells

38. Viral Life Cycle

- Self-replicating biological units that must reproduce within specific host cell
- Generalized phage and animal virus life cycles
- Viruses: Attachment to host, penetration of cell membrane or cell wall, and entry of viral genetic material
- Viruses: Use of host synthetic mechanisms to replicate viral components
- Viruses: Self-assembly and release of new viral particles
- Transduction: transfer of genetic material by viruses
- Retrovirus life cycle: integration into host DNA, reverse transcriptase, HIV
- Prions and viroids: subviral particles

39. Mitosis

- Mitotic process: prophase, metaphase, anaphase, telophase, interphase
- Mitotic structures (centrioles, asters, spindles, chromatids, centromeres, kinetochores, nuclear membrane breakdown and reorganization, mechanisms of chromosome movement)
- Phases of cell cycle: G₀, G₁, G₂, M
- Growth arrest
- Control of cell cycle
- Loss of cell cycle controls in cancer cells

40. Biosignalling

- Oncogenes, apoptosis

41. Reproductive System

- Gametogenesis by meiosis
- Ovum and Sperm: Differences in formation
- Ovum and Sperm: Differences in morphology
- Ovum and Sperm: Relative contribution to next generation
- Reproductive sequence: fertilization; implantation; development; birth

42. Embryogenesis

- Stages of early development (order and general features of each)
- Fertilization
- Cleavage
- Blastula formation
- Gastrulation (first cell movements, endoderm, mesoderm, ectoderm)
- Neurulation
- Major structures arising out of primary germ layers
- Neural crest
- Environment-gene interaction in development

43. Mechanisms of Development

- Cell specialization (determination, differentiation, tissues types)
- Cell-cell communication in development
- Cell migration
- Pluripotency: stem cells
- Gene regulation in development
- Programmed cell death
- Existence of regenerative capacity in various species
- Senescence and aging

44. Nervous System: Structure and Function

- High level control and integration of body systems
- Adaptive capabilities to external influences
- Organization of vertebrate nervous system
- Sensor and effector neurons
- Sympathetic and parasympathetic nervous system: antagonistic control
- Reflexes (feedback loop, reflex arc, role of spinal cord and supraspinal circuits)
- Integration with endocrine system: feedback control

45. Nerve Cell

- Cell body: site of nucleus, organelles
- Dendrites: branched extensions of cell body
- Axon: structure and function
- Myelin sheath, Schwann cells, insulation of axon
- Nodes of Ranvier: propagation of nerve impulse along axon
- Synapse: site of impulse propagation between cells
- Synaptic activity: transmitter molecules
- Resting potential: electrochemical gradient

- Action potential (threshold, all-or-none, sodium/potassium pump)
- Excitatory and inhibitory nerve fibers: summation, frequency of firing
- Glial cells, neuroglia

46. Biosignalling

- Gated ion channels (voltage gated, ligand gated)
- Receptor-enzymes
- G protein-coupled receptors

47. Lipids

- Description; structures
- Steroids
- Terpenes and terpenoids
- Storage (triacyl glycerols, free fatty acids, saponification)
- Structural (phospholipids and phosphatids, sphingolipids, waxes)
- Signals/cofactors (fat-soluble vitamins, steroids, prostaglandins)

48. Endocrine System: Hormones and Their Sources

- Function of endocrine system: specific chemical control at cell, tissue, and organ level
- Definitions of endocrine gland, hormone
- Major endocrine glands: names, locations, products
- Major types of hormones
- Neuroendocrinology—relation between neurons and hormonal systems

49. Endocrine System: Mechanisms of Hormone Action

- Cellular mechanisms of hormone action
- Transport of hormones: blood supply
- Specificity of hormones: target tissue
- Integration with nervous system: feedback control
- Regulation by second messengers

50. Respiratory System

- General function (gas exchange, thermoregulation, protection against disease: particulate matter)
- Structure of lung and alveoli
- Breathing mechanisms (diaphragm, rib cage, differential pressure, resiliency and surface tension effects)
- Thermoregulation: nasal and tracheal capillary beds; evaporation, panting
- Particulate filtration: nasal hairs, mucus/cilia system in lungs
- Alveolar gas exchange (diffusion, differential partial pressure, Henry's Law)
- pH control
- Regulation by nervous control (CO₂ sensitivity)

51. Circulatory System

- Functions: circulation of oxygen, nutrients, hormones, ions and fluids, removal of metabolic waste
- Role in thermoregulation
- Four-chambered heart: structure and function

- Endothelial cells
- Systolic and diastolic pressure
- Pulmonary and systemic circulation
- Arterial and venous systems (arteries, arterioles, venules, veins)
- Arteries and Veins: Structural and functional differences
- Arteries and Veins: Pressure and flow characteristics
- Capillary beds: Mechanisms of gas and solute exchange
- Capillary beds: Mechanisms of heat exchange
- Capillary beds: Source of peripheral resistance
- Composition of blood: Plasma, chemicals, blood cells
- Composition of blood: Erythrocyte production and destruction; spleen, bone marrow
- Composition of blood: Regulation of plasma volume
- Coagulation, clotting mechanisms
- Oxygen transport by blood (hemoglobin, hematocrit, oxygen content, oxygen affinity)
- Carbon dioxide transport and level in blood
- Nervous and endocrine control
- Arterial and venous systems; pressure and flow characteristics

52. Lymphatic System

- Structures of lymphatic system
- Equalization of fluid distribution
- Transport of proteins and large glycerides
- Production of lymphocytes involved in immune reactions
- Return of materials to the blood

53. Immune System

- Innate (non-specific) vs. adaptive (specific) immunity
- Adaptive immune system cells (T-lymphocytes, B-lymphocytes)
- Innate immune system cells (macrophages, phagocytes)
- Tissues (bone marrow, spleen, thymus, lymph nodes)
- Concept of antigen and antibody
- Antigen presentation
- Clonal selection
- Antigen-antibody recognition
- Structure of antibody molecule
- Recognition of self vs. non-self, autoimmune diseases
- Major histocompatibility complex

54. Digestive System

- Ingestion: saliva as lubrication and source of enzymes
- Ingestion: esophagus, transport function
- Stomach: storage and churning of food
- Stomach: low pH, gastric juice, mucal protection against self-destruction
- Stomach: production of digestive enzymes, site of digestion
- Stomach: structure (gross)

- Liver: structural relationship of liver within gastrointestinal system
- Liver: production of bile
- Liver: role in blood glucose regulation, detoxification
- Bile: storage in gall bladder
- Bile: function
- Pancreas: production of enzymes
- Pancreas: transport of enzymes to small intestines
- Small Intestine: absorption of food molecules and water
- Small Intestine: function and structure of villi
- Small Intestine: production of enzymes, site of digestion
- Small Intestine: neutralization of stomach acid
- Small Intestine: structure (anatomic subdivisions)
- Large Intestine: absorption of water
- Large Intestine: bacterial flora
- Large Intestine: structure (gross)
- Rectum: storage and elimination of waste, feces
- Muscular control (peristalsis)
- Endocrine control (hormones, target tissues)
- Nervous control: the enteric nervous system

55. Excretory System

- Roles in homeostasis (blood pressure, osmoregulation, acid-base balance, removal of soluble nitrogenous waste)
- Kidney structure (cortex, medulla)
- Nephron structure: Glomerulus
- Nephron structure: Bowman's capsule
- Nephron structure: Proximal tubule
- Nephron structure: Loop of Henle
- Nephron structure: Distal tubule
- Nephron structure: collecting duct
- Glomerular filtration
- Secretion and reabsorption of solutes
- Concentration of urine
- Counter-current multiplier mechanism
- Storage and elimination: ureter, bladder, urethra
- Osmoregulation: capillary reabsorption of H₂O, amino acids, glucose, ions
- Muscular control: sphincter muscle

56. Reproductive System

- Male and female reproductive structures and their functions (gonads, genitalia, differences between male and female structures)
- Hormonal control: male and female sexual development
- Hormonal control: female reproductive cycle
- Hormonal control: pregnancy, parturition, lactation
- Hormonal control: integration with nervous control

57. Muscle System

- Support: mobility
- Peripheral circulatory assistance
- Thermoregulation (shivering reflex)
- Structures of three basic muscle types: striated, smooth, cardiac
- Muscles structure/contraction: T-tubules system
- Muscles structure/contraction: contractile apparatus
- Muscles structure/contraction: sarcoplasmic reticulum
- Muscles structure/contraction: contractile velocity of different muscle types
- Regulation of cardiac muscle contraction
- Oxygen debt: fatigue
- Nervous control: motor neurons
- Nervous control: neuromuscular junction, motor end plates
- Nervous control: sympathetic and parasympathetic innervation
- Nervous control: voluntary and involuntary muscles

58. Specialized Cell-Muscle Cell

- Structural characteristics of striated, smooth, and cardiac muscle
- Abundant mitochondria in red muscle cells: ATP source
- Organization of contractile elements: actin and myosin filaments, crossbridges, sliding filament model)
- Sarcomeres: "I" and "A" bands, "M" and "Z" lines, "H" zone
- Presence of troponin and tropomyosin
- Calcium regulation of contraction

59. Skeletal System

- Function: structural rigidity and support
- Function: calcium storage
- Function: physical protection
- Skeletal structure: specialization of bone types, structures
- Skeletal structure: joints
- Skeletal structure: endoskeleton vs. exoskeleton
- Bone structure: calcium/protein matrix
- Bone structure: cellular composition of bone
- Cartilage: structures and functions
- Ligament, tendons
- Endocrine control

60. Skin System

- Structure: layer differentiation, cell types
- Structure: relative impermeability to water
- Functions in homeostasis and osmoregulation
- Functions in thermoregulation: hair, erectile musculature
- Functions in thermoregulation: fat layer for insulation
- Functions in thermoregulation: sweat glands, location in dermis
- Functions in thermoregulation: vasoconstriction and vasodilation in surface capillaries
- Physical protection (nails, calluses, hair, protection against abrasion, disease organisms)
- Hormonal control: sweating, vasodilation, and vasoconstriction

61. Translational Motion

- Units and dimensions
- Vectors, components
- Vector addition
- Speed, velocity (average and instantaneous)
- Acceleration

62. Force

- Newton's First Law, inertia
- Newton's Second Law ($F=ma$)
- Newton's Third Law, forces equal and opposite
- Friction, static and kinetic
- Center of mass

63. Equilibrium

- Vector analysis of forces acting on a point object
- Torques, lever arm

64. Work

- Work done by a constant force: $W= Fd \cos\theta$
- Mechanical advantage
- Work Kinetic Energy Theorem
- Conservative forces

65. Energy of Point Objects System

- Kinetic Energy: $KE= \frac{1}{2}mv^2$; units
- Potential Energy ($PE=mgh$, $PE=\frac{1}{2} kx^2$)
- Conservation of energy
- Power, units

66. Periodic Motion

- Amplitude, frequency, phase
- Transverse and longitudinal waves, wavelength and propagation speed

67. Fluids

- Density, specific gravity
- Buoyancy, Archimedes' Principle
- Hydrostatic pressure (Pascal's Law, Hydrostatic pressure, $P=\rho gh$)

- Viscosity: Poiseuille Flow
- Continuity equation ($A \cdot v = \text{constant}$)
- Concept of turbulence at high velocities
- Surface tension
- Bernoulli's equation
- Venturi effect, pitot tube

68. Gas Phase

- Absolute temperature, (K) Kelvin Scale
- Pressure, simple mercury barometer
- Molar volume at 0°C and $1 \text{ atm} = 22.4 \text{ L/mol}$
- Ideal Gas: definition
- Ideal Gas: $PV = nRT$
- Ideal Gas: Boyle's Law: $PV = \text{constant}$
- Ideal Gas: Charles' Law: $V/T = \text{constant}$
- Ideal Gas: Avogadro's Law: $V/n = \text{constant}$
- Kinetic Molecular Theory of Gases
- Heat capacity at constant volume and at constant pressure
- Boltzmann's Constant
- Deviation of real gas behavior from Ideal Gas Law (qualitative, qualitative, Van der Waals' Equation)
- Partial pressure, mole fraction
- Dalton's Law relating to partial pressure to composition

69. Electrostatics

- Charge, conductors, charge conservation
- Insulators
- Coulomb's Law
- Electric field \mathbf{E} (field lines, field due to charge distribution)
- Electrostatic energy, electric potential at a point in space

70. Circuit Elements

- Current $I = \Delta Q/\Delta t$, sign conventions, units
- Electromotive force, voltage
- Resistance: Ohm's Law $I = V/R$
- Resistance: Resistors in series
- Resistance: Resistors in parallel
- Resistance: Resistivity: $\rho = R \cdot A/L$
- Capacitance: parallel plate capacitor
- Capacitance: energy of charged capacitor
- Capacitance: capacitors in series
- Capacitance: capacitors in parallel
- Capacitance: dielectrics
- Conductivity (metallic, electrolytic)
- Meters

71. Magnetism

- Definition of magnetic field **B**
- Motion of charged particles in magnetic fields; Lorentz force

72. Electrochemistry

- Electrolytic cell: electrolysis
- Electrolytic cell: anode, cathode
- Electrolytic cell: Faraday's Law relating amount of elements deposited (or gas liberated)
- Electrolytic cell: Electron flow; oxidation, and reduction at the electrodes
- Galvanic or Voltaic cells: half-reactions
- Galvanic or Voltaic cells: reduction potentials; cell potential
- Galvanic or Voltaic cells: direction of electron flow
- Concentration cell
- Batteries: electromotive force, voltage
- Batteries: lead-storage batteries
- Batteries: Nickel-cadmium batteries

73. Sound

- Production of sound
- Relative speed of sound in solids, liquids, and gases
- Intensity of sound, decibel units, log scale
- Attenuation (Damping)
- Doppler Effect: moving sound source or observer, reflection of sound from a moving object
- Pitch
- Resonance in pipes and strings
- Ultrasound
- Shock waves

74. Light, Electromagnetic Radiation

- Concept of Interference; Young Double-slit Experiment
- Thin films, diffraction grating, single-slit diffraction
- Other diffraction phenomena, X-ray diffraction
- Polarization of light: linear and circular
- Properties of electromagnetic radiation
- Velocity equals constant c , *in vacuo*
- Electromagnetic radiation consists of perpendicularly oscillating electric and magnetic fields; direction of propagation is perpendicular to both
- Classification of electromagnetic spectrum, photon energy $E = hf$
- Visual spectrum, color

75. Molecular Structure and Absorption Spectra

- Infrared region (intramolecular vibrations and rotations, recognizing common characteristic group absorptions, fingerprint region)
- Visible region (absorption in visible region gives complementary color (e.g., carotene), effects of structural changes on absorption (e.g., indicators))

- Ultraviolet region (π -Electron and non-bonding electron transitions, conjugated systems)
- NMR spectroscopy (protons in a magnetic field; equivalent protons, spin-spin splitting)

76. Geometrical Optics

- Reflections from plane surface: angle of incidence equals angle of reflection
- Refraction, refractive index n ; Snell's law: $n_1 \sin \theta_1 = n_2 \sin \theta_2$
- Dispersion, change of index of refraction with wavelength
- Conditions for total internal reflection
- Spherical mirrors: center of curvature
- Spherical mirrors: focal length
- Spherical mirrors: real and virtual images
- Thin lenses: converging and diverging lenses
- Thin lenses: Use of formula $1/p + 1/q = 1/f$, with sign conventions
- Thin lenses: lens strength, diopters
- Combination of lenses
- Lens aberration
- Optical Instruments, including the human eye

77. Atomic Nucleus

- Atomic number, atomic weight
- Neutrons, protons, isotopes
- Nuclear forces, binding energy
- Radioactive decay (α , β , γ decay, half-life, exponential decay, semi-log plots)
- Mass spectrometer

78. Electronic Structure

- Orbital structure of hydrogen atom, principal quantum number n , number of electrons per orbital
- Ground state, excited states,
- Absorption and emission line spectra
- Use of Pauli Exclusion Principle
- Paramagnetism and diamagnetism
- Conventional notation for electronic structure
- Bohr atom
- Heisenberg Uncertainty Principle
- Effective nuclear charge
- Photoelectric effect

79. The Periodic Table- Classification of Elements into Groups by Electronic Structures

- Alkali metals
- Alkaline earth metals: their chemical characteristics
- Halogens: their chemical characteristics
- Noble gases: their physical and chemical characteristics
- Transition metals
- Representative elements

- Metals and non-metals
- Oxygen Group

80. The Periodic Table- Variations of Chemical Properties with Group and Row

- Valence electrons
- First and second ionization energy (definition, prediction from electronic structure for elements in different groups or rows)
- Electron affinity (definition, variation with group and row)
- Electronegativity (definition, comparative values for some representative elements and important groups)
- Electron shells and the sizes of atoms
- Electron shell and the sizes of ions

81. Stoichiometry

- Molecular weight
- Empirical versus molecular formula
- Metric units commonly used in the context of chemistry
- Description of composition by percent mass
- Mole concept, Avogadro's number N_A
- Definition of density
- Oxidation number (common oxidizing and reducing agents, disproportionation reactions)
- Conventions for writing chemical equations
- Balancing equations, including redox equations
- Limiting reactant
- Theoretical yield

82. Acid/Base Equilibria

- Brønsted-Lowry definition of acid, base
- Ionization of water: K_w its approximate value ($K_w = [H^+][OH^-] = 10^{-14}$ at 25°C, 1 atm)
- Ionization of water: definition of pH: pH of pure water
- Conjugate acids and bases (e.g., NH_4^+ and NH_3)
- Strong acids and bases (e.g., nitric, sulfuric)
- Weak acids and bases: dissociation of weak acids and bases with or without added salt
- Weak acids and bases: Hydrolysis of salts of weak acids or bases
- Weak acids and bases: Calculation of pH of solutions of salts of weak acids and bases
- Equilibrium constants K_a and K_b : pK_a , pK_b
- Buffers (definition and concepts [common buffer systems], influence on titration curves)

83. Ions in Solutions

- Anion, cation: common names, formulas and charges for familiar ions (e.g., NH_4^+ ammonium, PO_4^{3-} phosphate, SO_4^{2-} sulfate)
- Hydration, the hydronium ion

84. Solubility

- Units of concentration (e.g., molarity)
- Solubility product constant; the equilibrium expression K_{sp}

- Common-ion effect, its use in laboratory separations
- Complex ion formation
- Complex ions and solubility
- Solubility and pH

85. Titration

- Indicators
- Neutralization
- Interpretation of the titration curves
- Redox titration

86. Covalent Bond

- Lewis Electron Dot formulas
- Resonance structures
- Formal charge
- Lewis acids and bases
- Partial ionic character: role of electronegativity in determining charge distribution
- Partial ionic character: Dipole Moment
- σ and π bonds
- Hybrid orbitals: sp^3 , sp^2 , sp and respective geometries
- Valence shell electron pair repulsion and the prediction of shapes of molecules (e.g., NH_3 , H_2O , CO_2)
- Structural formulas for molecules involving H, C, N, O, F, S, P, Si, Cl
- Delocalized electrons and resonance in ions and molecules
- Multiple bonding (effect on bond length and bond energies, rigidity in molecular structure)
- Stereochemistry: Isomers (structural isomers, stereoisomers, conformational isomers)
- Stereochemistry: Polarization of light, specific rotation
- Stereochemistry: Absolute and relative configuration (*R* and *S*, *E* and *Z*)

87. Liquid Phase-Intermolecular Forces

- Hydrogen bonding
- Dipole Interactions
- Van der Waals' Forces (London dispersion forces)

88. Separations and Purifications

- Extraction: distribution of solute between two immiscible solvents
- Distillation
- Chromatography: Column chromatography, gas-liquid chromatography
- Chromatography: High pressure liquid chromatography
- Chromatography: Paper chromatography
- Chromatography: Thin-layer chromatography
- Electrophoresis
- Quantitative analysis
- Size-exclusion chromatography
- Ion-exchange chromatography

- Affinity chromatography
- Racemic mixtures, separation of enantiomers

89. Aldehydes and Ketones

- Nomenclature
- Physical properties
- Nucleophilic addition reactions at C=O bond (acetal, hemiacetal, imine, enamine, hydride, reagent, cyanohydrin)
- Oxidation of aldehydes
- Reactions at adjacent positions: enolate chemistry (Keto-enol tautomerism [α -racemization], aldol condensation, retro-aldol, kinetic versus thermodynamic enolate)
- Effects of substituents on reactivity of C=O; steric hindrance
- Acidity of α -H; carbanions

90. Alcohols

- Nomenclature
- Physical properties (acidity, hydrogen bonding)
- Oxidation
- Substitution reactions: S_N1 or S_N2
- Protection of alcohols
- Preparation of mesylates and tosylates

91. Carboxylic Acids

- Nomenclature
- Physical properties
- Carboxyl groups reactions (amides [and lactam], esters [and lactone], anhydride formation, reduction, decarboxylation)
- Reactions at 2-position, substitution

92. Acid Derivatives (Anhydrides, Amides, Esters)

- Nomenclature
- Physical properties
- Nucleophilic substitution
- Transesterification
- Hydrolysis of amides
- Relative reactivity of acid derivatives
- Steric effects
- Electronic effects
- Strain (e.g., β -lactams)

93. Phenols

- Oxidation and reduction (e.g., hydroquinones, ubiquinones): biological $2e^-$ redox centers

94. Polycyclic and Heterocyclic Aromatic Compounds

- Biological aromatic heterocycles

95. Energy Changes in Chemical Reactions-Thermochemistry, Thermodynamics

- Thermodynamic system – state function
- Zeroth Law – concept of temperature

- First Law – conservation of energy in thermodynamic processes
- PV diagram: work done = area under or enclosed by curve
- Second Law – concept of entropy (entropy as a measure of “disorder”, relative entropy for gas, liquid, and crystal states)
- Measurement of heat changes (calorimetry), heat capacity, specific heat
- Heat transfer – conduction, convection, radiation
- Endothermic/exothermic reactions (enthalpy, H , and standard heats of reaction and formation, Hess’ Law of Heat Summation)
- Bond dissociation energy as related to heats of formation
- Free energy: G
- Spontaneous reactions and ΔG°
- Coefficient of expansion
- Heat of fusion, heat of vaporization
- Phase diagram: pressure and temperature

96. Rate Processes in Chemical Reactions- Kinetics and Equilibrium

- Reaction rate
- Dependence of reaction rate on concentration of reactants
- Rate law, rate constant
- Reaction order
- Rate-determining step
- Dependence of reaction rate upon temperature
- Activation energy
- Activated complex or transition state
- Use of the Arrhenius Equation
- Kinetic control versus thermodynamic control of a reaction
- Catalysts
- Equilibrium: Law of Mass Action
- Equilibrium: Equilibrium Constant
- Equilibrium: Application of Le Châtelier’s Principle
- Relationship of the equilibrium constant and ΔG°

PsS Section

97. Sensory Processing

- Sensation: Threshold
- Sensation: Weber's Law
- Sensation: Signal detection theory
- Sensation: Sensory adaptation
- Sensation: Psychophysics
- Sensory receptors: Sensory pathways
- Sensory receptors: Types of sensory receptors

98. Vision

- Structure and function of the eye
- Visual processing (visual pathways in the brain, parallel processing, feature detection)

99. Hearing

- Structure and function of the ear
- Auditory processing (e.g., auditory pathways in the brain)
- Sensory reception by hair cells

100. Other Senses

- Somatosensation (e.g., pain perception)
- Taste (e.g., taste buds/ chemoreceptors that detect specific chemicals)
- Smell (Olfactory cells/ chemoreceptors that detect specific chemicals, pheromones, olfactory pathways in the brain)
- Kinesthetic sense
- Vestibular sense

101. Perception

- Bottom-up/Top-down processing
- Perceptual organization (e.g., depth, form, motion, constancy)
- Gestalt principles

102. Attention

- Selective attention
- Divided attention

103. Cognition

- Information-processing model
- Cognitive development: Piaget's stages of cognitive development
- Cognitive development: Cognitive changes in late adulthood
- Cognitive development: Role of culture in cognitive development
- Cognitive development: Influence of heredity and environment on cognitive development
- Biological factors that affect cognition
- Problem solving/decision making: Types of problem solving
- Problem solving/decision making: Barriers to effective problem solving

- Problem solving/decision making: Approaches to problem solving
- Problem solving/decision making: Heuristics and biases (e.g., overconfidence, belief perseverance)
- Theories of intelligence
- Influence of heredity and environment on intelligence
- Variations in intellectual ability

104. Consciousness

- State of consciousness: Alertness
- State of consciousness: Sleep (stages of sleep, sleep cycles, circadian rhythms, dreaming, sleep-wake disorders)
- State of consciousness: Hypnosis and meditation
- Consciousness-altering drugs (types of consciousness-altering drugs and their effects on the nervous system and behavior, drug addiction and the reward pathway in the brain)

105. Memory

- Encoding (process of encoding information, processes that aid in encoding memories)
- Storage (types of memory storage, semantic networks and spreading activation)
- Retrieval: Recall, recognition, and relearning
- Retrieval: Retrieval cues
- Retrieval: The role of emotion in retrieving memories
- Retrieval: Processes that aid retrieval
- Forgetting: Aging and memory
- Forgetting: Memory dysfunctions (e.g., Alzheimer's disease, Korsakoff's syndrome)
- Forgetting: Decay
- Forgetting: Interference
- Forgetting: Memory construction and source monitoring
- Neural plasticity
- Memory and learning
- Long-term potentiation

106. Language

- Theories of language development (e.g., learning, Nativist, Interactionist)
- Influence of language on cognition
- Brain areas that control language and speech

107. Emotion

- Three components of emotion (i.e., cognitive, physiological, behavioral)
- Universal emotions (i.e., fear, anger, happiness, surprise, joy, disgust, and sadness)
- Adaptive role of emotion
- Theories of emotion: James-Lange theory
- Theories of emotion: Cannon-Bard theory
- Theories of emotion: Schachter-Singer theory
- Brain regions involved in the generation and experience of emotions
- The role of the limbic system in emotion
- Emotion and the autonomic nervous system

- Physiological markers of emotion (signatures of emotion)

108. Stress

- Appraisal
- Different types of stressors (e.g., cataclysmic events, personal)
- Effects of stress on psychological functions
- Stress outcomes/response to stressors (physiological, emotional, behavioral)
- Managing stress (e.g., exercise, relaxation, spirituality)

109. Biological Bases of Behavior

- The nervous system: Neurons
- The nervous system: Neurotransmitters
- The nervous system: Structure and functions of the peripheral nervous system
- The brain: Forebrain
- The brain: Midbrain
- The brain: Hindbrain
- The brain: Lateralization of cortical functions
- The brain: Methods used in studying the brain
- The spinal cord
- Neuronal communication and its influence on behavior
- Influence of neurotransmitters on behavior
- The endocrine system (components of the endocrine system, effects of the endocrine system on behavior)
- Behavioral genetics: Genes, temperament, and heredity
- Behavioral genetics: Adaptive value of traits and behaviors
- Behavioral genetics: Interactions between heredity and environmental influences
- Experience and behavior
- Regulatory genes and behavior
- Genetically based behavioral variation in natural populations
- Human physiological development (prenatal development, motor development, developmental changes in adolescence)

110. Personality

- Theories of personality: Psychoanalytic perspective
- Theories of personality: Humanistic perspective
- Theories of personality: Trait perspective
- Theories of personality: Social cognitive perspective
- Theories of personality: Biological perspectives
- Theories of personality: Behaviorist perspective
- Situational approach to explain behavior

111. Psychological Disorders

- Biomedical vs. biopsychosocial approaches
- Classifying psychological disorders
- Rates of psychological disorders
- Anxiety disorders

- Obsessive-compulsive disorder
- Trauma- and stress-related disorder
- Somatic symptom and related disorders
- Bipolar and related disorders
- Depressive disorders
- Schizophrenia
- Dissociative disorders
- Personality disorders
- Biological bases of nervous system disorders: Schizophrenia
- Biological bases of nervous system disorders: Depression
- Biological bases of nervous system disorders: Alzheimer's disease
- Biological bases of nervous system disorders: Parkinson's disease
- Biological bases of nervous system disorders: Stem cell-based therapy to regenerate neurons in the central nervous system

112. Motivations

- Instinct
- Arousal
- Drives (e.g., negative feedback systems)
- Needs
- Theories of motivation: Drive reduction theory
- Theories of motivation: Incentive theory
- Theories of motivation: Other theories (e.g., cognitive, need-based)
- Biological and sociocultural motivators that regulate behavior (e.g., hunger, sex drive, substance, addiction)

113. Attitudes

- Components of attitudes (i.e., cognitive, affective, and behavioral)
- Processes by which behavior influences attitudes (e.g., foot-in-the door phenomenon, role-playing effects)
- Processes by which attitudes influence behavior
- Cognitive dissonance theory

114. How the Presence of Others Affects Individual Behavior

- Social facilitation
- Deindividuation
- Bystander effect
- Social loafing
- Social control
- Peer pressure
- Conformity
- Obedience

115. Group Decision-making Processes

- Group polarization
- Groupthink

116. Normative and Non-normative Behavior

- Social norms (sanctions, folkways, mores, and taboos, anomie)
- Deviance: Differential association
- Deviance: Labeling theory
- Deviance: Strain theory
- Aspects of collective behavior (e.g., fads, mass hysteria, riots)

117. Socialization

- Agents of socialization (e.g., the family, mass media, peers, workplace)

118. Habituation of Dishabituation

119. Associative Learning

- Classical conditioning: Neutral, conditioned, and unconditioned stimuli
- Classical conditioning: Conditioned and unconditioned response
- Classical conditioning: Processes: acquisition, extinction, spontaneous recovery, generalization, discrimination
- Operant conditioning: Processes of shaping and extinction
- Operant conditioning: Types of reinforcement: positive, negative, primary, conditional
- Operant conditioning: Reinforcement schedules: fixed-ratio, variable-ratio, fixed-interval, variable-interval
- Operant conditioning: Punishment
- Operant conditioning: Escape and avoidance learning
- The role of cognitive processes in associative learning
- Biological processes that affect associative learning (e.g., biological predispositions, instinctive drift)

120. Observational Learning

- Modeling
- Biological processes that affect observational learning (mirror neurons, role of the brain in experiencing vicarious emotions)
- Applications of observational learning to explain individual behavior

121. Theories of Attitude and Behavior Change

- Elaboration likelihood model
- Social cognitive theory
- Factors that affect attitude change (e.g., changing behavior, characteristics of the message and target, social factors)

122. Self-Concept, Self-Identity, and Social Identity

- The role of self-esteem, self-efficacy, and locus of control in self-concept and self-identity
- Different types of identities (e.g., race/ethnicity, gender age, sexual orientation, class)

123. Formation of Identity

- Theories of identity development (e.g., gender, moral, psychosexual, social)
- Influence of social factors on identity formation
- Influence of individual (e.g., imitation, looking-glass self, role-taking)
- Influence of groups (e.g., reference group)

- Influence of culture and socialization of identity formation

124. Attributing Behavior to Persons or Situations

- Attributional processes (e.g., fundamental attribution error, role of culture in attributions)
- How self-perceptions shape our perceptions of others
- How perceptions of the environment shape our perceptions of others

125. Prejudice and Bias

- Power, prestige, and class
- The role of emotion in prejudice
- The role of cognition in prejudice
- Stereotypes
- Stigmas
- Ethnocentrism (ethnocentrism vs. cultural relativism)

126. Processes Related to Stereotypes

- Self-fulfilling prophecy
- Stereotype threat

127. Elements of Social Interaction:

- Status (i.e., achieved, ascribed)
- Role: Role conflict and role strain
- Role: Role exit
- Groups: Primary and secondary groups
- Groups: In-group vs. out-group
- Group size (e.g., dyads, triads)
- Networks
- Organizations
- Bureaucracy: Characteristic of an ideal bureaucracy
- Bureaucracy: Perspectives on bureaucracy (e.g., iron law of oligarchy, McDonaldization)

128. Self-presentation and interacting with Others

- Expressing and detecting emotion (the role of gender, the role of culture)
- Presentation of self (impression management, front stage vs. back stage self [Dramaturgical approach])
- Verbal and nonverbal communication
- Animal signals and communication

129. Social Behavior

- Attraction
- Aggression
- Attachment
- Altruism
- Social support
- Foraging behavior
- Mating behavior and mate choice
- Applying game theory

- Altruism
- Inclusive fitness

130. Discrimination

- Individual vs. institutional discrimination
- The relationship between prejudice and discrimination
- How power, prestige, and class facilitate discrimination

131. Theoretical Approaches

- Microsociology vs. macrosociology
- Functionalism
- Conflict theory
- Symbolic interactionism
- Social constructionism
- Exchange-rational choice
- Feminist theory

132. Social Institutions

- Education: Hidden curriculum
- Education: Teacher expectancy
- Education: Educational segregation and stratification
- Family: Forms of kinship
- Family: Diversity in family forms
- Family: Marriage and divorce
- Family: Violence in the family (e.g., child abuse, elder abuse, spousal abuse)
- Religion: Religiosity
- Religion: Types of religious organization (e.g., churches, sects, cults)
- Religion: Religion and social change (e.g., modernization, secularization, fundamentalism)
- Government and economy: Power and authority
- Government and economy: Comparative economic and political systems
- Government and economy: Division of labor
- Health and medicine: Medicalization
- Health and medicine: The sick role
- Health and medicine: Delivery of health care
- Health and medicine: Illness experience
- Health and medicine: Social epidemiology

133. Culture

- Elements of culture (e.g., beliefs, language, rituals, symbols, values)
- Material vs. symbolic culture
- Culture lag
- Culture shock
- Assimilation
- Multiculturalism
- Subcultures and countercultures

- Mass media and popular culture
- Evolution and human culture
- Transmission and diffusion

134. Demographic Structure of Society

- Age: Aging and the life course
- Age: Age cohorts
- Age: Social significance of aging
- Gender: Sex versus gender
- Gender: The social construction of gender
- Gender: Gender segregation
- Race and Ethnicity: The social construction of race
- Race and Ethnicity: Racialization
- Race and Ethnicity: Racial formation
- Immigration status: Patterns of immigration
- Immigration status: Intersection with race and ethnicity
- Sexual orientation

135. Demographic Shifts and Social Change

- Theories of demographic change (i.e., Malthusian theory and demographic transition)
- Population growth and decline (e.g., population projections, population pyramids)
- Fertility and mortality rates (e.g., total, crude, age-specific)
- Patterns in fertility and mortality
- Push and pull factors in migration
- Social movements: Relative deprivation
- Social movements: Organization of social movements
- Social movements: Movement strategies and tactics
- Globalization: Factors contributing to globalization (e.g., communication technology, economic interdependence)
- Globalization: Perspectives on globalization
- Globalization: Social changes in globalization (e.g., civil unrest, terrorism)
- Urbanization: Industrialization and urban growth
- Urbanization: Suburbanization and urban decline
- Urbanization: Gentrification and urban renewal

136. Spatial Inequality

- Residential segregation
- Neighborhood safety and violence
- Environmental justice (location and exposure to health risks)

137. Social Class

- Social stratification: Social class and socioeconomic status
- Social stratification: Class consciousness and false consciousness
- Social stratification: Cultural capital and social capital
- Social stratification: Social reproduction
- Social stratification: Power, privilege, and prestige

- Social stratification: Intersectionality (e.g., race, gender, age)
- Social stratification: Socioeconomic gradient in health
- Social stratification: Global inequalities
- Social mobility: Intergenerational and intragenerational mobility
- Social mobility: Vertical and horizontal mobility
- Social mobility: Meritocracy

138. Poverty

- Relative and absolute poverty
- Social exclusion (segregation and isolation)

139. Health Disparities

- Class, gender, and race inequalities in health

140. Healthcare Disparities

- Class, gender, and race inequalities in health care