AP Biology

Revision Sheet · 考前速记

Learn these by heart before the exam. 考试前把这些内容背熟。

Chemistry of Life

Water: polar, hydrogen-bonded. Gives cohesion, adhesion, high specific heat, and ice that floats. Every property traces to the H-bond.

Hydrolysis vs dehydration synthesis 水解与脱水缩合: hydrolysis ADDS water to break a bond; dehydration synthesis removes water to form one

Four macromolecules: carbohydrates (monosaccharides), lipids (not polymers), proteins (amino acids), nucleic acids (nucleotides).

Protein structure: primary sequence, secondary (H-bonds, helix/sheet), tertiary (R-group interactions), quaternary (subunits). Shape determines function.

Denaturation by heat or pH breaks the 3-D shape, not the peptide bonds.

Cell Structure and Function

$\frac{\text{surface area}}{\text{volume}}$ falls as a cell grows: the reason cells stay small and divide 表面积体积比

Membrane: phospholipid bilayer, hydrophilic heads out, hydrophobic tails in. Fluid mosaic with embedded proteins.

Passive: diffusion, osmosis, facilitated diffusion (down the gradient, no ATP). Active: pumps, endo/exocytosis (against it, needs ATP).

$\Psi = \Psi_S + \Psi_P, \quad \Psi_S = -iCRT$ water moves from HIGH to LOW water potential; Ψ of pure water at atmospheric pressure is 0 水势

Hypotonic outside means water in (a plant cell becomes turgid; an animal cell bursts). Hypertonic means water out.

Cellular Energetics

Enzymes lower activation energy; they do not change ΔG. Competitive inhibitor binds the active site; allosteric binds elsewhere and changes shape.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{ATP}$ 细胞呼吸

Respiration: glycolysis (cytosol, 2 ATP), pyruvate oxidation, Krebs (matrix), oxidative phosphorylation (cristae, most ATP).

Chemiosmosis: the electron transport chain pumps H^+ to build a gradient; ATP synthase lets it flow back. Same principle in mitochondria and chloroplasts.

$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$ 光合作用

Light reactions (thylakoid) make ATP and NADPH and split water. Calvin cycle (stroma) fixes CO_2 with rubisco.

C4 and CAM separate fixation from the Calvin cycle in SPACE or in TIME to avoid photorespiration.

Cell Communication and Cell Cycle

Signal transduction: reception, transduction (cascade, amplifies), response. A cascade means one signal changes many molecules.

Feedback: negative restores the set point (most homeostasis); positive amplifies (childbirth, clotting).

Cell cycle: G1, S (DNA replicates), G2, M. Checkpoints at G1, G2 and M verify size, DNA damage, and spindle attachment.

Mitosis makes 2 identical diploid cells. Meiosis makes 4 genetically different haploid cells.

Variation from meiosis: crossing over (prophase I), independent assortment (metaphase I), and random fertilisation.

Heredity

Punnett: 3:1 (monohybrid), 9:3:3:1 (dihybrid) 孟德尔比例

Law of segregation: alleles separate in gametes. Independent assortment: different genes assort independently, UNLESS linked.

Linked genes stay together; recombination frequency measures map distance (1% = 1 map unit).

Non-Mendelian: incomplete dominance (blend), codominance (both shown), multiple alleles, polygenic, epistasis, sex-linked.

$\chi^2 = \sum \frac{(o-e)^2}{e}$ df = categories -1; $p < 0.05$ means REJECT the null and the difference is significant 卡方检验

Gene Expression and Regulation

Central dogma: DNA to RNA (transcription) to protein (translation). Replication is semi-conservative.

Transcription: RNA polymerase, promoter. Eukaryotic processing adds a 5' cap, poly-A tail, and splices out introns.

Translation: ribosome reads codons; tRNA brings the amino acid. Start AUG, stop UAA/UAG/UGA.

Mutations: silent (no change), missense (one amino acid), nonsense (early stop), frameshift (insert/delete, usually worst).

Operons (prokaryote): lac is INDUCIBLE (lactose turns it on); trp is REPRESSIBLE (tryptophan turns it off).

Biotech: PCR amplifies, gel electrophoresis separates

by size (small travels furthest), CRISPR edits.

Natural Selection

$p + q = 1$, $p^2 + 2pq + q^2 = 1$ $2pq$ is the heterozygote frequency; q^2 is the homozygous recessive 哈迪-温伯格

H-W conditions: no mutation, no selection, no migration, random mating, large population. If the numbers deviate, evolution IS happening.

Selection types: directional (one extreme), stabilising (the middle), disruptive (both extremes).

Evolution mechanisms: natural selection, mutation, gene flow, genetic drift (bottleneck, founder), non-random mating.

Evidence: fossils, homologous structures (common ancestry), analogous (convergent), molecular sequences, embryology.

Ecology

$\frac{dN}{dt} = r_{\max}N$ (exponential), $\frac{dN}{dt} = r_{\max}N\frac{K-N}{K}$ (logistic) K is the carrying capacity; growth is fastest at $N = K/2$ 种群增长

Energy: about 10% passes to the next trophic level. That is why food chains are short and biomass pyramids narrow.

Interactions: competition (−/−), predation (+/−), mutualism (+/+), commensalism (+/0), parasitism (+/−).

Succession: primary starts on bare rock (no soil); secondary follows a disturbance where soil remains.

Higher biodiversity means greater resilience to disturbance.

Exam technique

Free-response verbs matter: DESCRIBE says what happens; EXPLAIN says why (give the mechanism); JUSTIFY says use the data to support the claim.

Always link structure to function, and always use the data given. A general truth with no reference to the graph earns little.

For an experiment: name the independent and dependent variables, the control, and what is held constant.