AP Biology Exam Review

PART I: MOLECULES AND CELLS (25%)

Chemistry of Life (7%)

Water is a **highly polar** molecule due to the electronegativity of oxygen: the oxygen side has a slightly negative charge while the hydrogen side has a slightly positive charge, which allows for **hydrogen bonding**, the strong hydrogen attractions between molecules of water.

Characteristics of water –

- **Cohesion** is due to hydrogen bonds holding water molecules together. **Adhesion** is the clinging of one substance to another. **Capillary action** results from their combined forces and is important in the movement of water up a tree.
- Greater **surface tension** than most other liquids.
- **High specific heat** results in a stable environmental temperature for marine organisms.
- **High heat of vaporization**: evaporating water requires relatively greater amount of heat.
- Ice is **less dense** than water, allowing fish and other organisms to survive beneath a frozen pond in the winter.

Organic compounds are compounds that contain carbon. The four classes of organic compounds are as follows:

- **Carbohydrates**: consist of carbon, hydrogen, and oxygen. Monosaccharides include glucose and fructose. A disaccharide consists of two monosaccharides joined through **condensation** (removal of water), with **hydrolysis** (addition of water) being the reverse of condensation. Polysaccharides include **cellulose** (structure, plants), **starch** (storage, plants), **chitin** (structure, animals), and **glycogen** (storage, animals).
- **Lipids**: includes fats, oil, waxes, and steroids. All are hydrophobic. Most lipids consist of one **glycerol** molecule and three **fatty acid** tails (saturated or unsaturated hydrocarbon chains with a carboxyl group at the end). **Steroids** are lipids with four fused rings.
- **Proteins**: carry out many functions in the body, such as signaling and catalyzing chemical reactions. Smallest units are **amino acids**, which join together with **peptide bonds** to create a polypeptide chains. Be familiar with the four levels of protein structure: 1) linear sequence of amino acids, 2) alpha helices or beta pleated sheets, 3) interactions between side chains, such as hydrogen bonding, ionic bonding, Van der Waals, hydrophobic interactions, or disulfide bonds, 4) optional, refers to proteins consisting of more than one polypeptide chain.
- Nucleic **acids**: ribonucleic (RNA) or deoxyribonucleic (DNA), responsible for carrying **heredity** information. Made of nucleotides, which consist of phosphate, a 5-carbon sugar deoxyribose or ribose, and a nitrogen base: adenine, cytosine, guanine, or thymine (DNA), or uracil (RNA).

AP Biology Exam Review

The **first law of thermodynamics** states that energy cannot be created or destroyed, only transferred – otherwise known as the law of conservation of energy. The **second law of thermodynamics** states that in the course of energy conversions, the **entropy** (disorder) in the universe decreases. Gibb's free energy equation: $\Delta G = \Delta H - T\Delta S$, where ΔG represents free energy change, ΔH represents change in heat content, T represents absolute temperature, and ΔS represents entropy.

An **exergonic reaction** results in a net release of free energy, with ΔG being negative – the reactants have *more* energy than the products. This models a spontaneous or "downhill" reaction. An **endergonic reaction** absorbs free energy, *storing* it in products, resulting in a positive ΔG – the reactants have *less* energy than the products. This is an "uphill" reaction. **ATP**, adenosine triphosphate, powers cellular work by coupling exergonic reactions to endergonic reactions. In other words, through **phosphorylation**, the transfer of a phosphate group from ATP to another molecule, an otherwise endergonic reaction can become exergonic.

Catabolism is the breaking down of molecules, while the building of molecules is **anabolism**. **Enzymes** are catalytic proteins that speed up reactions by lowering the **energy of activation**.

Characteristics of Enzymes:

- Enzymes are **substrate specific**. Only the **active site** of an enzyme will bind to the substrate(s).
- The **induced-fit model** states that as substrates enter the active site, they induce the enzyme to alter its shape slightly so that the substrate fits better.
- Enzymes remain unchanged during a reaction and are reused. They catalyze reactions in both directions.
- Enzymes are affected by temperature and pH. Enzymes are inactive in low temperatures, with activity reaching a peak point at a certain temperature. After this peak, enzymes will begin to **denature**. Too low or too high pH levels can also denature an enzyme.
- In **competitive inhibition**, compounds resembling the substrate compete with the substrate for the same active site. In **noncompetitive inhibition**, binding of one substrate to another active site may block the other active site, preventing the other substrate from binding. In **allosteric inhibition**, the enzyme will have two active sites: one for a substrate and one for an inhibitor. The enzyme will oscillate between an active form and an inactive form, with an activator/inhibitor stabilizing the respective form.
- In **feedback inhibition**, the end product of a series of reactions serves as the allosteric inhibitor of an enzyme earlier in the pathway.

AP Biology Exam Review

Cells (10%)

The **cell theory** has three basic tenets: all living things are made of cells, cells are the basic unit of all organisms, and all cells arise from preexisting cells.

Prokaryotic cells have no nucleus or internal membranes. DNA is not enclosed by a nuclear membrane and is circular, concentrated in the region called the nucleoid. They are mainly unicellular, with small cells. **Eukaryotic cells** are larger and more complex, with distinct organelles, DNA enclosed in the nuclear membrane and wrapped around histones into chromosomes.

Cell membranes consist of a **phospholipid bilayer**. A phospholipid is **ampipathic**, meaning it has both hydrophobic and hydrophilic region. Membrane proteins include **integral proteins**, which penetrate the hydrophobic core of the lipid bilayer, and **peripheral proteins**, which are loosely bound to the surface of the membrane. They are important in transport, enzymatic activity, signal transduction, intercellular joining, cell-cell recognition, and attachment to the cytoskeleton and extracellular matrix. **Cholesterol molecules** are embedded in the interior of the bilayer to stabilize the membrane. Carbohydrates attached to the external surface are important for **cell-to-cell recognition**.

It is important to remember that animal cells do not have chloroplasts, a central vacuole/tonoplast, cell wall, and plasmodesmata. Plant cells do not have lysosomes, centrioles, or flagella (except in some plant sperm).

Subcellular Organization:

- **Nucleus**: contains chromosomes, surrounded by selectively permeable nuclear membrane.
- **Ribosomes**: the site of protein synthesis, found free in the cytoplasm or attached to endoplasmic reticulum.
- **The Endomembrane System**:
    - **Endoplasmic reticulum (ER)**: Smooth ER lacks ribosomes, while Rough ER has ribosomes located on its outer surface. Smooth ER synthesizes lipids, metabolizes carbohydrates, and detoxifies the cell of drugs and poison. Rough ER makes proteins and membranes.
    - **Golgi apparatus**: the "FedEx" of the cell, modifying, packaging, and directing products to the appropriate sites.
- **Lysosomes:** sacs of **hydrolytic enzymes**, the principal site of intracellular digestion. Play a role in **apoptosis**, programmed cell death. Not found in plant cells.
- **Peroxisomes:** contain **catalase**, which converts hydrogen peroxide into water with the release of oxygen atoms.
- **Mitochondria:** double-membraned, site of cellular respiration

- **Chloroplasts:** double-membraned, site of photosynthesis
- **Vacuoles:** single, membrane-bound structures for storage.
- **Cytoskeleton:** network of protein filaments that extend throughout the cytoplasm in order to give the cell its shape
  - **Microtubules**: hollow tubes, made of tubulin, found in cilia and flagella
  - **Microfilaments (actin filaments):** two intertwined strands of actin, found in pseudopodia, cell division, muscle contraction, and cytoplasmic streaming
  - **Intermediate filaments**: fibrous proteins coiled into thicker cables, anchors organelles and found in the nuclear lamina

Mitosis produces two genetically identical daughter cells, while **meiosis** occurs in sexually reproducing organisms and results in haploid cells. The **cell cycle** consists of five major phases: **G_1, S,** and **G_2**, which comprise interphase, and **mitosis** and **cytokinesis**, which make up the cell division phase.

Meiosis results in genetic variation:

- Independent assortment of chromosomes: homologous pairs of chromosomes separate depending on the random way they line up on the **metaphase plate** during metaphase I. There is an equal chance that a particular gamete will receive a maternal chromosome or a paternal chromosome.
- Crossover: crossover produces **recombinant chromosomes**, combining genes inherited from both parents.
- Random fertilization: any sperm can fertilize any egg

Cyclins and **cyclin-dependent kinases** are responsible for controlling the cell cycle. **Density-dependent growth factors** prevent cells from continuing to divide if there are no longer any sites upon which to anchor. **Cancer cells** do not exhibit such inhibition and have escaped form cell cycle controls.

<u>Cellular Energetics (8%)</u>

Cellular respiration involves glycolysis, the Krebs cycle, and the ETC/oxidative phosphorylation. **Glycolysis** is the conversion of glucose into two molecules of pyruvate. The net energy yield from glycolysis is 2 ATP and 2 NADH. After glycolysis, pyruvate will be converted into acetyl coenzyme A (Acetyl CoA). The **Krebs cycle** will then decompose Acetyl CoA into carbon dioxide, producing 2 NADH per glucose molecule. For every glucose molecule, there are 6 NADH produced, 2 $FADH_2$ produced, and 2 ATP produced. Any ATP produced so far has been through **substrate-level phosphorylation**. At this point, NADH and $FADH_2$ will be shuttled to the electron transport chain for **oxidative phosphorylation**. The total of 10 NADH will enter the electron transport chain at the beginning, while the two $FADH_2$ enter further along. Oxygen functions as the final electron acceptor. As the electrons release energy, this energy is used to pump protons (H^+) from the mitochondrial matrix to the intermembrane space, resulting in a concentration gradient. H^+ will only be able to diffuse back across to the mitochondrial matrix through **ATP synthases**. In **chemiosmosis**, the H^+ will pass through a channel in ATP synthase and cause the oxidative phosphorylation of ADP, creating ATP. *Chemiosmosis is an energy-coupling mechanism that uses energy stored in the form of an H^+ gradient across a membrane to drive cellular work*. A maximum of 38 ATP can be created from one glucose molecule in cellular respiration.

Fermentation, **anaerobic respiration**, is an alternate pathway that will recycle NAD^+ and create a minimal amount of ATP. Pyruvate is converted to ethanol in **alcohol fermentation** and is converted to lactic acid in **lactic acid fermentation**.

Photosynthesis is the conversion of light energy from the sun to chemical energy stored in sugar and other organic molecules. **Chloroplasts** are the site of photosynthesis in plants, with the light reactions taking place in the thylakoid membranes and dark reactions taking place in the stroma.

The purpose of the **light reactions** is to convert light energy to the chemical energy stored in NADPH and ATP. Photosystem II absorbs light at the same time that Photosystem I does. When Photosystem II absorbs light, an electron excited to a higher energy level will be captured by the primary electron acceptor. This electron will pass down an ETC to Photosystem I. Electrons excited in Photosystem I will be accepted by another primary electron acceptor and pass to a second ETC and finally, to $NADP^+$ reductase, which creates **NADPH**. Electrons are replaced in Photosystem II through **photolysis**, the splitting of water. As electrons fall down the ETC, ATP will be created in **noncyclic photophosphorylation**, providing energy for the synthesis of sugar during the Calvin cycle. In some cases, **cyclic electron flow**, which uses photosystem I but not photosystem II, will be used to compensate for the large amount of ATP consumed in the Calvin cycle.

The **Calvin Cycle** uses ATP and NADPH to convert CO_2 into sugar. Three molecules of CO_2 are required for the net synthesis of one molecule of **glyceraldehyde-3-phosphage (G3P)**. First, CO_2 is fixed by the enzyme rubisco to ribulose biphosphate (RuBP), creating an extremely unstable 6-carbon molecule that immediately splits into two molecules of **3-phosphoglycerate (3-PGA)**. Thus, there are now 6 molecules of 3-PGA. These molecules are then phosphorylated and given a pair of electrons each from NADPH, creating 6 molecules of G3P. However, only one molecule will be used to create glucose, with the other five being incorporated back into the cycle to create RuBP for future use.

Alternate methods of carbon fixation exist to prevent excessive water loss in hot, arid climates. These are the **C_4 pathway** and **CAM pathway**. The C_4 pathway uses bundle-sheath cells as a confined environment for CO_2 to be fixed, while CAM plants open stomata during the night.

AP Biology Exam Review

PART II: HEREDITY AND EVOLUTION

Heredity (8%)

See page 4 for information about genetic variation through meiosis. In **spermatogenesis**, four mature sperm cells will result. In **oogenesis**, only one daughter cell results from meiosis, with the rest becoming polar bodies that will degenerate.

DNA molecules are packaged into **chromosomes**. DNA is first wrapped around proteins called **histones**. Each DNA-wrapped histone and the DNA around it will form a **nucleosome**. The string of nucleosomes coils to form a **chromatin fiber**, which then become **looped domains** attached to a scaffold of nonhistone proteins. The chromatin folds further to result in the **chromosome**.

Important heredity concepts:

- **Incomplete dominance** is the blending of two characteristics to form an intermediate characteristic, such as in red and white carnations.
- **Codominance:** both traits will show, such as in roan cattle, with patches of red and white hair.
- **Multiple alleles:** occurs when there are more than two allelic forms of a gene, such as in ABO blood types
- **Pleiotropy:** the ability of one single gene to affect an organism in several or many ways, causing a "cascade" of symptoms
- **Epistasis:** two separate genes control one trait, with one gene masking the expression of the other gene. For example, a gene for production of melanin can be epistatic to one for the deposition of melanin
- **Polygenic Inheritance:** characters varying along a continuum, such as height or skin tone. There is no either-or option.

Genes that are on the same chromosome are **linked genes**. One **map unit** distance on a chromosome is the distance within which recombination occurs 1 percent of the time.

Molecular Genetics (9%)

DNA is a **double helix**, consisting of two strands running in opposite directions (**antiparallel**). One runs 5' to 3', while the other is 3' to 5'. Each nucleotide consists of a **five-carbon sugar (deoxyribose)**, a **phosphate**, and a **nitrogen base**. The nucleotides are connected by **phosphodiester linkages**. Adenine and guanine are purines, with two rings, while thymine and cytosine are pyrimidines, with one ring. Adenine always pairs with thymine (uracil in RNA), and guanine always pairs with cytosine. Nitrogenous bases are connected by hydrogen bonds.

AP Biology Exam Review

DNA replication is **semiconservative**, as proved by **Meselsohn and Stahl**. Each strand of a DNA double helix will be incorporated into a new strand of DNA.

1. Replication begins at the **origins of replication**, forming **replication bubbles**.
2. Replication proceeds in both directions, forming a **replication fork**.
3. **DNA polymerase** catalyzes the elongation of the DNA strands, going in the 5' to 3' direction. This is the **leading strand**.
4. Elongation of the **lagging strand**, in the 3' to 5' direction, must be accomplished with the assistance of Okazaki fragments. These are small segments of DNA synthesized, with ligase going back to join together the Okazaki fragments.

DNA synthesis is primed using **RNA primer** (RNA nucleotides joined together by primase).

The machinery that uses DNA to synthesize proteins read nucleotide sequences in **triplet code**, with each three nucleotides being one **codon**. Each codon will code for an amino acid. In **transcription**, DNA is transcribed into messenger RNA (mRNA). The RNA will be processed, given a 5' cap and poly (A) tail after having its introns excised by **snRNPs** (small nuclear ribonucleoproteins) and **spliceosomes**.

Translation is the process by which the codons are changed into a sequence of amino acids. **Transfer RNA** (tRNA) holds an amino acid corresponding to the **anticodon** that will match to the codon on a strip of mRNA. As a ribosomal RNA (rRNA) unit proceeds along a piece of mRNA, tRNAs will bring their amino acids to the translation machinery as necessary, forming a polypeptide chain.

Gene mutations include **point mutations**, in which only one base pair is changed. An **insertion** or **deletion** is more detrimental, as it will cause a **frameshift mutation**, altering the series of codons downstream of the mutation. This can either cause a **missense** (mutated polypeptide formed) or **nonsense mutation** (no polypeptide formed).

A **virus** consists of DNA or RNA enclosed in a protein coat called a **capsid**. Viruses can only reproduce within a host cell. The **bacteriophage** can reproduce using the **lytic cycle** or the **lysogenic cycle**. In the lytic cycle, the phage will enter a host cell, replicate itself, and cause the cell to lyse, releasing more infectious phages. In the lysogenic cycle, the phage DNA will integrate with the host genome, becoming a **prophage** that is replicated each time the host cell replicates. At a certain point, the prophage will switch to the lytic phase.

Biotechnology uses **recombinant DNA techniques** for practical purposes. Scientists have been able to clone genes by isolating a gene of interest, inserting it into a plasmid, and then inserting the plasmid into a vector, such as a bacterium. As the bacteria reproduce themselves, copies of the plasmid and gene of interest will also be reproduced. **Restriction enzymes** can be used to cut out desired genes. **Gel electrophoresis** separates large molecules of DNA based on their rate of movement through agarose gel in an electric field. The **polymerase chain reaction (PCR)** is an automated technique to rapidly copy a small piece of DNA. **Restriction fragment length polymorphisms** (RFLPs) are noncoding regions in human DNA that are as a DNA fingerprint.

Evolutionary Biology (8%)

Life originated between 3.5 and 4.0 billion years ago, with ancient prokaryotes such as **stromatolites**. About 2.7 billion years ago, oxygen began to accumulate as photosyntehsis developed. Eukaryotic life began about 2.1 billion years ago, with multicellular eukaryotes evolving by 1.2 billion years ago. The **Miller-Urey model** has shown to be somewhat successful in producing organic compounds from gases that would have been prevalent on early Earth. RNA may have been the first genetic material.

Evidence for evolution:

- **Fossil Record** – shows that species have become extinct or evolved into other species. There are transitional forms linking older fossils to modern species.
- **Homology** – anatomical homologies show structures with anatomical similarities may have had a common ancestor. Vestigial organs are historical remnants of structures that had important functions in ancestors. Embryological homologies show homologies that are not obvious in adult organisms. Molecular homologies help relate distantly related organisms by going as deep as the universality of the genetic code.
- **Biogeography** – species tend to be more closely related to other species from the same area than to other species with the same way of life but living in different areas.

Darwin's theory of **natural selection** proposes that populations tend to grow exponentially, overpopulate, and exceed their resources, resulting in a competition and struggle for existence. In any population, there is genetic variation resulting in an unequal ability of individuals to survive and reproduce. Only the fittest individuals survive and are able to pass on their traits to offspring. Evolution occurs as advantageous traits accumulate in a population.

Types of selection:

- **Stabilizing Selection:** eliminates the extremes, favoring the more common intermediate forms. Leads to greater numbers of an average phenotype.
- **Disruptive/Diversifying Selection:** increases the extreme types, with lower numbers of intermediates. **Balanced polymorphism**, one population divided into two distinct types, may result.
- **Directional Stabilization:** moves toward one extreme phenotype.
- **Sexual selection:** competition for mates
- **Artificial selection:** humans breeding for certain desired traits

AP Biology Exam Review

PART III: Organisms and Populations (50%)

Diversity of Organisms (8%)

Hierarchical classification uses **binomial nomenclature** to identify species, using their genus and species epithet. The hierarchical classification that is most often used is the three-domain, five-kingdom system, in which domain separate into phyla, which separate into classes, which separate into orders, which separates into families, which separate into genera, and finally, into individual species.

Domains:

- **Bacteria:** all are single-celled **prokaryotes**, with many being **pathogens**, have a thick, rigid cell wall containing **peptidoglycan**.
- **Archaea:** unicellular, prokaryotic, includes the **extremophiles**, no peptidoglycan
- **Eukarya:** all organisms have a nucleus and internal organelles

In Eukarya, there are four kingdoms: protista, fungi, plantae, and animalia.

Evolutionary Trends:

- **Specialized cells, tissues, and organs**: larger and more complex animals will have more specialization.
- **Germ layers:** Porifera and Cnidaria have only two cell layers, while other animals have **ectoderm**, **mesoderm**, and **endoderm**.
- **Bilateral symmetry:** the body is organized along a longitudinal axis with right and left sides mirroring one another.
- **Cephalization:** sensory apparatus and a brain will be clustered at the anterior.
- **Coelom:** There is a progression from **acoelomates**, which have no coelom, to **pseudocoelomates**, which have a coelom partly lined by mesoderm, and **coelomates**, which have a coelom completely lined by mesoderm.
- **Protostomes and deuterostomes:** coelomates are divided into these two categories. In **protostomes**, the first opening becomes the mouth, while in **deuterostomes**, the first opening becomes the anus with the second opening becoming the mouth.

Structure and Function of Plants and Animals (32%)

Plants

Plants are multicelled, eukaryotic, photosynthetic autotrophs. They store extra carbohydrates as starch, and their cells have cell walls and central vacuoles. **Bryophytes** are plants without transport vessels. **Tracheophytes** have xylem and phloem for support, lignified transport vessels to support the plant, roots, leaves, and a life cycle with a dominant sporophyte generation. They are divided into **gymnosperms** and **angiosperms**.

Angiosperms are divided into the **monocots** and the **dicots**. Monocots have one cotyledon, scattered vascular bundles in the stem, parallel leaf venation, floral parts in multiples of 3, and fibrous root systems. Dicots have two cotyledons, vascular bundles arranged in a rung, netlike leaf venation, floral parts in 4s and 5s, and taproots.

Primary growth involves elongation of the plant down into the soil and up into the air. Be familiar with the **zone of cell division**, **zone of elongation**, and **zone of differentiation**. **Secondary growth** involves increase in girth.

Plant Tissue:

- **Dermal**: endodermis, epidermis, and cells that produce a waxy cuticle. It covers and protects the plant.
- **Vascular**: consists of **xylem** and **phloem**. Xylem consists of tracheids and vessel elements, they are used for the transport of water and minerals. Phloem consists of chains of sieve tube members connected to companion cells. They carry sugars form the leaves to the rest of the plant by active transport.
- **Ground:** any tissue that is not dermal nor vascular is ground tissue, which functions in support, storage, and photosynthesis. They consist of **parenchymal cells, collenchymal** cells, and **sclerenchymal cells.**

Roots are responsible for absorbing nutrients from the soil, anchoring the plant, and storing food. The **transpirational pull-cohesion theory** states that for each molecule of water that evaporates from a leaf by transpiration, another molecule of water is drawn in at the root to replace it. Phloem sap is transported using **translocation**, as phloem moves from the sugar **source** to the sugar **sink**.

Plant Hormones:

- **Auxin**: responsible for **phototropisms**, **apical dominance**, and stimulates stem elongation.
- **Cytokinins:** stimulates cytokinesis and cell division, delay **senescence** by inhibiting protein breakdown.
- **Gibberellins:** promote stem and leaf elongation
- **Abscisic Acid:** inhibits growth, enables plants to withstand drought, closes stomata in time of stress, promotes seed dormancy
- **Ethylene:** promotes fruit ripening, facilitates **apoptosis**, promotes leaf **abscission**.

AP Biology Exam Review

Animals

Digestion can either occur in a **gastrovascular cavity**, which has only one opening, or in an **alimentary canal** (gastrointestinal tract), which has two openings. In humans, the breakdown of starch begins in the mouth. The **stomach** churns food mechanically and secretes gastric juice to begin the digestion of proteins. Digestion is completed in the duodenum, where bile will be used to break down fats. Peptidases continue to break down proteins, nucleases will break down nucleic acids, and lipases break down fats. Projections called **villi** absorb the released nutrients, and a **lacteal** will absorb fatty acids and glycerol. The **large intestine** removes undigested waste, excess water, and produces vitamins.

Gas exchange occurs passively by diffusion, and respiratory surfaces must be **thin, moist,** and have large **surface area**. Less complex respiratory systems are external, involving gas exchange at the skin. Arthropods and crustaceans have internal systems with spiracles. Aquatic animals have gills that take advantage of **countercurrent exchange**. In humans, air enters the naval cavity, passing through the larynx and down the trachea and bronchi to bronchioles. Diffusion of respiratory gases occurs in the alveoli. Oxygen is carried in the human blood by **hemoglobin**. A drop in pH lowers the affinity of hemoglobin for oxygen (**Bohr shift**).

In the circulatory system, **arteries** and **arterioles** carry blood away from the heart under high pressure, with walls made of thick, elastic, and smooth muscle. **Veins** and **venules** carry blood back to the heart under little pressure. They have thin walls with valves to prevent back flow. **Capillaries** allow for the diffusion of nutrients and wastes between cells and blood.

> Beginning with the pulmonary circuit, the right ventricle pumps blood to the lungs via the pulmonary arteries. As the blood flows through capillary beds, it will load oxygen and unload carbon dioxide. Oxygen-rich blood returns via the pulmonary veins to the left atrium of the heart. Next, the oxygen-rich blood will flow into the left ventricle, which will pump it out to body tissues in the systemic circuit.
>
> Blood leaves the left ventricle via the aorta, which conveys blood to arteries leading throughout the body. First branches supply blood to the heart, and then to the head and forelimbs. The aorta will then supply oxygen-rich blood to the abdominal organs and legs, picking up carbon dioxide. Capillaries will rejoin to form venules, which convey blood back to the veins. Oxygen-poor blood is emptied into the right atrium, where it will flow into the right ventricle.

Osmoregulation is the management of the body's water and solute concentration. **Excretion** is the removal of metabolic wastes, including **carbon dioxide** and **water** from cell respiration and **nitrogenous wastes** from protein metabolism. The **kidneys** are responsible for filter blood and producing urine. The functional unit of the kidney is the **nephron**.

AP Biology Exam Review

The **central nervous system** (CNS) consists of the brain and spinal cord. The **peripheral nervous system** consists of all nerves outside the CNS. The peripheral nervous system is further divided into the sensory system and motor system. The simplest nerve response is a **reflex arc**, such as the knee-jerk reflex, which only consists of a sensory neuron and motor neuron. An **action potential** can be generated in the **axon** of a neuron, which will result in **depolarization** of the membrane as potassium floods out of the cell. This causes an impulse to move along the axon.

The **first line of nonspecific defense** prevents pathogens from entering the body and includes skin, mucous membranes, cilia, and stomach acid. The **second line of defense** is also nonspecific, and includes the inflammatory response, phagocytes, interferons, and natural killer cells. The **third line of defense** is specific and consists of **lymphocytes** – B lymphocytes and T lymphocytes. B lymphocytes produce the **humoral response** by producing **antibodies**. **T-lymphocytes** fight pathogens in the **cell-mediated response**. They kill body cells that have been infected by recognizing protein fragments displayed by **MHC molecules**.

Fertilization, the fusion of sperm and ovum nuclei, begins with the **acrosome reaction**, when the head of the sperm releases hydrolytic enzymes that penetrate the egg. This will cause the **cortical reaction** as the vitelline layer hardens. Embryonic development consists of **cleavage**, **gastrulation**, and **organogenesis**. Cleavage is the rapid mitotic division. Protostomes have spiral, determinant cleavage. Deuterostomes have radial and indeterminate cleavage. Gastrulation involves the formation of the blastopore. Organogenesis involves differentiation of cells.

<u>Ecology (10%)</u>

Ecology is the study of the interactions of organisms with their physical environment and with each other. A **population** is a group of individuals of one species living in one area at one time.

Two models of population growth are **exponential growth**, modeled by the J-curve, and **logistic growth**, modeled by the S-curve. The logistic growth model involves a limit the number of individuals that can occupy one area in a particular time, known as the **carrying capacity (K)**. Limiting factors to population growth are either **density-dependent** or **density-independent**.

There are two growth patterns: **r-strategists**, which have many young, little or no parenting, rapid maturation, small young, and one-time reproduction, versus **K-strategists**, which have few young, intensive parenting, slow maturation, large young, and reproduction many times.

Symbiosis is an important element in interactions between organisms and can be either **mutualistic** (both benefit), **parasitic** (one is helped, one is harmed), or **commensal** (one is helped, one is neither helped nor harmed). Other means of interactions are **competition** and **predation**.

AP Biology Exam Review

The **food chain** is the pathway along which food is transferred from one trophic level to another. Energy transfer is very inefficient, with only about 10% being transferred to the next trophic level.

Primary ecological succession occurs in an area where an ecosystem has been completely destroyed. The first organisms will be **pioneer organisms** such as lichen and mosses. Soil must develop through the weathering of rock and accumulation of organic material. **Secondary succession** occurs when an existing community is cleared, but the soil is intact.

Biomes are very large regions of the earth whose distribution depends on **rainfall** and **temperature**. Each biome has different vegetation and plant life. The basic groupings are marine, tropical rainforest, desert, temperate grasslands, temperate deciduous forest, taiga, and tundra.

Chemical cycles are nature's way of recycling. In the **water cycle**, water evaporates form the earth, forms clouds, and rains over oceans and land. In the **carbon cycle**, cellular respiration adds carbon dioxide to the air and removes oxygen. Photosynthesis will remove the carbon dioxide from the air and add oxygen. In the **nitrogen cycle**, atmospheric nitrogen is fixed into a form usable by plants. Bacteria will then convert the nitrates back into atmospheric nitrogen.

Humans have had an effect on the biosphere through **eutrophication of lakes**, **air pollution** causing acid rain**, toxins**, **global warming,** and **introducing new species**.