Name _____ AP Biology

AP: END OF YEAR REVIEW

UNIT 1. THE CHEMISTRY OF LIFE

Section 1: Chemistry

Bonds

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

Section 2: Water

Properties

- excellent solvent
- high heat capacity—moderating influence, evaporative cooling
- ice floats
- strong cohesion & surface tension
- strong adhesion

Section 3: Macromolecules

Organic Molecules

- carbon, monomers, polymers, functional groups
- carbohydrates
  - function: energy storage, structure
  - groups: sugars, starch, glycogen, cellulose, chitin
- proteins
  - function: structure, transport, defense, enzymes
  - structure: amino acids, peptide bonds, 1°, 2°, 3°, 4°
- lipids
  - function: energy storage, structure, hormones
  - groups: triglycerides (fats, saturated, unsaturated), phospholipids, steroids (cholesterol, sex hormones)
- nucleic acids
  - function: information storage
  - structure: nucleotides, A,T,C,G,U
  - groups: DNA, RNA

Section 4: Enzymes

Structure

- globular (4°) proteins, RNA

Function

- metabolic catalysts = lowers activation energy
- catabolism (digestion, breakdown, hydrolysis)
- anabolism (synthesis, dehydration synthesis)
- lock & key model, induced fit model: substrate, active site, enzyme-substrate complex, product(s)
- "-ase", substrate specific, unchanged during reaction

Factors that affect function

- pH, temperature, salts, [substrate], [enzyme]
- coenzymes, cofactors
- activators: allosteric, cooperativity
- inhibitors: competitive, noncompetitive, allosteric
- negative feedback

Name _____ AP Biology

UNIT 2. THE CELL

Section 1: Cell & Membrane Structure & Function

Classification

- plants: cell wall, chloroplasts, central vacuole
- 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

Organelles & Other Structures

- nucleus, ribosomes, ER, Golgi, vesicles, mitochondria, chloroplasts, lysosomes, centrioles, vacuoles
- motility: flagella, cilia
- 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
- vesicular transport: exocytosis, endocytosis, phagocytosis, pinocytosis

Section 2: Cellular Respiration

Overview

- $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ + energy
- glycolysis, all organisms, cytosol
- chemiosmosis, all eukaryotes, mitochondria
- ATP production

Glycolysis

- glucose → pyruvate
- yield: net 2 ATP, 2 NADH, 2 pyruvate
- cytosol

Kreb's (Citric Acid) Cycle

- pyruvate → acetyl CoA → Kreb's cycle
- yield: 1 ATP, 3 NADH, 1 $FADH_2$, CO_2 (exhale)
- function: produce electron acceptors for the ETC
- matrix of mitochondria

Electron Transport Chain (ETC)

- chemiosmosis, oxidative phoshorylation
- NADH & $FADH_2$ donate electrons to ETC, cytochrome carrier proteins in membrane, pump H+ ions to intermembrane compartment, H+ flow down concentration gradient through ATP synthase, phosphorylate ADP → ATP
  - O_2 is final electron acceptor
- yield: ~36 ATP
- inner membrane of mitochondria, cristae
- anaerobic respiration: no O_2, lactic acid (animals), alcoholic fermentation (bacteria, yeast, plants)

Section 3: Photosynthesis

Overview

- light + 6 H_2O + 6 CO_2 → $C_6H_{12}O_6$ + 6 O_2
- chemiosmosis, autotrophs, chloroplasts
- ATP & sugar production

Light Reactions

- chloroplast, thylakoid membrane
- noncyclic photophosphorylation
  - photosystem II (P_{680}), photolysis, primary electron acceptor, electron transport chain, ADP→ATP (phosphorylation)
  - photosystem I (P_{700}), primary electron acceptor, electron transport chain, NADP→NADPH
- cyclic photophosphorylation

Calvin Cycle (Light Independent-Reactions or "Dark" Reactions)

- chloroplast, stroma

- carbon fixation, Rubisco, CO_2 + RuBP → PGA (3C) → glucose (6C)
- C3 metabolism

C4 & CAM photosynthesis

- photorespiration, inefficiency of Rubisco in high [O_2]
- C4: separate 2 steps of carbon fixation anatomically = 2 different cells
  - PEP carboxylase in outer ring of mesophyll cells, 4C "storage" compounds (oxaloacetate, malate).
  - passes carbon by regenerating CO_2 in inner bundle sheath cells to Rubisco & Calvin cycle.
  - 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 CO_2 from “storage” compounds to Calvin cycle
  - cacti, succulents, pineapple

Section 4: Cell Cycle/Mitosis

Mitosis

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

Name _____ AP Biology

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, 1n → 1n
  - prophase 2, metaphase 2, anaphase 2, telophase 2
- Function
  - haploid gamete (sex cell) production
  - genetic variation & recombination

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 non-homologous 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

- semiconservative 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, one-gene-one-polypeptide 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, transposons

Viruses

- bacteriophages, capsid, envelope, retroviruses, reverse transcriptase

Bacteria

- plasmids, conjugation, transduction, transformation
- regulation of gene expression: operons
  - regulatory gene, repressor protein, promoter, operator, structural gene
  - inducible enzyme: lac operon, when lactose present binds to repressor & induces it to release DNA, catabolic pathway
  - repressible enzyme: tryp operon, when tryptophan (corepressor) present binds to repressor & triggers it to bind to DNA, anabolic pathway

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), DNA library, cDNA library, reverse transcriptase, probes, DNA sequencing, Human Genome Project, Southern blotting, microarray

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
- 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/heterozygosity/pool of recessive alleles, outbreeding

Section 2: Evolution of Populations & Speciation

Hardy-Weinberg Equilibrium

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

Speciation

- adaptive radiation
- allopatric: geographic isolation
- sympatric: reproductive isolation
  - prezygotic isolation
    - habitat isolation
    - temporal isolation

- behavioral isolation
- 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
- parallel evolution
- coevolution
- macroevolution: gradualism vs, punctuated equilibrium

Origin of Life

- earth & atmosphere formed: low or no O_2
- complex molecules in primordial seas, monomers, polymers
- organic molecules & early cells formed
- heterotrophic prokaryotes
- autotrophic prokaryotes: O_2 & 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)
  - formerly included in Monera

Domain Archaea

- extremophiles: thermophiles, halophiles, methanogens
  - formerly included in Monera

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
    - cnidaria (jellyfish, hydra, corals):
      - gastrovascular cavity
  - bilaterals
    - protostome development (mouth 1st)
      - flatworms: acoelomates
      - annelids (segmented worms): coelomates
      - mollusks (snails, clams, squid, octopus): coelomates

- brachiopods: coelomates
- arthropods (insects, arachnids, crustaceans): coelomates
- nematodes (round worms): pseudocoelomates

- deuterostomes development (mouth 2nd)
  - invertebrates
    - echinoderms (sea stars, sea urchins): coelomates
  - vertebrates: coelomates

Section 2: Five Kingdom Survey

Monera

- no longer considered valid
- prokaryotes

Protists

- eukaryotes

Fungi

- eukaryotes

Plants

- eukaryotes

Animals

- eukaryotes

UNIT 6. PLANT FORM & FUNCTION

Section 1: Plant Structure & Function

Plant Tissues

- ground tissues: parenchyma, collenchyma, sclerenchyma
- dermal tissues: epidermis, cuticle
- vascular tissue
  - xylem
    - tracheids, vessel elements, cells interconnected through pits
    - conduction of water & minerals, transpirational pull
    - dead at functional maturity
  - phloem
    - sieve tubes interconnected through pores/sieve plates, companion cells connected to sieve tubes through plasmodesmata giving physiological support
    - conduction of sugars, bulk flow, source to sink flow
    - living at functional maturity; loss of nuclei, ribosomes & central vacuole

Plant Growth

- meristem growth
  - primary growth: vertical growth
    - apical shoot
    - apical root: root cap, zone of cell division, zone of elongation, zone of maturation/differentiation
  - secondary growth: increase in girth
    - lateral meristems: vascular cambium (2° xylem & 2° phloem), cork cambium (periderm & bark)

Plant Structures

- root
  - epidermis, root hairs
  - cortex
  - endodermis, Casparian strip
  - stele (vascular cylinder), xylem, phloem
- leaf
  - cuticle
  - upper palisade mesophyll (photosynthesis)

- lower spongy mesophyll (gas exchange), stomates, guard cells
- vascular bundle (vein), xylem, phloem

Plant Hormones

- auxin: promotes plant growth, cell elongation; apical dominance
- gibberellins: cell growth, fruit development; bigger grapes
- cytokinins: promote cell growth (cytokinesis); apical dominance
- ethylene: promote fruit ripening
- abscisic acid (ABA): maintains seed & bud dormancy
  - epidermis, root hairs

Section 2: Plant Reproduction

Alternation of Generation

- multicellular sporophyte (2n) —*meiosis*→ spores (1n) —*mitosis*→ multicellular gametophyte (1n) —*mitosis*→ gametes (1n) —*fertilization*→ multicellular sporophyte (2n)

Flowers & Seeds

- sepals, petals, anthers (pollen), pistil/carpel (egg)
- double fertilization:
  - zygote (2n): new plant
  - endosperm (3n): nutrition for new plant
- seed
  - embryo, seed coat, endosperm, cotyledons (seed leaves), hypocotyl (embryonic stem), radicle (embryonic root)

Section 3: Plant Response

Phototropism

- response to light
- auxin concentrates on shady side of plant, differential growth

Gravitropism

- response to gravity
- auxin & gibberellin, starch statolith plastids

Thigmotropism

- response to touch

Photoperiodism

- response to relative length of daylight & darkness, circadian rhythm

- phytochrome protein, P_r, P_{fr}, florigen
  - daylight: P_r + red light → P_{fr}
  - darkness: P_{fr} + far-red light → P_r
  - night length resets circadian-rhythm clock
- long-day plants flower in longer days / shorter nights
  short-day plants flower in shorter days / longer nights
  day-neutral are not triggered by daylight changes

Name _____ AP Biology

UNIT 7. ANIMAL FORM & FUNCTION

Section 1: Animal Structure & Function

Homeostasis

- thermoregulation

Respiratory System

- gill function: counter current exchange
- lung function: nose, pharynx, larynx, trachea, bronchi, bronchioles, alveoli, diaphragm
- CO_2 & O_2 diffusion across moist membranes, red blood cells,
  - O_2 transported by hemoglobin (iron)
  - CO_2 transported as dissolved bicarbonate
- regulation: monitor blood pH

Circulatory System

- open circulatory system (hemolymph)
  closed circulatory system (blood), 2-, 3-, 4-chambered hearts, arteries, veins, capillaries
- heart function
  - atria, ventricles, valves, pulmonary circuit, systemic circuit, SA node, AV node, systole, diastole
- blood: RBC, WBC, platelets, plasma

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

Digestive System

- mouth
  - salivary amylase, physical breakdown
- pharynx, epiglottis, esophagus, peristalsis
- stomach
  - gastric juices, HCl, pepsin, mucus
    - zymogen: pepsinogen
  - storage, disinfection, physical & chemical breakdown, controlled release

- small intestines
  - digestion & absorption: villi
  - duodenum: proteases, maltase, lactase, phosphatases
  - pancreas: trypsin, chymotrypsin, lipase, amylase
    - zymogens: trypsinogen chymotrypsin
- liver, gall bladder
  - bile (emulsify fats)
- large intestines
  - water absorption
  - E. coli symbiotic bacteria

Nervous System

- structure
  - 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: Ca^{2+} gates, neurotransmitters, ion-gated channels
      - neuromuscular: acetylcholine, cholinesterase
      - CNS: epinephrine, dopamine, serotonin

Muscle System

- skeletal, smooth, cardiac
- muscle fiber function
  - sarcomere, sarcoplasm, sarcoplasmic reticulum, T-tubules, thin filaments (actin, troponin, tropomyosin), thick filaments (myosin)
  - sliding-filament model
    - ATP-myosin binding, Ca^{2+} release, Ca^{2+}-troponin binding, myosin-actin binding, actin filaments slide

Immune System

- Non-specific barriers
  - skin, anti-microbial proteins, gastric juices, symbiotic bacteria
- Non-specific patrol
  - phagocytes, complement proteins, inflammatory response (histamine, vasodilation, phagocytes)
- Specific immunity
  - lymphocytes, antigens, MHC (major histocompatibility complex), self vs. nonself
  - B cells: antibodies (immunoglobulins), plasma cells, memory cells
    - humoral response, attack circulating invaders, bone marrow
  - T cells: cytotoxic T cells (killer), helper T cells
    - cell-mediated response, attack infected or cancer cells
- Supplements
    - antibiotics, vaccines, passive immunity

Endocrine System

- homeostasis
  - blood sugar regulation, blood calcium regulation
  - negative feedback, positive feedback
- neurosecretory cells
  - hypothalamus, posterior pituitary (storage of ADH, oxytocin), anterior pituitary (release of TSH. ACTH, FSH, LH)
- ductless glands
  - pancreas: insulin, glucagons
  - adrenal: epinephrine, aldosterone
  - gonads: ovaries (estrogen, progesterone), testes (testosterone)
- hormones
  - steroid: transcription factors
  - protein: secondary messenger

Section 2: Animal Reproduction & Development

Anatomy

- female: ovary, oviduct (fallopian tube), uterus, cervix, vagina, egg, corpus luteum
  - oogenesis
- male: testes (sperm production), epididymis (sperm maturation), vas deferens (sperm delivery), seminal vesicles (secretions), prostate gland (secretions), penis, sperm
  - spermatogenesis

Regulation

- female hormones: GnRH (hypothalamus), FSH (pituitary), estrogen (ovary), LH (pituitary), progesterone (corpus luteum),
  - ovulation

Development

- fertilization, cleavage, morula, blastula, gastrula, gastrulation, differentiation, organogenesis
  - ectoderm, mesoderm, endoderm, archenteron, blastopore
- regulation: egg cytoplasm (gray crescent in frogs), embryonic induction (dorsal lip in frogs), homeotic genes

Section 3: Animal Behavior

Types of Animal Behavior

- instinct, FAP (sign stimulus), imprinting (critical period), learning, classical conditioning, operant conditioning (trial-and-error), habituation
- movement: kinesis (undirected change in speed), taxis (directed movement), migration
- foraging: herds, flocks, schools, packs
- social: agonistic, dominance/hierarchy, territoriality, altruistic (kin selection), cooperation, colonial

Communication

- chemical (pheromones), visual (displays), auditory, tactile

Name _____ AP Biology

UNIT 8. ECOLOGY

Section 1: Population Ecology

Population growth & distribution

- size, density, dispersal patterns (clumped, uniform, random), age structure, survivorship curves, reproductive tables
- limiting factors: density-dependent, density-independent
- growth: exponential growth, logistic growth, carrying capacity (K), r-selected, K-selected, population cycles

Section 2: Community Ecology

Interaction of populations

- interspecific competition: (-/-) niche (competitive exclusion), resource partitioning, keystone species, dominant species
- predation: (+/-) predator, parasite, parasitoid, herbivore
- symbiosis: mutualism (+/+), commensalism (+/0), parasitism (+/-)
- coevolution: predator-prey adaptations, cryptic coloration, warning coloration, mimicry, Batesian mimicry (fooling) vs. Mullerian mimicry (warning), convergent evolution

Succession

- primary succession, pioneer species, climax community, secondary succession, fire climax

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 food chain, food web, ecological pyramids (energy, biomass, numbers), energy flow, nutrient recycling, eutrophication

Nutrient cycles

- carbon cycle, water cycle, nitrogen cycle, phosphorus cycle

Human Impact

- greenhouse effect (global warming), ozone depletion, acid rain, deforestation/loss of habitat & biodiversity/fragmented habitat, biomagnification, introduced species, over-exploitation, desertification