**AP: END OF YEAR REVIEW**

**UNIT 1. THE CHEMISTRY OF LIFE**

**Section 1: Chemistry**

**Bonds**

* ionic
* covalent: polar, non-polar
* hydrogen

**Section 2: Properties of Water**

* excellent solvent
* high heat capacity—moderating influence, evaporative cooling
* ice floats (most dense at 4oC
* strong cohesion & surface tension, adhesion

**Section 3: Macromolecules**

**Organic Molecules**

* carbon, monomers, polymers, functional groups
* dehydration synthesis vs. hydrolysis
* carbohydrates
	+ function: energy storage, structure
	+ groups:mono-, di-, and polysaccharides (starch, glycogen, cellulose, chitin)
* proteins
	+ function: structure, transport, defense, enzymes
	+ structure: amino acids, peptide bonds, 1°, 2°, 3°, 4° structure
* lipids
	+ function: energy storage (2X energy as carbs), cell membrane, hormones
	+ groups: triglycerides (fats, saturated, unsaturated), phospholipids, steroids
	+ (fats, oils, steroids-cholesterol, sex hormones)
* nucleic acids
	+ function: information storage
	+ structure: nucleotides, A,T,C,G,U—purines, pyrimidines
	+ groups: DNA, RNA

**Section 4: Enzymes**

**Structure**

* globular proteins, some kinds of RNA (Ribozymes)

**Function**

* catalysts = lowers activation energy
* catabolism (digestion, breakdown, hydrolysis, exergonic)
* anabolism (synthesis, dehydration synthesis, endergonic)
* induced fit model: substrate, active site, enzyme-substrate complex,
* product(s)
* “-ase”, substrate specific, unchanged during reaction

**Factors that affect function**

* pH, temperature, salts can denature
* coenzymes (organic), cofactors (inorganic)
* activators: allosteric, cooperativity
* inhibitors: competitive, noncompetitive, allosteric
* enzyme active site is “saturated” at Vmax
* negative feedback inhibition

**UNIT 2. THE CELL**

**Section 1: Cell & Membrane Structure & Function**

**Classification**

* plants: cell wall (cellulose), chloroplasts, central vacuole with tonoplast (membrane)
* animals: lysosomes, centrioles
* prokaryotes (bacteria): naked circular DNA, ribosomes, no nucleus or membrane-bound

organelles, sometimes cell wall (peptidoglycans)

* eukaryotes: nucleus & membrane-bound organelles

**Cell Membrane Structure**

* phospholipid bilayer: hydrophilic heads, hydrophobic tails; fluid mosaic model
* proteins
	+ integral & transmembrane: channel, transport, electron transfer
	+ peripheral: recognition, receptor, adhesion
	+ cholesterol maintains fluidity

**Organelles & Other Structures**

* nucleus, ribosomes, ER, Golgi, vesicles, mitochondria, chloroplasts, lysosomes,

centrioles, vacuoles

* motility: flagella, cilia (9 + 2 arrangement of microtubules, dynein side arms, use ATP)
* cytoskeleton: microtubules, intermediate filaments, microfilaments
* cell wall
* cell junctions: desmosomes, tight junctions, gap junctions, plasmodesmata

**Cell Membrane Function—Movement of Materials**

* selectively permeable membrane
* diffusion, osmosis, facilitated diffusion, active transport
* hypertonic, hypotonic, isotonic, plasmolysis
* bulk transport: exocytosis, endocytosis (phagocytosis, pinocytosis)

**Section 2: Cellular Respiration**

**Overview**

* C6H12O6 + 6 O2 → 6 CO2 + 6 H2O + energy
* glycolysis, all organisms, cytosol
* chemiosmosis (ATP production), all eukaryotes, mitochondria
* oxidize (lose e-), reduce (gain e-), reduced molecules have higher energy

**Glycolysis**

• glucose → pyruvate

• yield: net 2 ATP, 2 NADH, 2 pyruvate

• cytosol, anaerobic

**Kreb’s (Citric Acid) Cycle**

• pyruvate → acetyl CoA → Kreb’s cycle (2 turns of Krebs per glucose)

• yield per glucose: 2 ATP, 6 NADH, 2 FADH2, 4CO2 (exhale)

• function: reduces electron carriers (NADH and FADH2) for the ETC

• matrix of mitochondria

**Electron Transport Chain (ETC)**

* chemiosmosis, oxidative phoshorylation
* NADH & FADH2 donate electrons to ETC, cytochrome carrier proteins in membrane,
* pump H+ ions to intermembrane space, H+ flow down concentration gradient

through ATP synthase, phosphorylate ADP → ATP

* O2 is final electron acceptor
* yield: ~36 ATP per glucose plus heat
* inner membrane of mitochondria, cristae
* anaerobic respiration: no O2, lactic acid (animals), alcoholic fermentation (bacteria,

yeast, plants)

**Section 3: Photosynthesis**

**Overview**

* light + 6 H2O + 6 CO2 → C6H12O6 + 6 O2
* Autotrophs

**Light Reactions**

* chloroplast, thylakoid membrane
* noncyclic photophosphorylation
* photolysis (water provides electrons)🡪photosystem II (P680)🡪 electron transport chain,

🡪photosystem I (P700)🡪NADP→NADPH

* proton gradient in thylakoid space, ADP🡪ATP (phosphorylation), chemiosmosis
* cyclic photophosphorylation

**Calvin Cycle (Light Independent-Reactions or “Dark” Reactions)**

* chloroplast, stroma
* carbon fixation, Rubisco (enzyme), CO2 + RuBP 🡪PGA (3C) 🡪glucose (6C)
* C3 plants
* 6 turns of Calvin cycle to make one glucose

**C4 & CAM photosynthesis**

* photorespiration, inefficiency of Rubisco in high [O2]
* C4: separate carbon fixation and Calvin cycle—2 locations
	+ PEP carboxylase for carbon fixation—doesn’t bind to O2, found in spongy mesophyll
	+ Calvin cycle occurs in bundle sheath cells away from high O2
	+ grasses, corn, rice, sugar cane
* CAM separate 2 steps of carbon fixation temporally = 2 different times
	+ fix carbon at night (when stomates open), put it in “storage” compounds (organic
	+ acids: malic acid, isocitric acid),
	+ then in day (when stomates closed), release CO2 from “storage” compounds to Calvin cycle
	+ cacti, succulents, pineapple

**Section 4: Cell Cycle/Mitosis**

**Mitosis**

* clones, asexual reproduction, growth, repair
* chromosomes, chromatids, centromere, kinetochore (where spindles attach)
* interphase, G1, S, G2, G0
* prophase, metaphase, anaphase, telophase
* cytokinesis: cleavage furrow (animals, microfilamants), cell plate (plants)
* cell division triggered by growth (surface to volume ratio), density dependent inhibition

**UNIT 3. GENETICS**

**Section 1: Meiosis**

**Gamete Production**

* 1st division of meiosis separates homologous pairs
	+ reduction division, diploid 🡪 haploid, 2n 🡪 1n
	+ interphase 1, prophase 1 (crossing over), metaphase 1, anaphase 1, telophase 1
	+ crossing over: tetrad, synapsis
	+ independent assortment
* 2nd division of meiosis separates sister chromatids
	+ haploid 🡪 haploid, remains 1N
	+ prophase 2, metaphase 2, anaphase 2, telophase 2
	+ Function
	+ haploid gamete (sex cell) production
* genetic variation: crossing over, independent assortment at meta I, and random fert.

**Section 2: Heredity**

**Mendelian Inheritance**

* locus, gene, allele, homologous pairs, dominant, recessive, phenotype, genotype,
* homozygous, heterozygous, monohybrid cross, dihybrid cross; P, F1, F2 generations,
* test cross, Punnett squares
* Law of Segregation: random segregation of alleles to separate gametes
* Law of Independent Assortment: chromosomes segregate separately from other nonhomologous chromosomes

**Non-Mendelian Inheritance**

* incomplete dominance, codominance, multiple alleles, epistasis, pleiotropy, polygenic

inheritance, linkage, sex-linked, X inactivation, non-disjunction, deletion, duplication,

translocation, inversion

**Section 3: Molecular Genetics**

**DNA Replication**

* semi-conservative replication, template strand, DNA polymerase, leading strand, lagging

strand, helicase, replication fork, single stranded binding proteins, DNA ligase, Okazaki

fragments, RNA primase, RNA primer, 3’ vs. 5’ end

* mutations: deletion, substitution, insertion, frame shift

**Protein Synthesis**

* one-gene-one-enzyme hypothesis
* transcription
	+ mRNA, RNA polymerase
	+ RNA processing: introns, exons, 5’ cap, poly-A tail
* translation
	+ mRNA, codon, tRNA, anticodon, rRNA, ribosome, small RNA subunit, large RNA
	+ subunit, P site, A site, wobble, stop codon, start codon (Met)
	+ initiation, elongation, termination

**DNA Organization**

* chromatin, histone proteins, nucleosomes, euchromatin, heterochromatin,
* transposable elements (jumping genes)

**Viruses**

* bacteriophages, capsid, envelope, retroviruses, reverse transcriptase,
* lytic and lysogenic cycle

**Bacteria**

* plasmids, conjugation, transduction, transformation
* quorum sensing and biofilms
* regulation of gene expression: operons
	+ regulatory gene, repressor protein, promoter, operator, structural genes
	+ inducible enzyme: lac operon, when lactose present it binds to repressor and inactivates it so transcription can begin
	+ repressible enzyme: trp operon, when tryptophan (corepressor) is present it binds to

repressor & activates it so that transcription/translation is blocked.

**Section 4: Biotechnology**

**Recombinant DNA**

* restriction enzymes, sticky ends, ligase, plasmids (vector), transformation

**Other Technologies**

* gel electrophoresis, RFLPs (restriction fragment length polymorphisms), PCR

(polymerase chain reaction), reverse transcriptase, probes, Southern blot

**UNIT 4. MECHANISMS OF EVOLUTION**

**Section 1: Darwinian Evolution**

**Evidence**

* paleontology, biogeography, embryology, comparative anatomy, homologous structures,

analogous structures, vestigial structures, molecular biology, artificial selection

**Natural Selection**

* over-production, inherited variation, competition, adaptations, fitness, survival of the

fittest, accumulation of advantageous traits, differential reproductive success

* stabilizing selection, directional selection, disruptive selection, sexual selection
	+ directional: pesticide resistance, peppered moth
	+ sexual: male competition, female choice, sexual dimorphism
* variation: mutations, sexual reproduction (crossing over, independent assortment,

random fertilization), diploidy preserves variation

**Section 2: Evolution of Populations & Speciation**

**Hardy-Weinberg Equilibrium**

* genetic equilibrium
	+ infinitely large population (ie no genetic drift)
	+ no natural selection
	+ no mutations
	+ no gene flow (no migration)
	+ random mating
* frequency of alleles: p + q = 1
* frequency of genotypes or individuals: p2 + 2pq + q2 = 1
* non-equilibrium
	+ genetic drift,(founder effect, bottleneck), natural selection, gene flow, mutation, non-random mating, sexual selection

**Speciation**

* Patterns: adaptive radiation, allopatric: speciation following a geographic isolation, sympatric: speciation occurring in midst of parent population
* prezygotic isolation
	+ habitat, temporal, behavioral, mechanical isolation, gametic isolation
* postzygotic isolation
	+ reduced hybrid viability, reduced hybrid fertility, hybrid breakdown

**Patterns of Evolution**

* divergent evolution, adaptive radiation
* convergent evolution, analogous structures
* coevolution
* macroevolution: gradualism vs, punctuated equilibrium

**Origin of Life**

* earth & atmosphere formed: low or no O2
* complex molecules in primordial seas, monomers, polymers
* organic molecules & early cells formed
* heterotrophic prokaryotes first cells
* autotrophic prokaryotes: O2 & ozone layer formed
* eukaryotes formed, endosymbiotic theory
* mitochondria & chloroplasts have own DNA, reproduce independently (~binary

fission), have ribosomes similar to bacteria & cyanobacteria

**UNIT 5. BIOLOGICAL DIVERSITY**

**Section 1: Three Domain Survey**

**Domain Bacteria**

* prokaryotes: bacteria, spirochetes, cyanobacteria (autotrophs)
	+ Gram positive (stain blue) and Gram negative (stain pink)
	+ Bacilli (rod), spirilli (spiral), and cocci (spherical)
	+ Chemoautotrophs, chemoheterotrophes, photoautotrophs, photoheterotrophs

**Domain Archaea**

* extremophiles: thermophiles, halophiles, methanogens

**Domain Eukarya**

* “simple” Eukaryotes: unicellular eukaryotes
	+ formerly known as Protists
	+ algae, euglenozoans, dinoflagellates, amoebozoans, ciliates, diatoms
* Fungi: chitin cell wall, heterotrophs
* Plants: cellulose cell wall, photosynthetic
	+ eukaryotes
	+ bryophytes (mosses): seedless non-vascular, dominant gametophyte
	+ ferns: seedless vascular, dominant sporophyte, free-living gametophyte
	+ gymnosperm (conifers): pollen, naked seeds, vascular, reduced dependent
	+ gametophyte
	+ angiosperm: (flowering): pollen, flowers, fruit, seeds, reduced dependent
	+ gametophyte, monocot vs. dicot
* Animals
	+ porifera
		- sponges:
		- no true tissues
	+ radials (true tissues)
		- cnidaria (jellyfish, hydra, corals):
		- gastrovascular cavity
	+ bilaterals
		- protostome development (mouth 1st)
			* flatworms
			* annelids (segmented worms):
			* mollusks (snails, clams, squid, octopus)
			* arthropods (insects, arachnids, crustaceans)
			* nematodes (round worms)
		- deuterostomes development (mouth 2nd)
			* invertebrates
				+ echinoderms (sea stars, sea urchins)
			* vertebrates: chordates—notochord, dorsal hollow nerve cord, gill slits, post-anal tail

**UNIT 6. PLANT FORM & FUNCTION**

**Section 1: Plant Structure & Function**

**Characteristics**

* + Apical Meristems: many plants, growth occurs at tips of shoots and roots
	+ Embryo is surrounded and protected
	+ Sporopollenin—tough material surrounding spore and pollen
	+ Alternation of Generations life cycle

• multicellular sporophyte (2n) 🡪 *meiosis* 🡪 spores (1n) 🡪 *mitosis* 🡪 multicellular gametophyte (1n) 🡪 *mitosis*🡪gametes (1n) 🡪 *fertilization*🡪multicellular sporophyte (2n)

* + Other adaptations to life on land
* Leaf: cuticle, mesophyll cells carry out photosynthesis
	+ - (gas exchange), stomata, guard cells
* Vascular Tissue:
	+ - * Xylem: transpiration
				+ conduction of water & minerals, transpirational pull
			* phloem: translocation
				+ conduction of sugars, bulk flow, source to sink, pressure-flow hypothesis

**Section 2: Plant Reproduction**

**Flowers & Seeds**

* sepals, petals,
* anthers create pollen (male gametophyte) which produces the sperm
* pistil/carpel contains the ovary with ovule (female gametophyte) which produces the egg
* double fertilization: 1 sperm fertilizes egg, second sperm fertilizes 2 polar nuclei
* seed
	+ seed coat
	+ endosperm (3n): nutrition for new plant
	+ embryo (2N)

**UNIT 7. ANIMAL FORM & FUNCTION**

**Section 1: Animal Structure & Function**

**Homeostasis**

* thermoregulation: endotherms, adjusting metabolic rates, hypothalamus, vasoconstriction, vasodilation, behavioral modifications, etc.
* feedback loops: ex: maintaining body temp, hormone levels, enzyme activity
* hormones: ex: insulin and glucagon work to maintain constant blood glucose

**Respiratory System**

* gill function: counter current exchange
* lung function: nose, pharynx, larynx, trachea, bronchi, bronchioles, alveoli, diaphragm
* CO2 & O2 diffusion across moist membranes, red blood cells, O2 transported by hemoglobin (iron)
	+ Hb: 4 subunits each with iron which binds to an O2
	+ 4 subunit show cooperativity
* CO2 transported as dissolved bicarbonate (70%) in blood plasma
* Regulation by medulla: monitor blood pH
* Negative pressure breathing
* Myoglobin: O2 reserve in muscles, similar to Hb but only one subunit

**Circulatory System**

* open circulatory system (hemolymph)
* closed circulatory system (blood), 2-, 3-, 4-chambered hearts, arteries, veins, capillaries
	+ arteries elastic, high pressuer
	+ veins have valves, skeletal muscles aid in movement of blood through veins
* heart function
	+ atria, ventricles, valves, pulmonary circuit, systemic circuit, SA node, AV node,
	+ systole, diastole
* blood: RBC, WBC, platelets, plasma
* Hydrostatic pressure higher than osmotic pressure at arteriole end of capillary

**Excretory System**

* N waste: ammonia, urea, uric acid
* nephron function
	+ glomerulus, Bowman’s capsule, proximal tubule, loop of Henle, distal tubule, collecting duct, ureter, bladder, urethra
	+ filtration, secretion, reabsorption
* osmoregulation: ADH (antidiuretic hormone), aldosterone

**Nervous System**

* CNS: brain, spinal cord
* peripheral nervous system: sensory & motor neurons
	+ somatic: skeletal muscle
	+ autonomic
		- sympathetic: stimulate activities
		- parasympathetic: calming/slowing down effect, tranquil functions
* reflex arc
* neuron function
	+ cell body, dendrites, axon, synapse, myelin sheath, Schwann cells
	+ polarized, resting potential, action potential, depolarization, repolarization,
	+ hyperpolarization, refractory period
	+ K+, Na+, voltage-gated channels, Na-K pumps
* synapse: Ca2+ gates, neurotransmitters, ion-gated channels
* neuromuscular junction: acetylcholine, cholinesterase (breaks down acetylcholine)
* CNS neurotransmitters: epinephrine, dopamine, serotonin
* Brain structure
	+ Cerebrum (frontal, temporal, parietal, occipital lobes)
		- Corpus callosum connects 2 hemispheres
	+ Thalamus, hypothalamus
	+ Cerebellum
	+ Medulla and pons

**Immune System**

* Non-specific defenses
	+ skin, anti-microbial proteins, gastric juices, symbiotic bacteria
	+ phagocytes, complement proteins, inflammatory response (histamine, vasodilation, phagocytes)
* Specific immunity
	+ lymphocytes, antigens, MHC (major histocompatibility complex), self vs. nonself
	+ role of antigen-presenting cell and helper T cell
	+ B cells: plasma cells, antibodies (immunoglobulins), memory cells
		- humoral response, attack invaders in circulation
	+ T cells: cytotoxic T cells (killer)
		- cell-mediated response, attack infected cells
		- release perforin
* Role of memory cells in second exposure to same antigen
* Active vs. passive immunity

**Endocrine System**

* Homeostasis of blood glucose and calcium
	+ pancreas: insulin, glucagon (lowers blood glucose/raises blood glucose)
	+ thyroid and parathyroid: Calcitonin and PTH (lowers blood calcium, raises blood calcium)
* hypothalamus,
	+ neurosecretory cells
	+ ADH and oxytocin produced by hypothalamus stored in post. pituitary
	+ controls release of hormones from anterior pituitary
		- TSH (thyroid stimulating hormone) FSH, LH, growth hormone
* adrenal gland: epinephrine and norepinephrin, aldosterone
* gonads: ovaries (estrogen, progesterone), testes (testosterone)
* steroid hormones can pass through cell membrane, act as transcription factors
* protein hormones must bind to cell membrane receptor, trigger secondary messenger

**Section 2: Animal Reproduction & Development**

**Anatomy**

* female
	+ ovary, oviduct (fallopian tube), uterus, cervix, vagina, oogenesis
* male
	+ testes (sperm production), epididymis (sperm maturation), vas deferens, seminal vesicles, prostate gland, cowpers gland, urethra, penis, spermatogenesis

**Regulation**

* female hormones:
	+ GnRH (hypothalamus)
	+ FSH and LH (pituitary) stimulate follicle and ovlulation
	+ estrogen and progesterone (corpus luteum), maintain endometrium
* male hormones
	+ GnRH (hypothalamus)
	+ FSH and LH (pituitary) stimulate spermatogenesis and testosterone production

**Development**

* fertilization, cleavage, morula, blastula, gastrula, gastrulation, organogenesis
* ectoderm, mesoderm, endoderm, archenteron, blastopore
* regulation
	+ embryonic induction (dorsal lip in frogs induces gastrulation)
	+ homeotic genes

**Section 3: Animal Behavior**

**Types of Animal Behavior**

* Innate: FAP (sign stimulus/releaser),
* Learned
	+ imprinting (critical period)
	+ classical conditioning
	+ operant conditioning (trial and error)
	+ habituation
* movement: kinesis (undirected change in speed), taxis (directed movement),
* social: agonistic, dominance/hierarchy, territoriality, altruistic (kin selection),

**UNIT 8. ECOLOGY**

**Section 1: Population Ecology**

**Population growth & distribution**

* size, density, dispersal patterns (clumped, uniform, random), age structure, survivorship

curves

* limiting factors: density-dependent, density-independent
* growth: exponential growth: rmaxN, logistic growth: rmaxN(K-N/K), carrying capacity (K)
* r-selected, K-selected
* population cycles (boom and bust)

**Section 2: Community Ecology**

**Interaction of populations**

* interspecific competition:
	+ niche (competitive exclusion)
	+ keystone species
	+ predation: (+/-)
* symbiosis: mutualism (+/+), commensalism (+/0), parasitism (+/-)
* coevolution: predator-prey adaptations, mimicry
	+ Batesian mimicry (fooling) vs. Mullerian mimicry (warning), convergent evolution

**Succession**

* primary succession, pioneer species, climax community, secondary succession, climax community

**Section 3: Ecosystems**

**Biomes**

* tropical rain forest, savanna, temperate grassland, temperate deciduous forest, desert,

taiga, tundra (permafrost), freshwater, marine

**Trophic levels**

* primary producers, primary consumers, secondary consumers, tertiary consumers,
* decomposers, detritivores
* food chain, food web
* ecological pyramids (energy, biomass, numbers),
	+ energy flow, 10 percent rule
	+ limited to 4-5 trophic levels
* eutrophication

**Nutrient cycles**

* carbon cycle, water cycle, nitrogen cycle (nitrogen fixation, denitrification), phosphorus cycle

**Human Impact**

* greenhouse effect (global warming)
* impact on nutrient cycling (burning fossil fuels, fertilizer run-off, ground water depletion, etc)
* ozone depletion
* pesticides
* deforestation/loss of habitat & biodiversity
* fragmented habitat
* biological magnification (fat-soluble toxins like DDT)
* introduced/invasive species