Monomers and polymers of the four macromolecules

Macromolecule	Monomer	Bond	Polymers	Elements	Functions
Carbohydrates	monosaccharides: glucose, fructose, galactose (C6H12O6); ribose, deoxyribose	glycosidic	disaccharides (sucrose, lactose, maltose); polysaccharides (starch, glycogen, cellulose, chitin)	C, H, O (1:2:1)	quick energy; energy storage (starch, glycogen); structure (cellulose, chitin)
Proteins	amino acids (20)	peptide	polypeptides folded into proteins: enzymes, haemoglobin, collagen, keratin, antibodies, insulin	C, H, O, N (S)	enzymes, structure, transport, signalling, defence, movement
Nucleic acids	nucleotides: sugar + phosphate + base (A, T/U, G, C)	phosphodiester	DNA (deoxyribose, double helix), RNA (ribose, single strand)	C, H, O, N, P	store and transmit genetic information; ATP carries energy
Lipids	NOT a polymer: fatty acids + glycerol; steroids are four rings	ester (fatty acid to glycerol)	triglycerides, phospholipids, steroids, waxes	C, H, little O (P in phospholipids)	long-term energy, membranes, insulation, waterproofing, hormones

[ ] Dehydration synthesis (condensation): two monomers join, a water molecule is REMOVED, a covalent bond forms. glucose + glucose → maltose + H2O

[ ] Hydrolysis: water is ADDED across the bond and the polymer splits: digestion (amylase on starch, proteases on protein, lipases on fat)

[ ] Hook: proteins, peptide; carbs, glycosidic; nucleic, phosphodiester; lipids, ester, and not a polymer

Carbohydrates	
Monosaccharides	glucose, fructose, galactose (isomers of C6H12O6); ribose and deoxyribose (5 C)
Disaccharides	sucrose = glucose + fructose; lactose = glucose + galactose; maltose = glucose + glucose
Polysaccharides	starch (plant store), glycogen (animal store, branched), cellulose (plant walls, indigestible fibre), chitin (fungi, insects); all glucose, differing in bond orientation and branching

Proteins	
Amino acid	central carbon with amino group (-NH2), carboxyl group (-COOH), H, and one of 20 R groups; 9 essential in the diet
Structure	primary (sequence), secondary (alpha helix, beta sheet; H bonds), tertiary (3D fold; R-group bonds, disulfide bridges), quaternary (several chains, e.g. haemoglobin)
Denaturation	heat or pH unfolds the protein and it stops working

From sciencewithshobha.com/blog/monomers-and-polymers-of-the-four-macromolecules-the-chart-proteins-from-amino-acids-carbohydrates-from-monosaccharides-nucleic-acids-from-nucleotides-and-lipids-which-are-not-polymers-with-the-bonds-and-functions/ · 1-on-1 online science and AP tutoring, KS2 to A level, Grades 5 to 12, free 30-minute first class.

Nucleic acids, lipids, the food tests, the traps, and a practice set

Nucleic acids	
Nucleotide	pentose sugar (deoxyribose in DNA, ribose in RNA) + phosphate + base: A, G, C, and T (DNA) or U (RNA)
Backbone	phosphodiester bonds, phosphate of one to sugar of the next; bases pair A-T, G-C by hydrogen bonds in DNA's double helix; RNA single-stranded (mRNA, tRNA, rRNA)
ATP	a nucleotide with three phosphates: the energy currency, so a nucleic-acid monomer

Lipids	
Triglycerides	glycerol + 3 fatty acids by ester bonds; saturated (no C=C, solid: butter) against unsaturated (kinked, liquid: olive oil); twice the energy per gram of carbohydrate
Phospholipids	glycerol + 2 fatty acids + phosphate; hydrophilic head, hydrophobic tails: the membrane bilayer
Steroids; waxes	four fused rings (cholesterol, testosterone, oestrogen, cortisol); long fatty acids and alcohols (leaf and feather waterproofing)

Test	For	Reagent	Positive
Benedict's	reducing sugars	Benedict's solution, heated	blue → green → yellow → brick red
Iodine	starch	iodine solution	yellow-brown → blue-black
Biuret	proteins	NaOH then CuSO4	blue → purple
Emulsion	lipids	ethanol, then water	cloudy white emulsion

[ ] Lipids have no monomer (write fatty acids and glycerol if forced); starch, glycogen and cellulose are all glucose; ATP is a nucleotide, not a nucleic acid; N is in proteins and nucleic acids, P in nucleic acids and phospholipids; polymers are built by dehydration synthesis; enzymes are proteins

Curriculum	Where
US	HS-LS1-6; AP Biology Unit 1 Chemistry of Life
England	GCSE Biology digestion and food tests; A-level biological molecules
Australia	Year 11-12 Biology biomacromolecules
CBSE	Class 11 Biomolecules; Class 12 Molecular Basis of Inheritance
IB	B1.1, B1.2, A1.2

Practice

1. For each macromolecule give the monomer, the bond, one polymer and one function.
2. Word equation for two glucose molecules joining; name the reaction and the bond.
3. Why are lipids not classed as polymers?
4. A food turns blue-black with iodine and purple with biuret, and gives no change with Benedict's. What does it contain?
5. Name the three parts of a nucleotide and two differences between a DNA and an RNA nucleotide.
6. What happens to an enzyme at high temperature, and why does it stop working?

Answers

1. Carbs: monosaccharide, glycosidic, starch, energy store. Proteins: amino acid, peptide, enzyme, catalysis. Nucleic acids: nucleotide, phosphodiester, DNA, genetic information. Lipids: fatty acids + glycerol (not a polymer), ester, triglyceride, energy store (any valid). 2. Glucose + glucose → maltose + water; dehydration synthesis (condensation); glycosidic bond. 3. They are not long chains of one repeating monomer; a triglyceride is one glycerol and three fatty acids. 4. Starch and protein, no reducing sugar. 5. Sugar, phosphate, base; deoxyribose against ribose; thymine against uracil. 6. It denatures: the bonds holding the tertiary structure break, the active site changes shape and the substrate no longer fits.