**Topic 1 The Chemistry of**

**LifeChapter 2: The Chemical Context of Life**

**You MUST KNOW**

* The three subatomic particles and their significance.
* The types of bonds, how they form, and their relative strengths

**Chapter 3: Water and the Fitness of the Environment**

**You MUST KNOW**

* The importance of hydrogen bonding to the properties of water.
* Four unique properties of water, and how each contributes to life on Earth.
* How to interpret the pH scale.
* The importance of buffers in biological systems.

**Chapter 4: Carbon and the Molecular Diversity of Life**

* The properties of carbon that make it so important.

**Chapter 5 The Structure and function of Macromolecules**

**You MUST KNOW**

* The role of **dehydration synthesis** in the formation of organic compounds and **hydrolysis** in the digestion of organic compounds.
* How to recognize the four biologically important organic compounds (carbohydrates, lipids, proteins, and nucleic acids) by their structural formulas.
* The cellular functions of all four organic compounds.
* The four structural levels that proteins can go through to reach their final shape (**conformation**) and the **denaturing** impact that heat and pH can have on protein structure.

**A TIP FROM THE GRADERS:** Be able to recognize the structural formulas of a monosaccharide, amino acid, fat, phospholipids, and DNA. Know the functions of each, and where they would be found.

**TOPIC 2 CELLS**

**You MUST KNOW**

**Chapter 6 A tour of the cell**

* The differences between prokaryotic and eukaryotic cells.
* The structure and function of organelles common to plant and animal cells.
* The structure and function of organelles found only in plant cells or only in animal cells

***STUDY TIP:*** Know the structure and function of each organelle, and whether it is found in a plant cell, animal cell, or both. As an example, be prepared to discuss structures found in plant cells, but not in animal cells. (Plant cells have a large central vacuole, chloroplasts, and a cell wall.)

**Chapter 7 Membrane structure and function**

* Why membranes are selectively permeable.
* The role of phospholipids, proteins, and carbohydrates in membranes.
* How water will move if a cell is placed in an isotonic, hypertonic, or hypotonic solution.
* How electrochemical gradients are formed.

***Study Hint:*** AP Lab 1 deals with osmosis and diffusion. Work with these ideas until you can predict the direction of water movement based on the concentration of solutes inside and outside the cell.

***Study Hint:*** Both photosynthesis and cellular respiration, the topics of two upcoming chapters, utilize electrochemical gradients as potential energy sources to generate ATP. By carefully studying electrochemical gradients now, you will be in a good position to understand more complex processes later.

**Chapter 8 An introduction to metabolism**

* The key role of ATP in energy coupling.
* That enzymes work by lowering the energy of activation.
* The catalytic cycle of an enzyme that results in the production of a final product.
* The factors that influence the efficiency of enzymes.

***Study Hint:*** Over the last twenty years one of the most consistently asked section of the AP curriculum have been enzymes. Laboratory 2 focuses on enzymes, so be sure to review the important steps in the experimental design of this lab. Using the figures as an aid, review thoroughly this section on enzyme function.

**Chapter 11 Cell communication**

**You MUST KNOW**

* The three stages of cell communication: reception, transduction, and response.
* How G-protein-linked receptors receive cell signals and start transduction.
* How receptor tyrosine kinase receives cell signals and start transduction.
* How a phosphorylation cascade amplifies a cell signal during transduction.
* How a cell response in the nucleus is different than in the cytoplasm.
* What apoptosis means and why it is important to normal functioning of multicellular organisms.

**Chapter 12 The cell cycle**

**You MUST KNOW**

* The structure of the replicated chromosome.
* The stages of mitosis.
* The role of kinases and cyclin in the regulation of the cell cycle.

***For Additional Review***

Compare the process of meiosis with the process of mitosis. In your comparison, include a study of the change in chromosomal number through the cell, the purposes of each process within an organism, and the starting material and product for each.

**Topic 3**

**respiration and photosynthesis**

**Chapter 9 cellular respiration: harvesting chemical energy**

You **MUST KNOW**:

* The difference between fermentation and cellular respiration.
* The role of glycolysis in oxidizing glucose to two molecules of pyruvate
* The process that brings pyruvate from the cytosol into the mitochondria and introduces it into the citric acid cycle.
* The role of the citric acid cycle in oxidizing pyruvate and generating NADH, FADH2, and ATP in the process
* How the process of chemiosmosis utilizes the electrons from NADH and FADH2 to produce ATP.

**Chapter 10 Photosynthesis**

You **MUST KNOW**:

* How photosystems convert solar energy to chemical energy.
* How linear electron flow in the light reactions results in the formation of ATP, NADPH, and O2

* How chemiosmosis generates ATP in the light reactions.
* How the Calvin cycle uses the energy molecules of the light reactions to produce G3P.
* The metabolic adaptations of C4 and CAM plants to arid, dry regions.

***For Additional Review***

Compare and contrast the process of chemiosmosis in both the mitochondrion and the chloroplast. Note how the H+ gradient is established, and the orientation of the ATP synthase molecules.

**Topic 4 Mendelian Genetics**

**Chapter 13 Meiosis and Sexual life cycles**

You **MUST KNOW**:

* The differences between asexual and sexual reproduction.
* The role of meiosis and fertilization in sexually reproducing organisms.
* The importance of homologous chromosomes to meiosis.
* How the chromosome number is reduced from diploid to haploid through the stages of meiosis.
* Three important differences between mitosis and meiosis.
* The importance of crossing over, independent assortment, and random fertilization to increasing genetic variability.

***ORGANIZE YOUR THOUGHTS***

In Prophase I:

1. Synapsis occurs, forming tetrads

2. Tetrads undergo crossing over

3. Crossing over increases genetic variation

4. Areas of crossing over form chiasmata

5. The nuclear envelope disintegrates, allowing the spindle to attach to the homologues

**Chapter 14 Mendel and the Gene Idea**

You **MUST KNOW:**

* Terms associated with working genetics problems: P, F1, F2, dominant, recessive, homozygous, heterozygous, phenotypic, and genotypic.
* How to derive the proper gametes when working a genetics problem
* The difference between an allele and a gene.
* How to read a pedigree.

**Chapter 15 The Chromosomal Basis of Inheritance**

**You MUST KNOW:**

* How the chromosome theory of inheritance connects the physical movement of chromosomes in meiosis to Mendel’s laws of inheritance.
* The unique pattern of inheritance in sex-linked genes.
* How alteration of chromosome number or structurally altered chromosomes (deletions, duplications, etc) can cause genetic disorders.

**Topic 5 Molecular Genetics**

**Chapter 16 The MOLECULAR BASIS OF INHERITANCE**

You **MUST KNOW**:

* The structure of DNA.
* The major steps to replication.
* The difference between replication, transcription, and translation.
* How DNA is packaged into a chromosome.

**Chapter 17 From gene to protein**

You **MUST KNOW**:

* The key terms gene expression, transcription, and translation.
* How to explain the process of transcription.
* How eukaryotic cells modify RNA after transcription.
* The steps to translation.
* How point mutations can change the amino acid sequence of a protein.

**Tip from the Readers**: This is the central chapter for molecular genetics. It is one of the top five chapters you must know to perform well on the AP exam!

**Chapter 18 regulation of gene expression**

You **MUST KNOW**:

* The functions of the three parts of an operon.
* The role of repressor genes in operons.
* The impact of DNA methylation and histone acetylation on gene expression.
* The role of oncogenes, proto-oncogenes, and tumor suppressor genes in cancer.

**Chapter 19 VIRUSES**

You **MUST KNOW**:

* The components of a virus.
* The differences between lytic and lysogenic cycles.

**CHAPTER 20 DNA TECHNOLOGY AND GENOMICS**

* The terminology of biotechnology.
* The steps in gene cloning with special attention to the biotechnology tools that make cloning possible.
* The key ideas that make PCR possible.
* How gel electrophoresis can be used to separate DNA and protein molecules.

**TOPIC 6: Mechanisms of Evolution**

**CHAPTER 22 DESCENT WITH MODIFICATION: A DARWINIAN VIEW OF LIFE**

**YOU MUST KNOW**

* How Lamarck’s view of the mechanism of evolution differed from Darwin’s.
* Several examples of evidence for evolution.
* The difference between structures that are homologous and those that are analogous, and how this relates to evolution.
* The role of adaptations, variation, time, reproductive success and heritability in evolution.

**EVIDENCE FOR EVOLUTION is seen in the following ways:**

* **Direct observations**
* **The fossil record**
* **Homology**
* **Biogeography**

1. Evolution is change in species over time.
2. Heritable variations exist within a population.
3. These variations can result in differential reproductive success.
4. Over generations, this can result in changes in the genetic composition of the population.

*And remember . . . Individuals do not evolve!* ***Populations*** *evolve.*

**CHAPTER 23 THE EVOLUTION OF POPULATIONS**

**You MUST KNOW**

* How mutation and sexual reproduction each produce genetic variation.
* The conditions for Hardy-Weinberg Equilibrium
* How to use the Hardy-Weinberg equation to calculate allelic frequencies and to test whether a population is evolving.

***ORGANIZE YOUR THOUGHTS***

**Five Conditions for Hardy-Weinberg Equilibrium**

1. **No mutations**.
2. **Random mating.**
3. **No natural selection.**
4. **The population size must be extremely large.** (No genetic drift.)
5. **No gene flow.** (Emigration, immigration, transfer of pollen, etc.)

**CHAPTER 24 THE ORIGIN OF SPECIES**

**You MUST KNOW**

* The difference between **microevolution** and **macroevolution**
* The **biological concept of species.**
* **Prezygotic** and **postzygotic** barriers that maintain reproductive isolation in natural populations
* How **allopatric** and **sympatric** speciation are similar and different.
* How an **autopolyploid** or an **allopolyploid** chromosomal change can lead to sympatric speciation
* How **punctuated equilibrium** and **gradualism** describe two different tempos of speciation

**A TIP FROM THE READERS**

Remember this: Individuals do not evolve! They do not “struggle to survive.” They cannot change their genetic makeup in response to a catastrophe. The individual lives or dies. Those that live reproduce and pass on adaptive heritable variations. ***INDIVIDUALS DO NOT EVOLVE! ONLY POPULATIONS CAN EVOLVE!***

**CHAPTER 25 THE HISTORY OF LIFE ON EARTH**

**You MUST KNOW**

* The age of the Earth, and when prokaryotic and eukaryotic life emerged.
* Characteristics of the early planet and its atmosphere.
* How Miller and Urey tested the Oparin-Haldane hypothesis, and what they learned.
* Methods used to date fossils and rocks.
* Evidence for endosymbiosis.
* How continental drift can explain the current distribution of species

**TOPIC 7The Evolutionary History of Biodiversity**

**CHAPTER 26 PHYLOGENY AND THE TREE OF LIFE**

**You MUST KNOW**

* The taxonomic categories and how they indicate relatedness.
* How systematics is used to develop phylogenetic trees.
* The three domains of life including their similarities and their differences.

**CHAPTER 27 BACTERIA AND ARCHEA**

**You MUST KNOW**

* The key ways in which prokaryotes differ from eukaryotes with respect to genome, membrane-bound organelles, size, and reproduction.
* Mechanisms that contribute to genetic diversity in prokaryotes including transformation, conjugation, transduction and mutation.

**CHAPTER 28 PROTISTS**

**You MUST KNOW**

* Protista is no longer considered a kingdom! This probably contradicts what you learned in your introductory biology class.
* How chloroplasts and mitochondria evolved through endosymbiosis.

**Chapter 29 Plant Diversity I: How plants colonized land**

You **MUST KNOW**:

* Why land plants are thought to have evolved from green algae, plus some of the disadvantages and advantages of life on land.
* That plants have a unique life cycle termed alternation of generations with a gametophyte generation and a sporophyte generation.
* The role of antheridia and archegonia on gametophytes.
* The major characteristics of bryophytes.
* The major characteristics of seedless vascular plants.

**Chapter 30 Plant Diversity II: The evolution of seed plants**

You **MUST KNOW**:

* Key adaptations to life on land unique to seed plants
* The evolutionary significance of seeds and pollen.
* The role of stamens and carpels in angiosperm reproduction

**CHAPTER 31 FUNGI**

**You MUST KNOW**

* The characteristics of fungi.
* Important ecological roles of fungi in mycorrhizal associations, and as decomposers and parasitic plant pathogens.

**CHAPTER 32 AN INTRODUCTION TO ANIMAL DIVERSITY**

**You MUST KNOW**

* The characteristics of animals.
* The stages of animal development.
* How to sort the animal phyla based on symmetry, development of a body cavity, and the fate of the blastopore. The blastopore either becomes a mouth or anus.

**CHAPTER 33 INVERTEBRATES**

**You MUST KNOW**

* The traits which are used to divide the animals into groups
* Examples and unique traits for each phylum discussed
* The evolution of systems for gas exchange, respiration, excretion, circulation and nervous control

**CHAPTER 34: VERTEBRATES**

**You MUST KNOW**

* The four chordate characteristics
* Traits which distinguish each of the following groups: Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Birds, and Mammalia.
* Adaptations that allowed animals to move onto land.
* How the 3 classes of mammals differ in their reproduction.

**Topic 8 Plant form and function**

**Chapter 35Plant structure, growth, and development**

You **MUST KNOW**:

* The function of xylem and phloem tissue.
* The specific functions of tracheids, vessels, sieve-tube elements, and companion cells.
* The correlation between primary growth and apical meristems versus secondary growth and lateral meristems.

**Chapter 36 Resource Acquisition and transport in vascular plants**

You **MUST KNOW**:

* The role of passive transport, active transport, and cotransport in plant transport.
* The role of diffusion, active transport, and bulk flow in the movement of water and nutrients in plants.
* How the transpiration cohesion-tension mechanism explains water movement in plants.
* How pressure flow explains translocation.

**A TIP FROM THE GRADERS:** Hydrogen bonding plays a key role in cohesion-tension mechanisms. Be able the explain the importance of cohesion, adhesion (water hydrogen bonded to the xylem walls), and surface tension in this mechanism.

**Chapter 38 Angiosperm reproduction and Biotechnology**

You **MUST KNOW**:

* The process of double fertilization, a unique feature of angiosperms.
* .The relationship between seed and fruit.
* The structure and functions of all parts of the flower.

**Chapter 39 Plant responses to internal and external signals**

You **MUST KNOW**:

* The three steps to a signal transduction pathway.
* The role of auxins in plants.
* The survival benefits of phototropism and gravitropism.
* How photoperiodism determines when flowering occurs.

**topic 9 Animal Form and Function**

**Chapter 40: Basic Principles of Animal Form and Function**

**You MUST KNOW**

The four types of tissues and their general functions.

* The importance of homeostasis and examples.
* How feedback systems control homeostasis, and one example of positive feedback and one example of negative feedback.

**Chapter 41: Animal Nutrition**

**You MUST KNOW**

* + The major compartments of the alimentary canal –oral cavity, pharynx, esophagus, stomach, small intestines, and large intestines – and their contributions to animal nutrition.
  + The major digestive glands – salivary glands, pancreas, and liver – and their contributions to animal nutrition.
* The general scheme of chemical digestion of carbohydrates, fats, proteins, and nucleic acids.

**Chapter 42: Circulation and Gas Exchange**

**YOU MUST KNOW**

* The circulatory vessels, heart chambers, and route of mammalian circulation
* How RBCs demonstrate the relationship of structure to function
* The general characteristics of a respiratory surface
* The pathway a molecule of oxygen takes from the air until it is picked up by the hemoglobin of a red blood cell

**CHAPTER 43 THE IMMUNE SYSTEM**

You **MUST KNOW**:

* Several elements of an innate immune response.
* The differences between B and T cells relative to their activation and actions.
* How antigens are recognized by immune system cells.
* The differences in humoral and cell-mediated immunity.
* Why Helper T cells are central to immune responses.

**CHAPTER 44 OSMOREGULATION AND EXCRETION**

**You MUST KNOW**

* Three categories of nitrogenous waste, which animal groups produce each, and why.
* The components of a nephron, and what occurs in each region.
* How hormones affect water balance by acting on the nephron.

**CHAPTER 45 HORMONES AND THE ENDOCRINE SYSTEM**

**You MUST KNOW**

* Two ways hormones affect target organs.
* The secretion, target, action, and regulation of at least 3 hormones.
* An illustration of both positive and negative feedback in the regulation of homeostasis by hormones.

**CHAPTER 47 ANIMAL DEVELOPMENT**

You **MUST** **KNOW**

* What occurs in cleavage, gastrulation, and organogenesis.
* Two structures derived from each germ layer
* The events that occur when a sperm contacts an egg

**CHAPTER 48 NEURONS, SYNAPSES, AND SIGNALING**

You **MUST** **KNOW**

* The anatomy of a neuron.
* The mechanisms of impulse transmission in a neuron.
* The process that leads to release of neurotransmitter, and what happens at the synapse.

**CHAPTER 49 NERVOUS SYSTEMS**

You **MUST** KNOW

* The components of a reflex arc and how they work.
* The organization and function of the major parts of the nervous system.
* One function for each major brain region.

**Topic 10 ecology**

**CHAPTER 52 AN INTRODUCTION TO ECOLOGY AND THE BIOSPHERE**

You **MUST KNOW**:

* The role of abiotic factors in the formation of biomes.
* Features of freshwater and marine biomes.
* Major terrestrial biomes and their characteristics.

**CHAPTER 53 POPULATION ECOLOGY**

You **MUST KNOW**:

* How density, dispersion, and demographics can describe a population.
* The differences between exponential and logistic models of population growth.
* How density-dependent and density-independent factors can control population growth.

**CHAPTER 54 COMMUNITY ECOLOGY**

You **MUST KNOW**:

* The difference between a fundamental niche and a realized niche.
* The role of competitive exclusion in interspecific competition.
* The symbiotic relationships of parasitism, mutualism, and commensalism.
* The impact of keystone species on community structure.
* The difference between primary and secondary succession.

**CHAPTER 55 ECOSYSTEMS**

You **MUST KNOW**:

* How energy flows through the ecosystem by understanding the terms in bold that relate to food chains and food webs.
* The difference between gross primary productivity and net primary productivity.
* The carbon and nitrogen biogeochemical cycles.