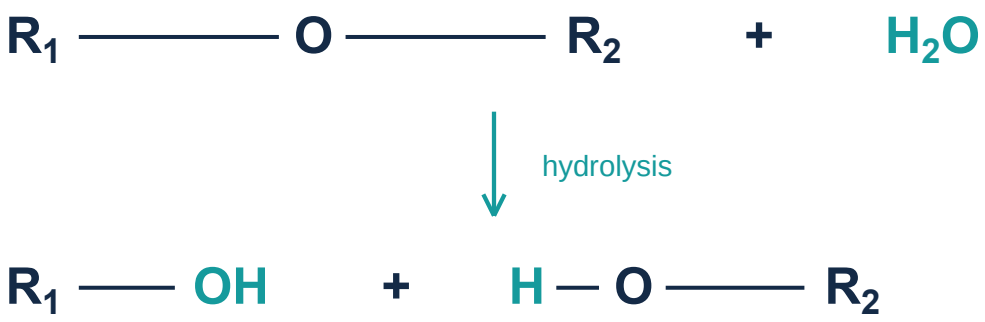
Use water to split the linkage

Hydrolysis breaks a glycosidic linkage using water. It reverses the net change in condensation: one water molecule is consumed for each linkage hydrolysed.

THE NET CHANGE AT ONE GLYCOSIDIC LINKAGE



Water supplies OH to one product and H to the other.

R_1 and R_2 represent the rest of the sugar structures. This is an atom-accounting schematic, not a complete ring drawing or a detailed reaction mechanism.

1. WATER IS A REACTANT, NOT JUST THE SOLVENT

Water contributes atoms to the products when the linkage is cleaved. Hydrolysis is not simply dissolving sugar in water: dissolving disperses molecules without necessarily changing their covalent structure.

2. CATALYSTS SPEED THE REACTION

Appropriate enzymes can catalyse hydrolysis in organisms. In the laboratory, dilute acid and heat can promote carbohydrate hydrolysis. A catalyst speeds the reaction; it does not replace the water used in it.

Keep the directions clear: condensation joins sugar units and releases water; hydrolysis splits a linkage and uses water.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 6, p. 18.

Predict the products

Breaking one linkage does not always release individual monosaccharides. The products depend on the starting carbohydrate and how many linkages are hydrolysed.

DISACCHARIDES: ONE LINKAGE, ONE WATER MOLECULE

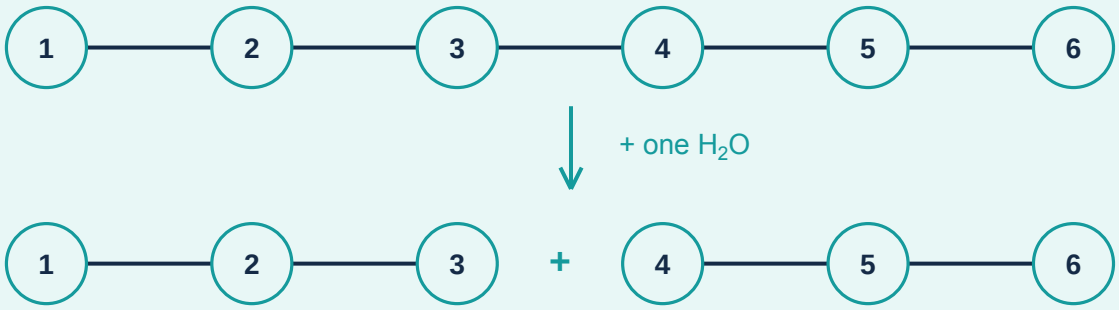
maltose + water → glucose + glucose

sucrose + water → glucose + fructose

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 2\ C_6H_{12}O_6$$

The same formula balance fits both examples; the sugar identities differ.

PARTIAL HYDROLYSIS: ONE INTERNAL LINK IS BROKEN



A six-unit model becomes two three-unit fragments, not six free sugars. Circles represent subunits, not atoms; new H and OH groups at the cut are omitted here.

COMPLETE HYDROLYSIS: ALL INTER-UNIT LINKS ARE BROKEN

Starch and glycogen yield glucose when completely hydrolysed. For an open chain containing n residues, complete hydrolysis of its n - 1 glycosidic links uses n - 1 water molecules. In the six-unit model, that means five waters and six monosaccharides.

Enzyme specificity matters: one enzyme may only cut particular linkages, so one treatment need not give complete hydrolysis.

Supporting reading: OpenStax Biology 2e, 3.1 Macromolecule synthesis.

Why sucrose needs pretreatment

Intact sucrose is non-reducing. Hydrolysis releases glucose and fructose, which are reducing sugars. The final Benedict's test detects those products, not unchanged sucrose.

1. TEST AN UNTREATED PORTION

Add Benedict's reagent and heat in a hot water bath. Record the direct result. Pure sucrose should remain blue under the usual test conditions.

2. HYDROLYSE A FRESH PORTION

Heat a separate, untreated portion with dilute hydrochloric acid using the approved method. Water breaks the sucrose linkage; the acid catalyses the reaction.

3. COOL AND NEUTRALISE

Cool, then carefully add the prescribed alkali and check the pH as instructed. Residual acid can interfere because Benedict's reagent requires alkaline conditions.

4. ADD FRESH BENEDICT'S REAGENT AND HEAT

Heat again in the water bath. A positive result may be green, yellow, orange or brick-red, with precipitate. The glucose and fructose products now reduce copper(II) ions.

INTERPRET THE PAIR, NOT JUST THE FINAL TUBE

Negative before + positive after: supports a non-reducing sugar in a simple sugar sample.
Positive before + positive after: reducing sugar was already present; this alone cannot show whether non-reducing sugar was also present.

Limits and safety: other hydrolysable carbohydrates can also yield reducing sugars. Wear eye protection and follow the teacher's heating, acid, alkali and disposal procedures.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 6, p. 18.