

## week - 2

### Assignment 2: Role-based & Chain-of-Thought Prompting

- **Objective:** Learn role-based and step-by-step reasoning prompts.
- **Instructions:**
  1. Choose a task like “Explain how photosynthesis works.”
  2. Create a **role-based prompt**:
    - “You are a high school biology teacher. Explain photosynthesis to students in simple words.”
  3. Create a **chain-of-thought prompt**:
    - “Explain photosynthesis step by step, reasoning each step clearly.”
  4. Test both prompts and observe the difference in response detail and clarity.
- **Deliverables:** A table with prompts, model outputs, and short reflections.

### ROLE BASED PROMPT:

Prompt and output:

The screenshot shows a web browser window with a single tab titled 'ment analysis'. The address bar displays 'bdc7-b4c4f9d3b626'. Below the browser window, a chat interface is visible. The prompt, enclosed in a light blue bubble, reads: "You are a high school biology teacher. Explain photosynthesis to students in simple words." The response, in a white bubble, begins with "Here's how I'd explain it in a simple, high-school-friendly way:" followed by a detailed explanation of photosynthesis. The explanation includes a definition, a list of five bullet points detailing the process (leaves as tiny kitchens, intake of carbon dioxide and water, role of chlorophyll, conversion to glucose, and release of oxygen), and a summary line: "In short: Plants use sunlight + water + carbon dioxide → to make food (glucose) + oxygen." Below the response, there is a follow-up question: "Would you like me to also make a diagram-style explanation (like bullet arrows or a visual flow) that you". At the bottom of the chat window, there is a text input field with a plus icon and the placeholder text "Ask anything", along with microphone and voice recording icons. A small disclaimer at the bottom of the page states: "ChatGPT can make mistakes. Check important info. See [Cookie Preferences](#)."

ment analysis x +

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"You are a high school biology teacher. Explain photosynthesis to students in simple words."

Here's how I'd explain it in a simple, high-school-friendly way:

🌱 **Photosynthesis** is the process by which **plants make their own food** using sunlight.

- Think of leaves like **tiny kitchens**.
- The plant takes in **carbon dioxide (CO<sub>2</sub>)** from the air through small holes in its leaves.
- It also takes in **water (H<sub>2</sub>O)** from the soil through its roots.
- With the help of **sunlight** and a green pigment called **chlorophyll** (found in leaves), the plant changes carbon dioxide and water into **glucose (sugar)**, which is food for the plant.
- During this process, plants also release **oxygen (O<sub>2</sub>)** into the air, which we breathe.

📌 In short: **Plants use sunlight + water + carbon dioxide → to make food (glucose) + oxygen.**

↓

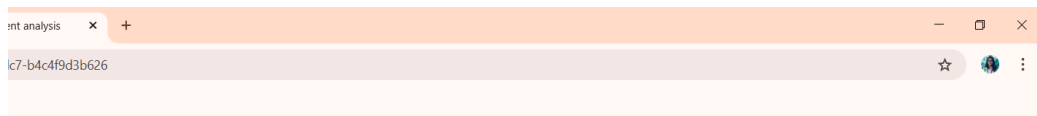
Would you like me to also make a **diagram-style explanation** (like bullet arrows or a visual flow) that you

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### CHAIN OF THOUGHT BASED PROMPT

Prompt and output:



"Explain photosynthesis step by step, reasoning each step clearly."

Thought for 15s

Here's a clear, step-by-step walkthrough with the *why* behind each step.

## Photosynthesis, Explained Step by Step

**Where it happens:** Inside chloroplasts.

- **Thylakoid membranes:** light reactions (capture sunlight, make ATP & NADPH).
- **Stroma:** Calvin cycle (use ATP & NADPH to build sugar).

### 1) Capture sunlight (Photosystems absorb photons)

**What:** Chlorophyll and other pigments in **Photosystem II (PSII)** and **Photosystem I (PSI)** absorb light; electrons in chlorophyll get excited to higher energy levels.

**Why:** Sunlight energy must first be converted into excited electrons—this is the starting "charge" that powers everything else.

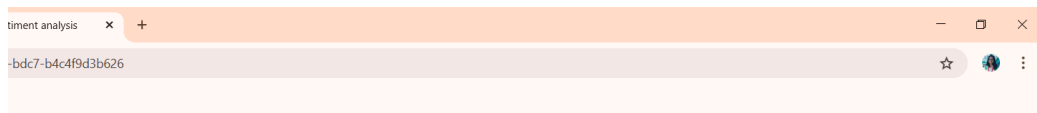


### 2) Split water (Photolysis) at PSII

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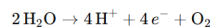


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### 2) Split water (Photolysis) at PSII

**What:** PSII pulls electrons from water:



**Why:** Replaces the electrons that PSII lost to light excitation and supplies protons ( $\text{H}^+$ ) to help build a proton gradient. Oxygen is released as a byproduct.

### 3) Energized electrons flow through an electron transport chain (ETC)

**What:** The excited electrons from PSII move through carriers (like plastoquinone, cytochrome complex, plastocyanin).

**Why:** As electrons move "downhill," the ETC uses their energy to **pump  $\text{H}^+$  into the thylakoid lumen**, building a proton gradient—like water behind a dam.

### 4) Make ATP by chemiosmosis (ATP synthase)

**What:** The high  $\text{H}^+$  concentration in the lumen flows back to the stroma through **ATP synthase**, which spins to make **ATP** from **ADP +  $\text{P}_i$** .



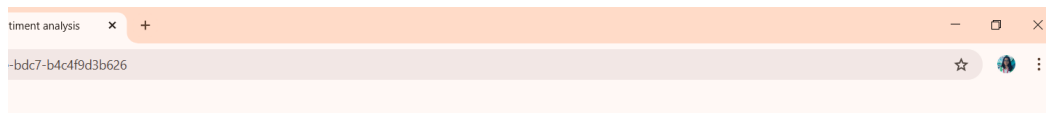
**Why:** ATP is the cell's "energy currency." The Calvin cycle will spend it to build sugar.

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### 5) Re-excite electrons in PSI and make NADPH

**What:** Electrons reaching PSI get re-energized by light and are passed to **NADP<sup>+</sup> reductase**, forming **NADPH** from **NADP<sup>+</sup> + H<sup>+</sup>**.

**Why:** **NADPH** is a high-energy electron carrier—essential reducing power to convert **CO<sub>2</sub>** into carbohydrates.

**End of Light Reactions:** Inputs—light, water, ADP, NADP<sup>+</sup>.  
Outputs—**O<sub>2</sub>**, **ATP**, **NADPH**.

### 6) Fix carbon dioxide (Calvin cycle—Phase 1: Fixation)

**What:** In the **stroma**, the enzyme **Rubisco** attaches **CO<sub>2</sub>** to **RuBP** (a 5-carbon sugar), making two molecules of **3-PGA** (3-phosphoglycerate).

**Why:** This step **incorporates inorganic CO<sub>2</sub> into organic molecules**—the first step in turning “air” into sugar.

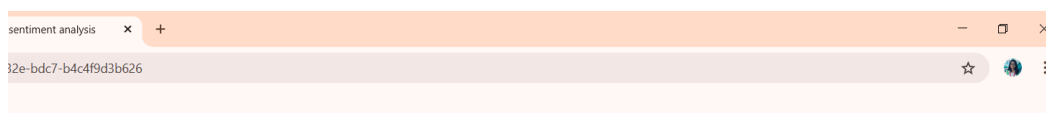
### 7) Reduce 3-PGA to G3P (Phase 2: Reduction)

**What:** **ATP** and **NADPH** from the light reactions convert 3-PGA into **G3P** (glyceraldehyde-3-phosphate), a higher-energy 3-carbon sugar.

**Why:** Adding energy (**ATP**) and electrons (**NADPH**) **raises the energy content** of the carbon skeleton so it can become glucose and other carbs.

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### 8) Regenerate RuBP (Phase 3: Regeneration)

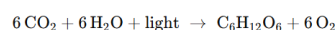
**What:** Most **G3P** molecules are recycled, using **ATP**, to remake **RuBP** so the cycle can continue capturing **CO<sub>2</sub>**. A small portion of **G3P** exits the cycle.

**Why:** **RuBP must be replenished**; otherwise **CO<sub>2</sub>** can't be fixed in the next round. The **G3P that exits** is the building block for **glucose, starch, cellulose**, etc.

### 9) Put it all together (Stoichiometry)

To net one molecule of **glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>)**, the Calvin cycle typically uses:

- **6 CO<sub>2</sub>, 18 ATP, 12 NADPH** (numbers vary slightly by accounting, but this is the classic estimate).
- Overall summary equation:

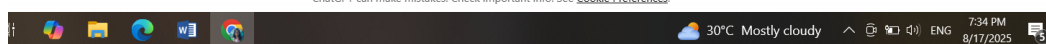


### 10) Why conditions matter (brief)

- **Light intensity & quality:** Drives the light reactions.
- **CO<sub>2</sub> availability:** Limits how fast the Calvin cycle can run.
- **Water:** Needed for electrons/H<sup>+</sup>; drought closes stomata, reducing **CO<sub>2</sub>** intake.
- **Temperature:** Affects enzymes like **Rubisco**; high heat can increase **photorespiration** (a wasteful side

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Observation Table:

Type	Prompt	Model output	Reflection
Role-based	You are a high school biology teacher. Explain photosynthesis to students in simple words.	Explained photosynthesis in everyday terms: leaves are like “tiny kitchens,” plants use sunlight, water, and CO <sub>2</sub> to make sugar (glucose) and release oxygen. Ended with a short equation.	Clear, simple, and student-friendly. Good for beginners since it avoids heavy jargon. However, it’s a surface-level explanation and doesn’t cover the steps in depth.
Chain-of-thought style prompt	Explain photosynthesis step by step, reasoning each step clearly	Provided a structured, detailed breakdown: light capture, water splitting, electron transport, ATP & NADPH production, Calvin cycle (fixation, reduction, regeneration). Included equations, why each step is needed, and conditions affecting photosynthesis.	Much more detailed and logical. Suitable for advanced high school or college-level students. Explains not just <i>what</i> happens but also <i>why</i> each step matters. Might be overwhelming for beginners but excellent for deeper learning.