

GLYCOGENESIS AND GLYCOGENOLYSIS

By Alka Mariam And Jeevana

INTRODUCTION

- Carbohydrates are stored in the body as glycogen
- Glycogen is mainly stored in:
 - Liver
 - Muscles
- Two important processes:
- Glycogenesis → formation of glycogen
- Glycogenolysis → breakdown of glycogen

1. WHAT IS GLYCOGENESIS ?

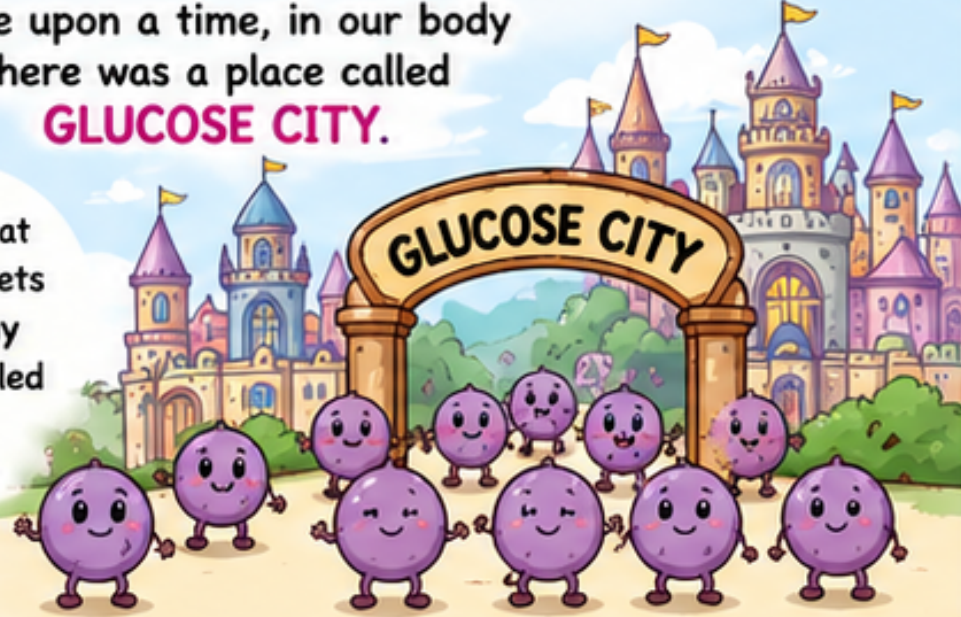
Glycogenesis is the process of converting glucose into glycogen for storage

THE STORY OF GLYCOGENESIS

How our body stores extra glucose

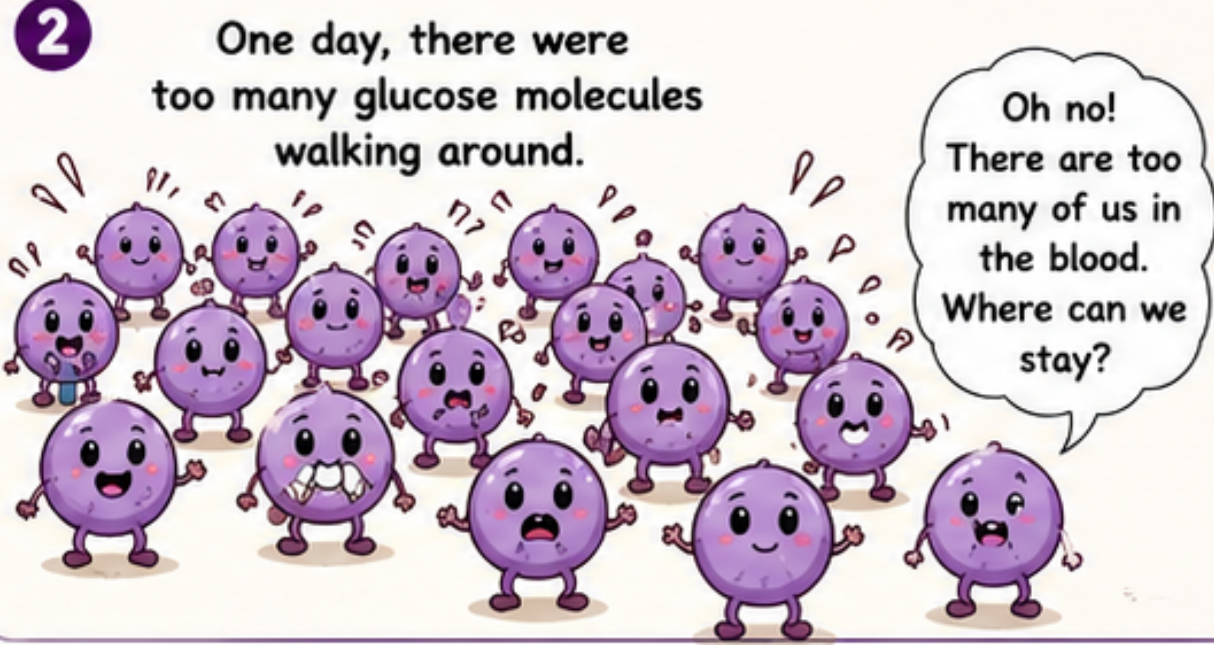
1 Once upon a time, in our body there was a place called **GLUCOSE CITY**.

Every time we eat rice, bread, sweets or chapati, many tiny workers called **GLUCOSE** molecules enter Glucose City.

A group of purple, round glucose molecules with faces are walking towards a large, ornate archway labeled 'GLUCOSE CITY'. In the background, there is a colorful castle with multiple towers and flags.

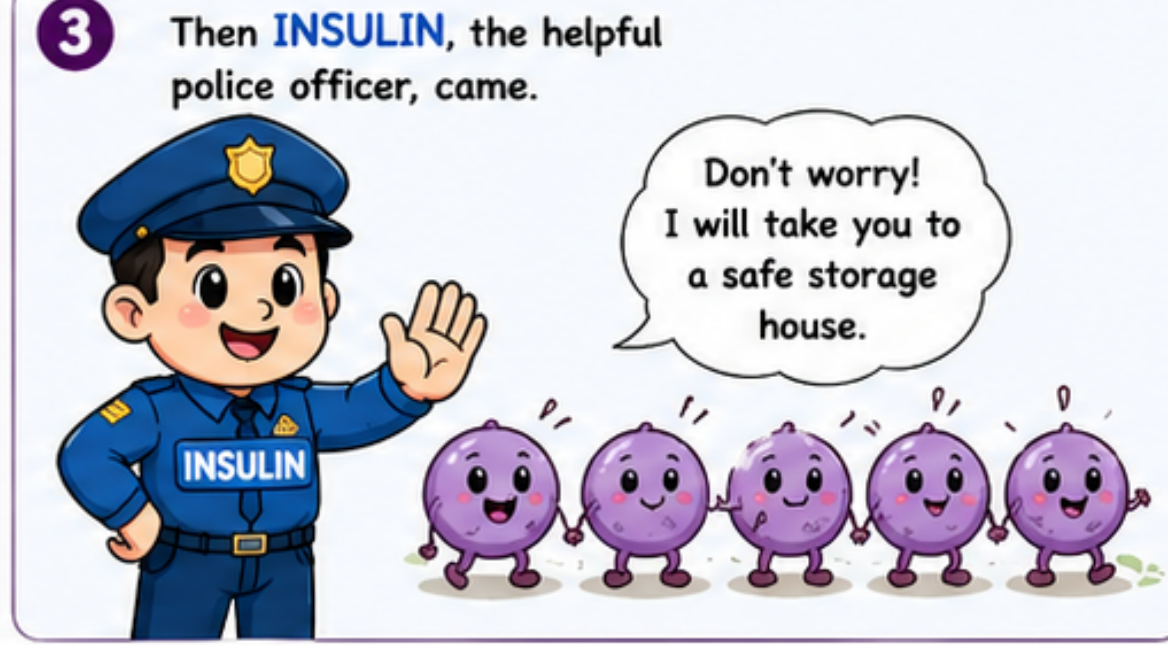
2 One day, there were too many glucose molecules walking around.

Oh no! There are too many of us in the blood. Where can we stay?

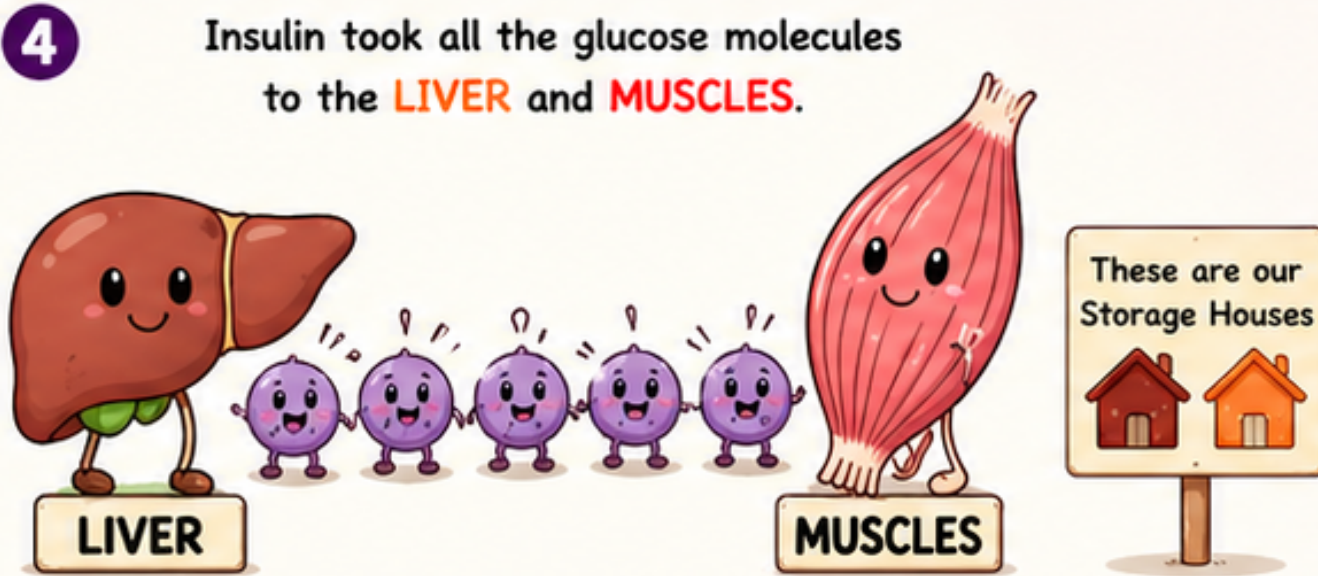
A large group of purple glucose molecules are crowded together. One molecule is speaking, expressing concern about the high number of molecules in the blood.

3 Then **INSULIN**, the helpful police officer, came.

Don't worry! I will take you to a safe storage house.

A police officer character named 'INSULIN' in a blue uniform and cap is talking to a line of purple glucose molecules. The molecules are looking up at him with relief.

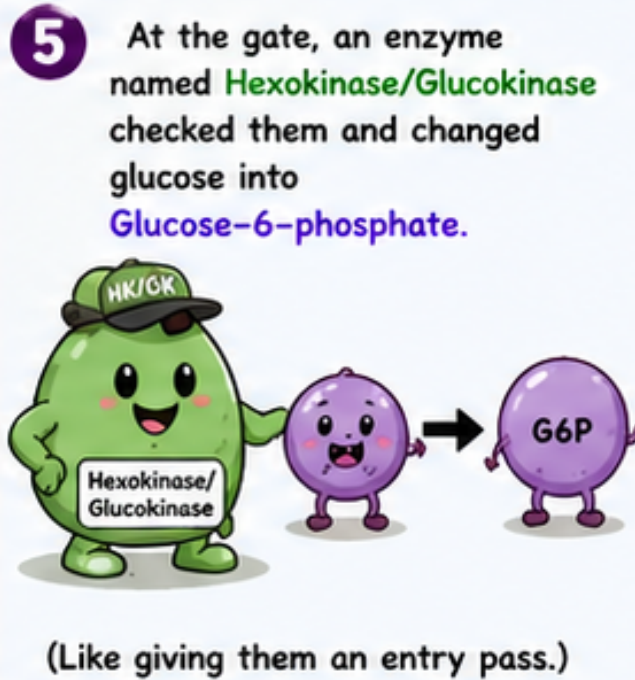
4 Insulin took all the glucose molecules to the **LIVER** and **MUSCLES**.

A purple glucose molecule is being carried by a line of molecules towards two destinations: a liver organ labeled 'LIVER' and a muscle bundle labeled 'MUSCLES'. A signpost points to these locations.

5 At the gate, an enzyme named **Hexokinase/Glucokinase** checked them and changed glucose into **Glucose-6-phosphate**.

Hexokinase/Glucokinase

(Like giving them an entry pass.)

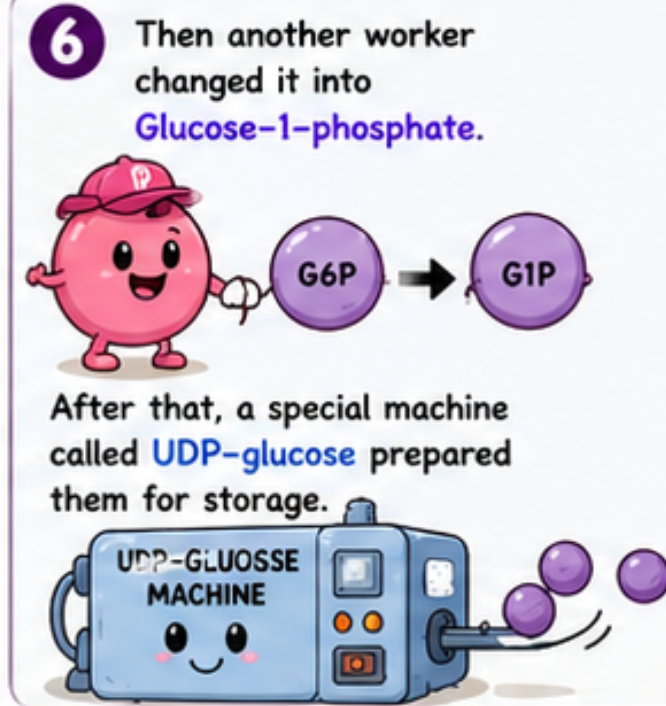
A green, bean-shaped enzyme character wearing a cap with 'HK/GK' on it is shown. It is taking a purple glucose molecule and converting it into a purple circle labeled 'G6P'.

6 Then another worker changed it into **Glucose-1-phosphate**.

G6P → G1P

After that, a special machine called **UDP-glucose** prepared them for storage.

UDP-GLUCOSE MACHINE

A pink worker character is shown converting a purple circle 'G6P' into another purple circle 'G1P'. Below, a blue machine labeled 'UDP-GLUCOSE MACHINE' is shown with purple circles being processed.

7 Finally, the builder called **GLYCOGEN SYNTHASE** joined all glucose molecules together and built a big storage building called **GLYCOGEN HOUSE**.

GLYCOGEN SYNTHASE

GLYCOGEN HOUSE

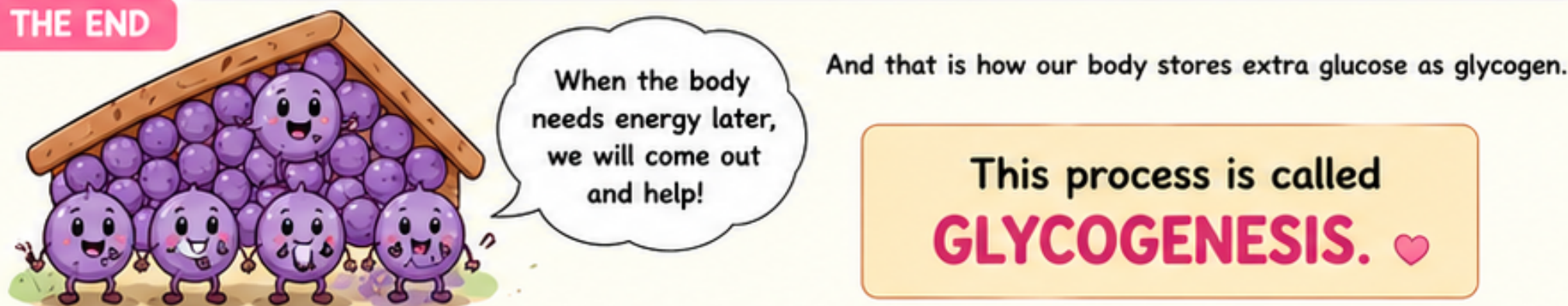
A yellow worker character wearing a hard hat labeled 'GLYCOGEN SYNTHASE' is using a tool to build a large, multi-story house made of many purple circles. The house is labeled 'GLYCOGEN HOUSE'.

THE END

When the body needs energy later, we will come out and help!

And that is how our body stores extra glucose as glycogen.

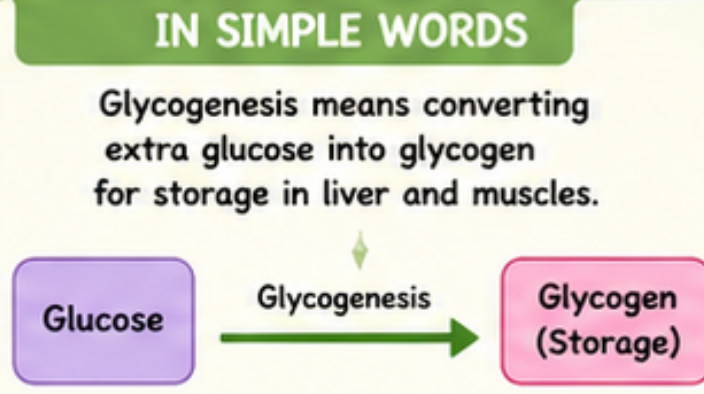
This process is called **GLYCOGENESIS**. ♥

A group of purple glucose molecules are standing in front of a small house made of purple circles. One molecule is speaking, saying they will come out to help when the body needs energy.

IN SIMPLE WORDS

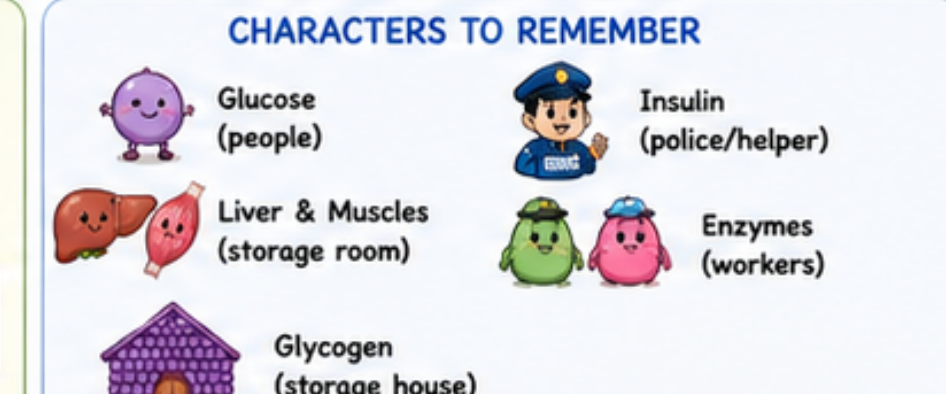
Glycogenesis means converting extra glucose into glycogen for storage in liver and muscles.

Glucose → Glycogenesis → Glycogen (Storage)

A simple flow diagram showing a purple box labeled 'Glucose' with an arrow pointing to a purple box labeled 'Glycogen (Storage)'. The arrow is labeled 'Glycogenesis'.

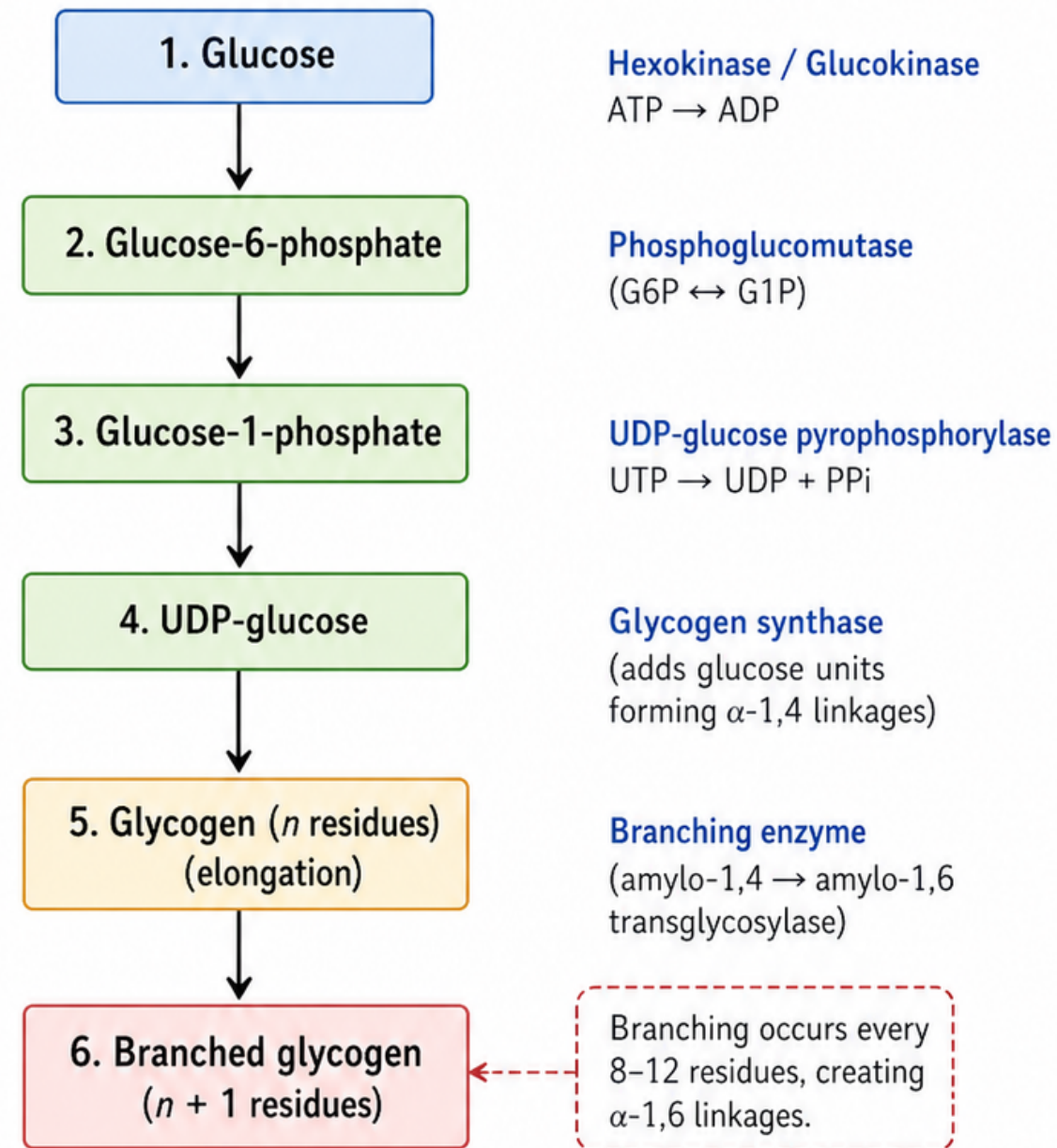
CHARACTERS TO REMEMBER

- Glucose (people)
- Liver & Muscles (storage room)
- Glycogen (storage house)
- Insulin (police/helper)
- Enzymes (workers)

A key showing icons for each character: a purple circle for Glucose, a liver and muscle for Liver & Muscles, a purple house for Glycogen, a police officer for Insulin, and two green bean shapes for Enzymes.

GLYCOGENESIS (SYNTHESIS OF GLYCOGEN)

Glycogen synthesis from glucose



ENERGY COST

Consumes:

- 1 ATP (step 1)
- 1 UTP (step 3)
- Total = 1 ATP + 1 UTP per glucose incorporated (excluding branch formation energy).

KEY POINTS

- Glycogenesis occurs in cytosol.
- Substrate: UDP-glucose (activated glucose donor).
- Glycogen synthase extends chains with α -1,4 linkages.
- Branching enzyme forms α -1,6 linkages.
- Hormonal regulation: Insulin stimulates, Glucagon/Epinephrine inhibit.

ENZYMES OF GLYCOGENESIS

1. Hexokinase (most tissues) / Glucokinase (liver)
2. Phosphoglucomutase
3. UDP-glucose pyrophosphorylase
4. Glycogen synthase
5. Branching enzyme (amylo-1,4 $\rightarrow$ amylo-1,6 transglycosylase)

2.What is Glycogenolysis?

Glycogenolysis is the breakdown of glycogen into glucose

THE NEXT CHAPTER: GLYCOGENOLYSIS

How our body releases stored glucose when we need energy

1

After a while, the body needs
ENERGY!

To run...



To think...



Even to breathe!

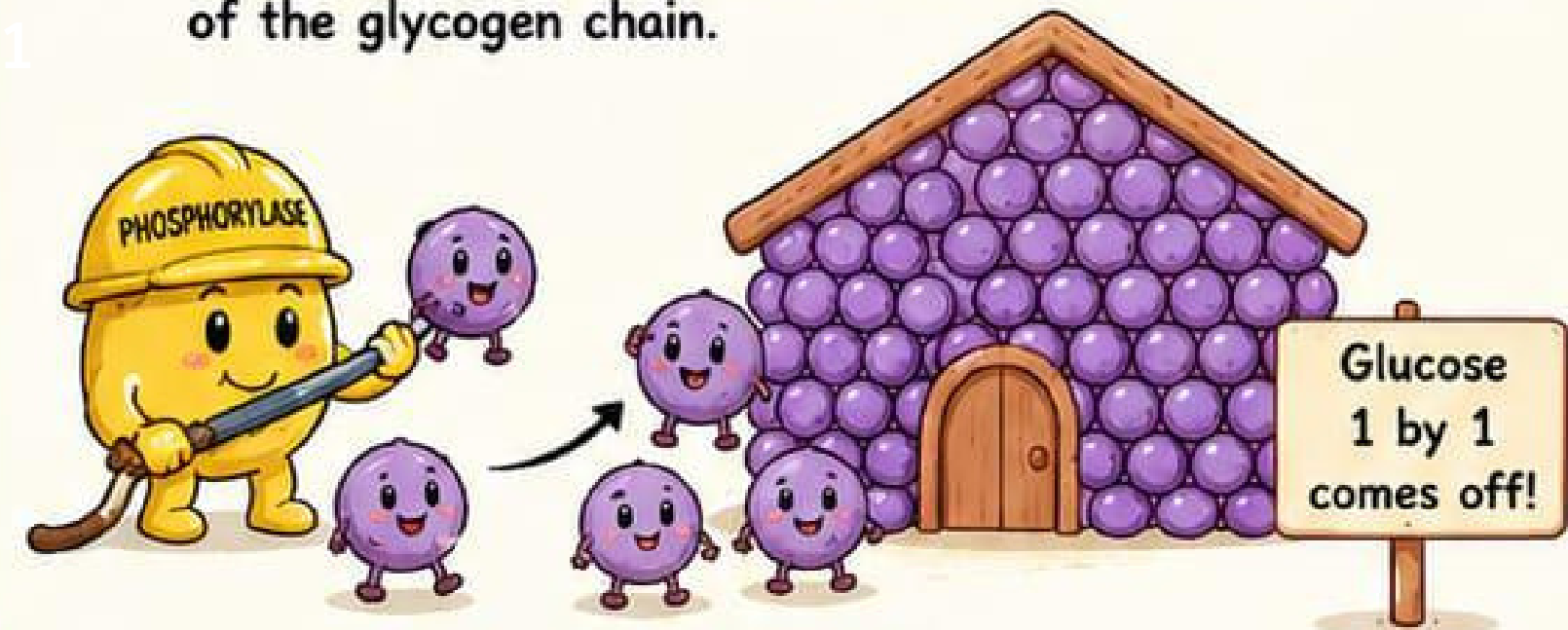


So the body sends a message:

"We need glucose! Let's open the **GLYCOGEN HOUSE!**"

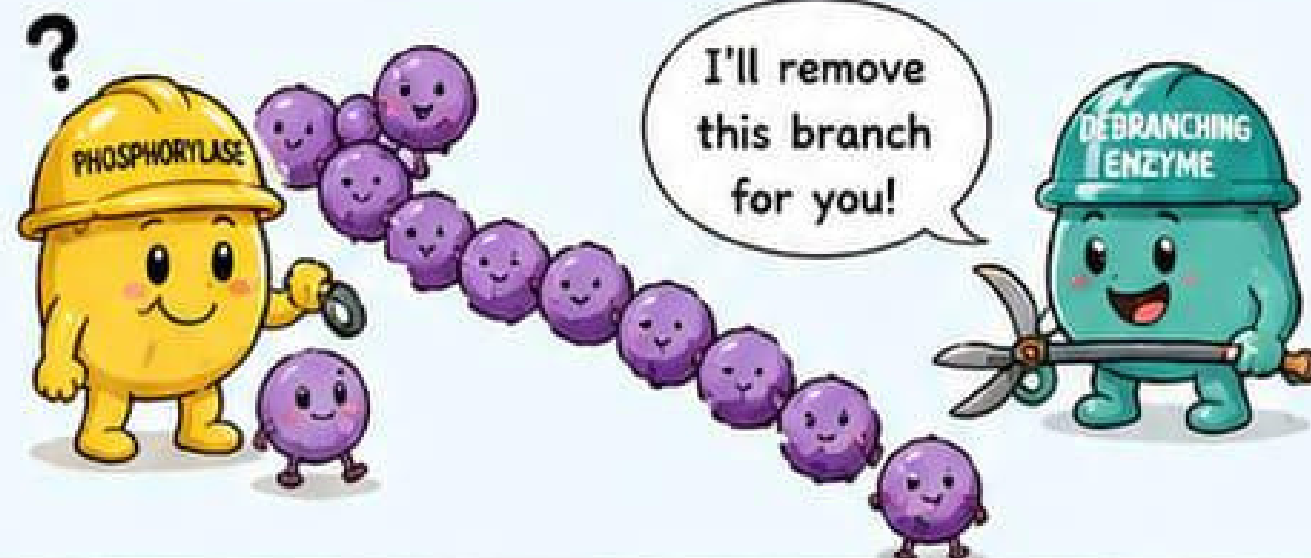
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First, an enzyme called **GLYCOGEN PHOSPHORYLASE** comes to the Glycogen House. It starts taking off glucose units from the ends of the glycogen chain.



3

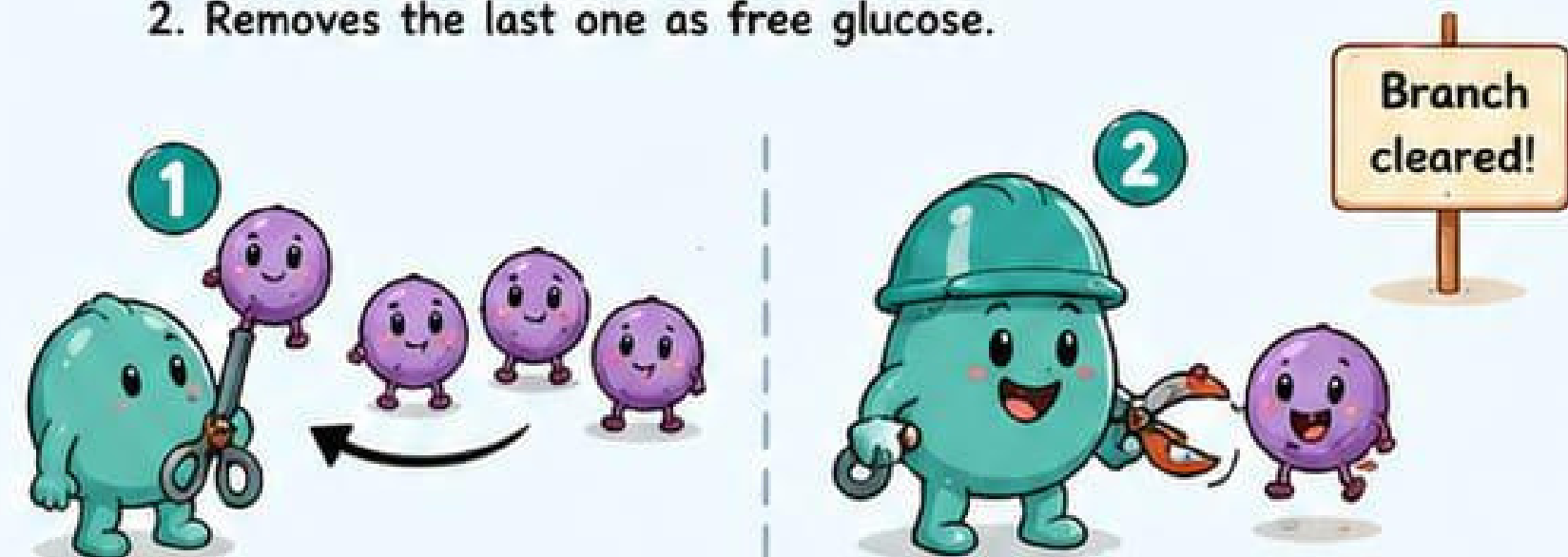
When **PHOSPHORYLASE** reaches a branch, it stops 4 units away and calls for help. A helper enzyme called **DEBRANCHING ENZYME** arrives!



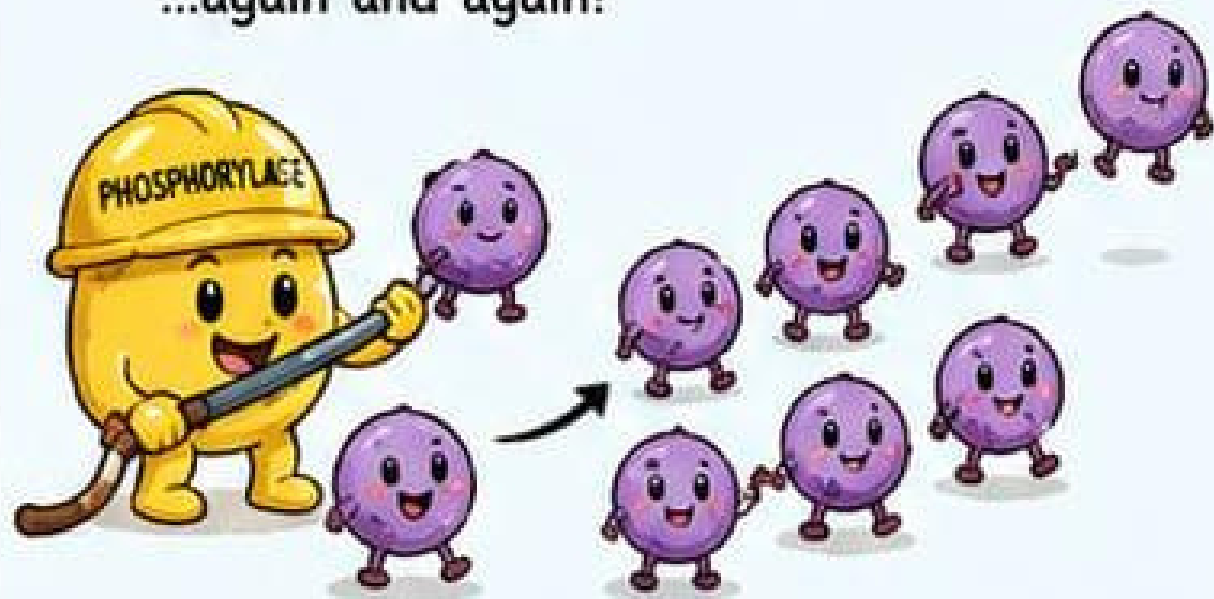
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The **DEBRANCHING ENZYME** has two jobs:

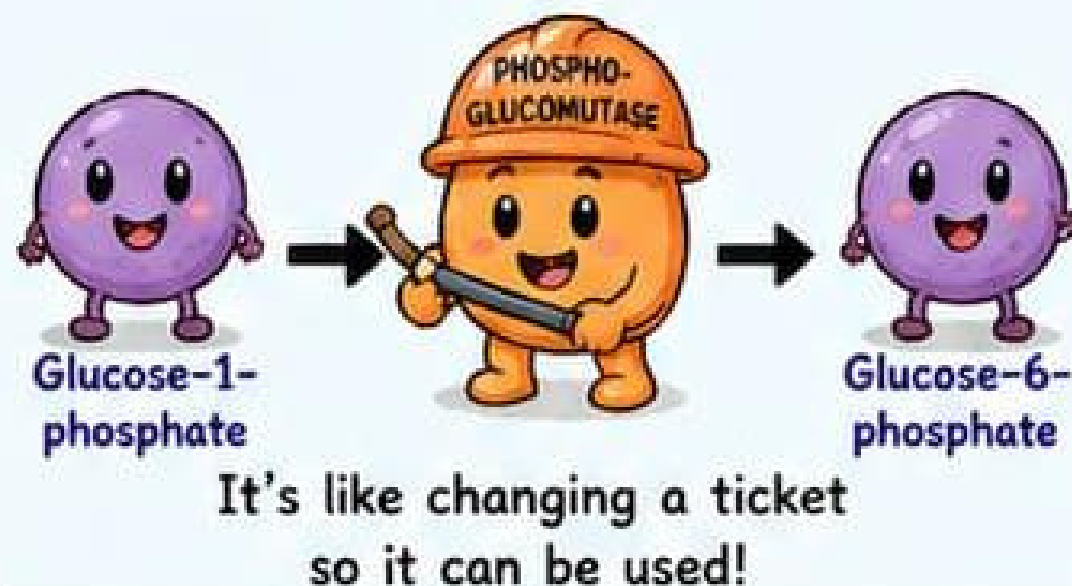
1. Moves 3 glucose units to the main chain.
2. Removes the last one as free glucose.



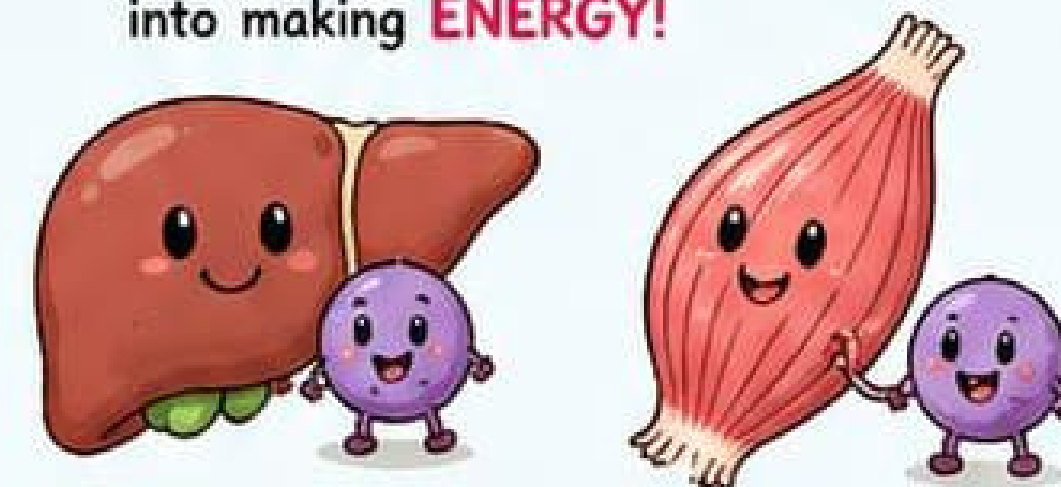
- 5** Now **PHOSPHORYLASE** can continue releasing glucose units...
...again and again!



- 6** All released glucose-1-phosphate is changed into glucose-6-phosphate by **PHOSPHOGLUCOMUTASE**.



- 7** In the **LIVER**, glucose-6-phosphate can be changed into **GLUCOSE** and sent out to the blood. In the **MUSCLES**, it goes straight into making **ENERGY**!



THE END



We gave glucose when the body needed it!
Teamwork saves the day!

This process is called **GLYCOGENOLYSIS**.

It's how our body breaks down glycogen to release glucose and make energy when we need it.

IN SIMPLE WORDS

Glycogenolysis means breaking down stored glycogen into glucose for energy.

Glycogen
(Storage)

Glycogenolysis

Glucose
(Energy)

CHARACTERS TO REMEMBER



Glucose
(people)



Phosphorylase
(enzyme)



Debranching
Enzyme
(helper)



Phosphoglucomutase
(enzyme)



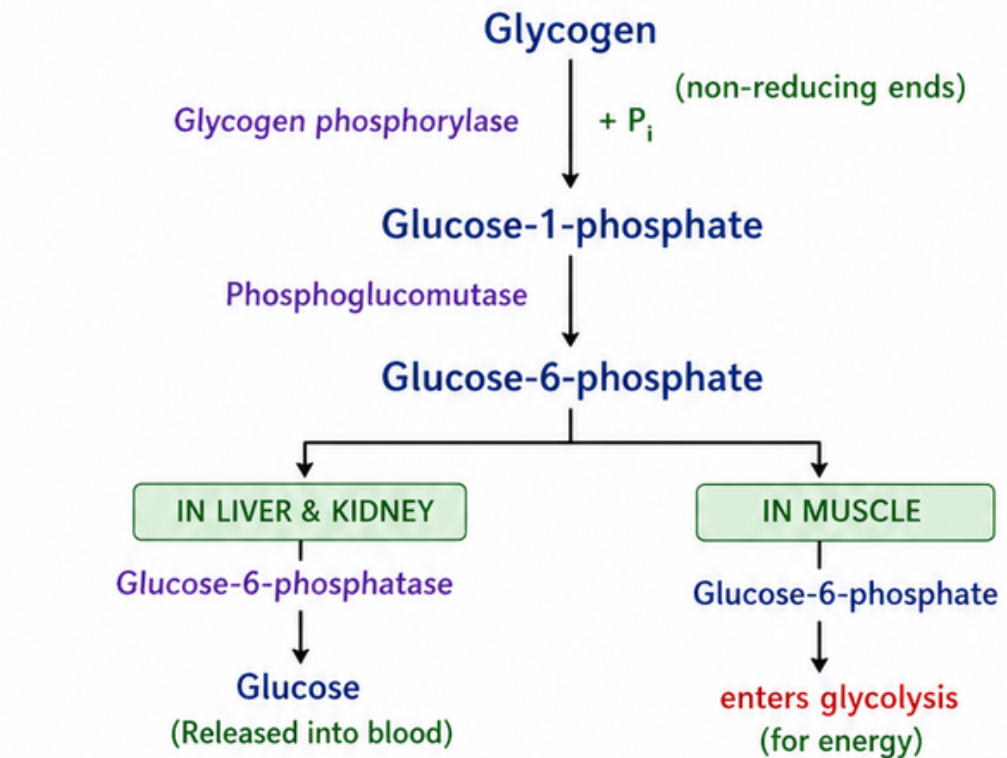
Liver & Muscles
(users)



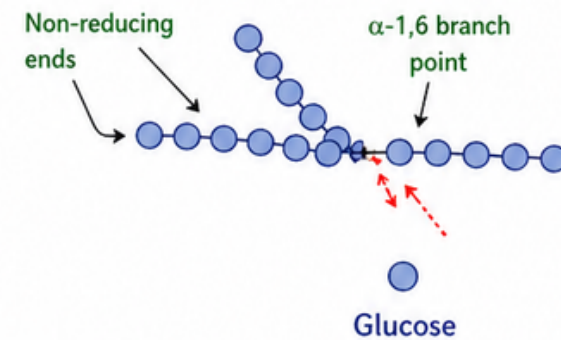
Glycogen House
(storage)

GLYCOGENOLYSIS

(Breakdown of Glycogen to Glucose)



BRANCH POINT (Debranching enzyme)



- 1 **4- α -Glucanotransferase** (Transferase)
Moves 3 glucose residues from branch to a nearby chain.
- 2 **Amylo-1,6-glucosidase** (α -1,6-glucosidase)
Hydrolyzes the remaining α -1,6-linked glucose $\rightarrow$ releases free Glucose.

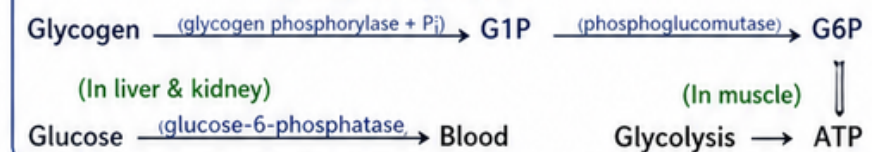
KEY POINTS (Corrected)

- Glycogen phosphorylase removes glucose residues as Glucose-1-phosphate (not glucose-6-phosphate).
- Phosphoglucomutase converts G1P $\rightarrow$ G6P.
- In liver & kidney, G6P is dephosphorylated by Glucose-6-phosphatase to free glucose.
- In muscle, G6P enters glycolysis (no glucose-6-phosphatase present).
- Debranching enzyme has two activities: transferase and α -1,6-glucosidase.

LEGEND

P_i = Inorganic phosphate
G1P = Glucose-1-phosphate
G6P = Glucose-6-phosphate

SUMMARY PATHWAY



Note: Sub-cellular site of glycogenolysis is CYTOSOL.

Difference Between Glycogenesis and Glycogenolysis

Feature	Glycogenesis	Glycogenolysis
Meaning	Formation of glycogen	Breakdown of glycogen
Purpose	Storage of glucose	Release of glucose
Main Hormone	Insulin	Glucagon / Epinephrine
State	Fed state	Fasting / Exercise
Key Enzyme	Glycogen synthase	Glycogen phosphorylase

Easy Memory Trick

Think of glycogen like a glucose bank:

- **Glycogenesis** = Putting glucose into the bank for storage.
- **Glycogenolysis** = Taking glucose out from the bank for energy.

Thank you!