AP BIOLOGY · UNIT 1 · TOPIC 1.3

Introduction to Macromolecules

Learning objective 1.3.A Describe the chemical reactions that build and break biological macromolecules.

Name: Date: Period:

Use the tool **The Water Ledger**. On **The bench** tab you drag monomers together to bond them, and drag a water molecule onto a bond to break it. Do Parts 1 to 3 there, then switch to **Read the reaction** for Part 4.

Part 1 · Predict, then check

The bench starts with four separated monomers. Before you drag anything, predict what the ledger will show once you have dragged all four together into one chain. Then do it and record what actually happened.

Once all four are joined	My prediction	What actually happened
Bonds formed		
Water released		
Water on the bench		
Water used up		

Part 2 · The same reaction, four families

Switch families using the buttons under Which macromolecule; choosing a family resets the bench. For each family, drag two monomers together and record the monomer name and the name of the bond that forms.

Macromolecule	Monomer	Name of the bond formed
Carbohydrate		
Protein		
Nucleic acid		
Lipid		

Part 3 · The count that matters

Press **Add a monomer** until you have six, drag them all into one chain, then drag each water molecule back onto a bond until the chain is fully apart. Use the ledger to answer questions 1 to 3.

1. A chain of 6 monomers was assembled.
(a) Calculate the number of covalent bonds in the chain from the number of monomers. Show your work.

(b) Determine the number of water molecules released as the chain was assembled.

2. (a) Determine the number of water molecules consumed to break the 6-monomer chain in question 1 completely apart.

(b) Explain why this number of water molecules is consumed.

3. Predict how many water molecules are released when 40 amino acids are joined into one polypeptide. Justify your prediction.

Part 4 · Apply the two reactions

Switch to the **Read the reaction** tab and work the cards. Then answer questions 4 to 6 on your own.

4. The stems of pineapple plants contain bromelain, a group of protein-digesting enzymes. Identify the type of monomer that makes up bromelain.

5. Bromelain breaks other proteins into smaller molecules.
(a) Explain how bromelain breaks the bonds between amino acids.

(b) Identify whether water is a reactant or a product in this reaction.

6. A student claims that dehydration synthesis and hydrolysis are two unrelated reactions. Using the water counts in the ledger, evaluate the student's claim.

What the model simplifies

Monomers are drawn as schematic blocks rather than real structures, so the reaction pattern stays visible. Only the H and OH groups that take part in the reaction are shown, and they sit on the side of the monomer that is still free.

On the bench a bond forms as soon as two monomers are dragged close enough, and a bond breaks as soon as a water molecule is dragged onto it. Real reactions need an enzyme and do not happen on contact.

Chains on the bench are unbranched, which is what makes the $n - 1$ arithmetic exact. Real polysaccharides such as glycogen branch; a branched polymer of n monomers still has $n - 1$ bonds but a different shape.

In a cell these reactions are catalyzed by enzymes and do not proceed at any useful rate on their own. The bench runs them on a button press.