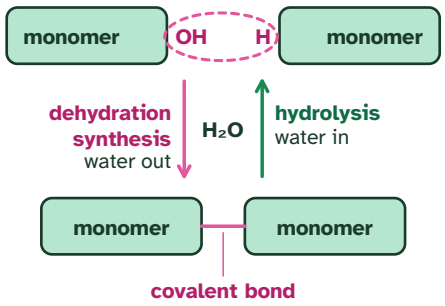
Big molecules from *small parts*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Cells build polymers from monomers by taking water out, and break them by putting water back. How the monomers join decides the job.



Follow the water. It leaves when a bond forms and is used up when a bond breaks.

1.3.A START HERE

Water out to *build*, water in to *break*

- **Dehydration synthesis**: a cell removes an OH from one monomer and an H from the other. They leave together as water, and a **covalent bond** forms between the monomers.
- **Hydrolysis** runs it backward: a water molecule is **split**, its H joins one monomer and its OH the other, and the bond between them breaks.
- **One water for every bond**, made or broken. Enzymes speed up both reactions, and building costs the cell energy.
- **Order matters:** the same few monomers, joined in another order or another way, make a different polymer with a different job.

WHICH WAY THE WATER GOES

D **Dehydration synthesis**
water out: a bond is built

H **Hydrolysis**
water in: a bond is broken

1.3.A THREE OF THE FOUR CLASSES ARE CHAINS

Monomers, bonds and *polymers*

CLASS	MONOMER	BOND BETWEEN MONOMERS	POLYMER
Carbohydrates	**Monosaccharides** such as glucose	Glycosidic bond	Polysaccharides: starch, glycogen, cellulose.
Proteins	**Amino acids** 20 kinds	Peptide bond	Polypeptides, which fold into proteins.
Nucleic acids	**Nucleotides** 4 kinds in each	Phosphodiester bond	DNA and RNA.
Lipids the odd one out	**None** a fat is glycerol and three fatty acids	Built by dehydration synthesis all the same	**Not a polymer:** large, but not a chain of repeating units.

All four classes are macromolecules. Three are polymers.

Order and joining decide what a polymer is

1.3.A

Digest, then *rebuild*

- **Digestion is hydrolysis.** Starch, protein and DNA in food are too big to be absorbed, so enzymes split them into glucose, amino acids and nucleotides.
- Cells then **rebuild the monomers into their own polymers** by dehydration synthesis: glucose from a potato can become glycogen in your liver.
- Breaking large molecules down is **catabolism**; building them up is **anabolism**. Each reaction has its own enzyme.



1.3.A A FAVORITE CALCULATION

Count the *waters*

- A chain of **n** monomers has **n – 1** bonds.
- So building it releases n – 1 water molecules, and digesting it completely uses the same number.

9
waters released joining 10 glucose

299
waters used to digest a chain of 300

Carbohydrates: *sugars*, stores and structure

1.4.A

One unit, two units, *many*

- Carbohydrates contain C, H and O, usually **1:2:1**. Their monomers are **monosaccharides**, joined by **glycosidic bonds**.
- Glucose, fructose and galactose are all $C_6H_{12}O_6$ with the atoms arranged differently: they are **isomers**.



one unit | two units | many units

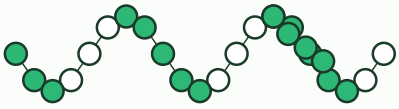
ONE UNIT
Monosaccharides
Glucose, fructose, galactose. Ribose and deoxyribose have five carbons.

TWO UNITS
Disaccharides
Sucrose: glucose and fructose. Lactose: glucose and galactose. Maltose: two glucose.

MANY UNITS
Polysaccharides
Starch, glycogen, cellulose, chitin. Too large to dissolve or to taste sweet.

1.4.A THE STRUCTURE OF THE MONOMER DECIDES THE PROPERTIES OF THE POLYMER

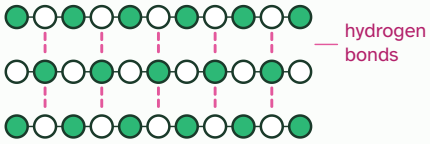
Same glucose, *different jobs*



starch: a coil, few branches



glycogen: many branches



cellulose: straight chains

	STARCH	GLYCOGEN	CELLULOSE
Found in	Plants: grains in a potato or a seed.	Animals and fungi: liver and muscle cells.	The cell wall of every plant cell.
Built from	**Alpha glucose**	**Alpha glucose**	**Beta glucose** Every other unit is turned over.
Shape	Coiled chains, some with occasional branches.	Coiled, and branched far more often.	Straight chains that lie side by side in bundles called microfibrils.
Job	**Energy store**	**Energy store** More branches mean more ends for enzymes, so glucose comes off fast.	**Structure** Holds the plant up and stops its cells bursting.
Why it suits	**Compact**, and too large to dissolve, so it does not **draw water into the cell**.	Enzymes hydrolyze glucose from the **ends of the chains**, one unit at a time.	One hydrogen bond is weak; **thousands between chains** are strong. Humans cannot hydrolyze it: fiber.

Each bead is one glucose unit.

Chitin, a structural polysaccharide with nitrogen, makes fungal cell walls and insect exoskeletons

WATCH OUT

Five mistakes that *cost points*

- ✕ **A fat is not a polymer.** It is large, but not a chain of repeating monomers.
- ✕ **Dehydration is not drying out.** The water is made from atoms of the two monomers.
- ✕ **In hydrolysis the water is split.** Its H and its OH end up on the two new ends.
- ✕ **Insoluble does not mean hydrophobic.** Starch is polar, but too large to dissolve.
- ✕ **Cellulose is structure, not a store.** Plants store glucose as starch.

COVER THE SHEET

Can you *answer these?*

1. Identify the monomer and the bond of a protein.
2. Describe what happens in dehydration synthesis.
3. Calculate the waters released as 50 amino acids join.
4. Explain why digestion is called hydrolysis.
5. Explain why a fat is not a polymer.
6. Describe how lactose differs from starch.
7. Explain why glycogen releases glucose faster than starch.
8. Explain how beta glucose makes cellulose strong.

IN THE EXAM

Say where the water goes ("a water molecule is released as a covalent bond forms"), then **link structure to function**: branched, so many ends, so glucose comes off fast.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.