The Simple AP® Biology Unit 1 Cheat Sheet

1.1 Water: Polarity & Hydrogen Bonds

Why Water Is Polar

Polar covalent bond: O pulls shared e^- harder than H → O partly – (δ^-), H partly + (δ^+).
Hydrogen bond: weak attraction, δ^+ H of one molecule ↔ δ^- O (or N) of another. Each H_2O → up to 4 H-bonds w/ its neighbors.
Covalent bonds hold atoms *within* H_2O; **H-bonds** act *between* molecules. They constantly break & re-form in liquid water, many times a second.

Properties From H-Bonds

Property	Cause	Bio example
Cohesion	H_2O sticks to H_2O	Xylem transport
Adhesion	H_2O sticks to others	Clings to xylem
High sp. heat	Resists temp Δ	Stable body temp
High heat vap.	Evap. takes heat	Sweat cools you
Ice floats	Less dense solid	Insulates lakes

Water as Solvent

Hydrophilic (polar/ionic: sugars, ions, amino acids w/ polar R) → dissolve; H_2O forms **hydration shells** around each dissolved particle, keeping it apart.
Hydrophobic (nonpolar: lipid tails, oils) → don't dissolve → cluster together, away from H_2O.
Capillary action = cohesion + adhesion → H_2O rises in narrow tubes (xylem, paper towel).

⚠ H-bonds are BETWEEN water molecules, not within one. Bonds inside H_2O are polar covalent.

1.2 Elements of Life

The Big Six: CHONPS

C, H, O = the most common elements in all 4 macromolecule classes of living things.
Carbon: forms 4 covalent bonds → chains & rings = backbone of life's molecules.

Molecule	Elements	Tracer clue
Carbs	C, H, O	Only CHO
Lipids	C, H, O (+P)	P in phospholipids
Proteins	C, H, O, N, S	S = protein only
Nucleic ac.	C, H, O, N, P	P in backbone

Nitrogen: in amino groups (proteins) + nitrogenous bases (DNA/RNA) + ATP's adenine base.
Phosphorus: phosphate groups → nucleic acid backbones, phospholipids & ATP (energy).

Where Organisms Get Them

C: CO_2 is fixed by photosynthesis → organic molecules → passed through food webs.
N & P: plants absorb them from soil (NO_3^-, NH_4^+, PO_4^{3-}); animals get them by eating plants or prey.

Isotope-Tracing Logic

^{35}**S** labels proteins, NOT DNA. ^{32}**P** labels DNA/RNA (+ phospholipids), NOT proteins.
^{15}**N** labels proteins AND nucleic acids. ^{14}**C** labels all 4 classes, so it can't sort them.

⚠ Carbs & most lipids lack N. A molecule w/ N + P (no S) → nucleic acid. N + S → protein.

✓ Data Qs: match the labeled element to the only molecule class that has it (S → protein).

1.3 Building & Breaking Macromolecules

Two Core Reactions

Dehydration synthesis: monomers join by a covalent bond; H_2O released (–OH from one + H from the other). Builds polymers.
Hydrolysis: H_2O added → bond broken; one monomer gets H^+, the other gets –OH. Breaks polymers apart (e.g., digestion of food).
Energy: synthesis needs energy input; hydrolysis usually releases energy. Both use enzymes.

Monomers, Polymers & Bonds

Class	Monomer	Bond
Carbs	Monosacch.	Glycosidic
Proteins	Amino acid	Peptide
Nucleic ac.	Nucleotide	Phosphodiester
Fats*	Glycerol + FA	Ester

***Lipids** are NOT true polymers: no repeating chain of monomers. Fat = 1 glycerol + 3 fatty acids.

Counting Water

Linear chain: n monomers → n – 1 bonds → n – 1 H_2O released when the chain is built.
e.g., a 10-glucose chain → 9 H_2O out. Hydrolyzing it fully back to glucose → 9 H_2O used up.

Exam Examples

Digestion: amylase hydrolyzes starch → sugars; proteases hydrolyze peptide bonds → amino acids.
Triglyceride: 3 ester bonds → 3 H_2O out.

⚠ Don't mix up names: dehydration = water OUT (build). Hydrolysis = "hydro" + "lysis" = water splits it apart (break). Enzymes run both.

1.4 Carbohydrates

Building Blocks

Monosaccharide = monomer (glucose, fructose, ribose, deoxyribose). Many –OH groups → polar, hydrophilic → dissolves in water.
Disaccharide = 2 monomers (sucrose = glucose + fructose; lactose; maltose = 2 glucose).
Polysaccharide = many monomers linked by covalent (glycosidic) bonds → linear or branched.

Key Polysaccharides

Polymer	Found in	Role / shape
Starch	Plants	Storage; some branch
Glycogen	Animals	Storage; very branched
Cellulose	Plant walls	Structure; linear

Branched (glycogen) → many chain ends → enzymes release glucose fast (liver, muscle).
Linear (cellulose) → chains lie side by side, H-bond → strong fibers → rigid cell walls.
Digestion: humans hydrolyze starch & glycogen but lack enzyme for cellulose (= fiber).

Functions

Energy: glucose → cellular respiration → ATP.
Storage: starch (plants), glycogen (animals).
Structure: cellulose. **Recognition**: carb chains on membrane glycoproteins/glycolipids.

⚠ Exact structures of starch, glycogen & cellulose aren't tested. Know the monomer, the branching & the function of each one.

✓ Predict Qs: more branching → faster glucose release; linear packing → strength.

1.5 Lipids

Big Picture

Lipids: mostly C–H bonds → nonpolar, **hydrophobic**. Not polymers of a monomer.
Fat (triglyceride) = glycerol + 3 fatty acids. Stores energy (~2× carbs/g), insulates, cushions.

Saturated vs. Unsaturated

Feature	Saturated	Unsaturated
C–C bonds	All single	≥1 double
Tail shape	Straight	Kinked
Room temp	Solid	Liquid
Example	Butter	Olive oil

More double bonds → more kinks → looser packing → more fluid at room temp (plant oils).

Phospholipids & Steroids

Phospholipid = glycerol + 2 fatty acids + phosphate group. **Amphipathic**: polar head, nonpolar tails → forms bilayers in water.
Bilayer: in water, heads face out, tails hide inside → membranes form on their own.
Steroids: 4 fused carbon rings. Hormones (estrogen, testosterone) → growth, development & homeostasis; cholesterol is one too.
Cholesterol: steroid in animal membranes → stabilizes; buffers fluidity vs. temp swings.
Membrane fluidity: ↑ unsaturated tails → ↑ fluid.
Fatty acid: hydrocarbon chain + carboxyl. Saturated → straight → higher melting point.

✓ Predict: temp drops → membranes stiffen; more unsaturated (kinked) tails restore fluidity.

1.6 Nucleic Acids

Nucleotide Structure

Nucleotide = 5-C sugar + phosphate + nitrogenous base. Info stored in base **sequence**.
Backbone: sugar–phosphate, joined by covalent (phosphodiester) bonds; bases stick out.
5′ end = free phosphate. **3′ end** = free –OH on the sugar of the last nucleotide in the chain.
Directionality: new nucleotides are added only to the 3′ end → strands grow 5′→3′.

DNA vs. RNA

Feature	DNA	RNA
Sugar	Deoxyribose	Ribose
Bases	A, T, G, C	A, U, G, C
Strands	Usually 2	Usually 1
Job	Stores info	Makes proteins

Double Helix Rules

Antiparallel: the 2 strands run opposite ways (5′→3′ paired w/ 3′→5′), side by side.
Complementary pairs held by H-bonds: A–T (2), G–C (3) → GC-rich DNA more stable.
Base % rule: %A = %T, %G = %C. If A = 30% → T = 30%, so G = C = 20% each (100% total).
Complement: 5′-ATGC-3′ pairs w/ 3′-TACG-5′ (written 5′→3′, that's GCAT). Flip it.

⚠ Strands are held together by H-bonds (weak, easy to separate w/ heat). The backbone is covalent (strong); don't swap the two.

✓ Label 5′ and 3′ ends on every strand you write.

1.7 Proteins

Amino Acids & Peptide Bonds

Amino acid: central C + H + amine ($–NH_2$) + carboxyl (–COOH) + variable **R group**.
Peptide bond: carboxyl of one AA + amine of the next, by dehydration → **polypeptide** (amine end → carboxyl end, read in that order).
R groups: nonpolar/hydrophobic, polar/hydrophilic, or ionic (charged). Their chemistry → how the chain folds → its shape → its function.

4 Levels of Structure

Level	What	Held by
1°	AA sequence	Peptide bonds
2°	α-helix, β-sheet	Backbone H-bonds
3°	Full 3D shape	R-group interact.
4°	2+ polypeptides	R-group interact.

3° interactions: H-bonds, ionic bonds, hydrophobic interactions & **disulfide bridges** (covalent, S–S) between R groups.
1° sets the rest: AA sequence → folding → 3D shape → the function of the protein.

Shape Changes

Denaturation: heat, pH, salt disrupt H-bonds/ionic bonds → 3D shape lost → function lost.
Mutation: 1 AA swap can change folding. Sickle cell: polar Glu → nonpolar Val → Hb clumps.

⚠ Denaturation does NOT break peptide bonds; 1° structure stays. Only 2°–4° shape is lost.

✓ AA swap: compare R groups (polar/nonpolar/charged) → fold → function.

Unit 1 Exam Strategy & Connections

Bond & Interaction Map

Type	Where	Strength
Covalent	Backbones, S–S	Strong
Ionic	Charged R	Medium
Hydrogen	H_2O, DNA, 2°	Weak (adds up)
Hydrophobic	Lipid tails	Weak

Science Practices Tested

1.A Describe: name the structure + its function: "Branched glycogen → fast release."
6.E Predict: "If X changes → which bonds/interactions are disrupted → shape → function goes ↑ or ↓." Say each step.

FRQ Moves

Structure → function: always link a molecular feature to what it lets the molecule do.
Justify w/ chemistry: name the bond (H-bond, hydrophobic), not just "it changes."
ID the molecule: N + P → nucleic acid; S → protein; nonpolar → lipid; CHO → carb.

Links to Later Units

Unit 2: phospholipid bilayer, cholesterol, membrane proteins. **Unit 3**: enzymes are proteins → heat & pH can denature them.
Unit 4: steroid hormones cross membranes. **Unit 6**: 5′→3′ replication, transcription, translation.

⚠ A formula sheet is provided, but Unit 1 is structures & functions you must know cold.

✓ Every answer: structure → interaction → function, w/ each link named out loud.