

Introduction:

Worldwide, 2.37 billion people are unable to afford a balanced diet on a regular basis.¹ The world hunger problem is worsened by population growth and decrease in agricultural output due to factors like extreme weather. Hence, some scientists begin to turn to a more efficient mode of creating food, namely artificial synthesis of starch in a laboratory.

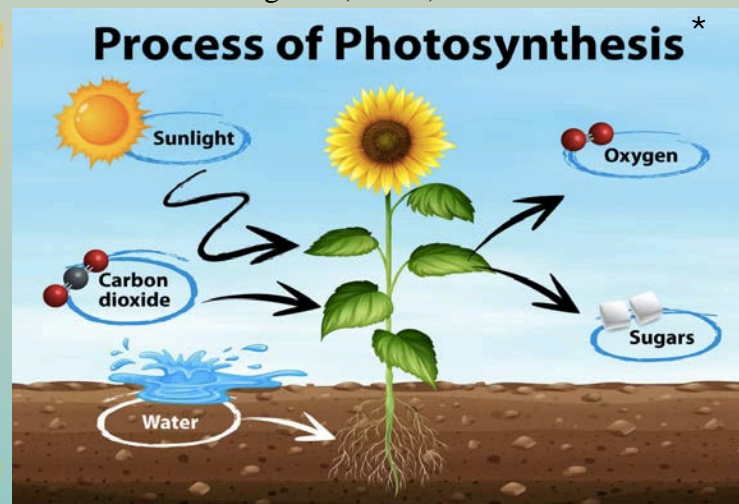
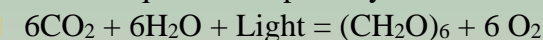
Principles behind traditional agriculture:

With suitable minerals in the soil, sunlight and water, crops like corn can be grown for its carbohydrate content to satisfy the nutritional needs of people. The plant crop converts light energy, carbon dioxide and water into glucose, which is then stored as starch (a form of carbohydrate)

This is achieved via two major stages in photosynthesis:

1. (Light dependent stage) The chlorophyll absorbs light energy and converts it and water into chemical energy.
2. (Light independent stage or the Calvin cycle) Carbon dioxide is converted into glucose with energy provided from the first stage.

Overall equation for photosynthesis:



Problems with traditional agriculture leading to world hunger:

- urban development
- degradation to the environment
- desertification

Starch from scratch- Zero Hunger!

Principles behind artificial synthesis of starch:

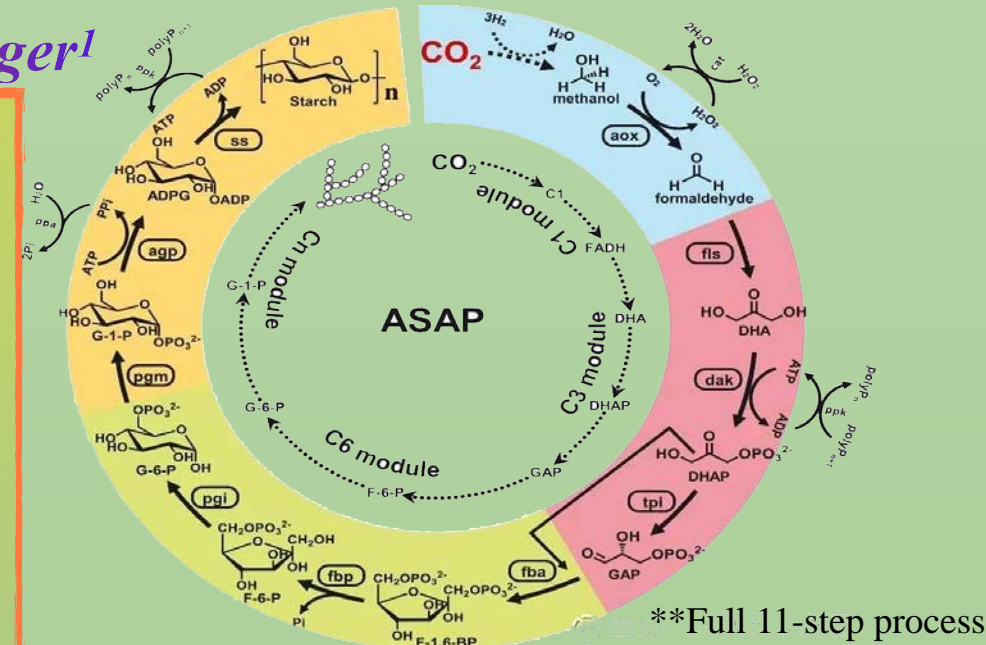
A team of Chinese scientists from the Tianjin Institute of Industrial Biotechnology discovered a way to convert carbon dioxide into starch artificially. Below are the four major stages in the 11 steps reaction:²

Step 1:
Transform carbon dioxide into methanol:
 $2\text{CO}_2 + 3\text{H}_2 \rightarrow \text{CH}_3\text{OH} + \text{H}_2\text{O}$

Step 2:
convert methane into a three carbon dihydroxyacetone (formaldehyde as intermediate product):
 $\text{CH}_3\text{OH} + \text{O}_2 \rightarrow \text{CH}_2\text{O} + \text{H}_2\text{O}_2$
 $3\text{CH}_2\text{O} \rightarrow \text{C}_3\text{H}_6\text{O}_3$

Step 3:
three carbon dihydroxyacetone is converted to a six carbon Fructose 6-phosphate ($\text{C}_6\text{H}_{13}\text{O}_9\text{P}$)

Further conversions into a series of complicated Cn organic molecules yield amylose and amylopectin (isomers with chemical formula $\text{C}_6\text{H}_{10}\text{O}_5$)_n, combining to form starch that are almost identical to starch found in plant crops such as maize (backed up by MRI scans)



Comparison between traditional agriculture and artificial synthesis of starch:

1. Traditional agriculture requires land with suitable nutrients and environment which is hard to come by:
 - eg. With only 10% of land being suitable for grain farming, China is responsible for feeding one fifth of the world population.³
 2. Traditional agriculture is threatened by climate change:
 - eg. Massive crop yield loss due to the flooding in Henan province in 2021⁴.
 - V.S. A laboratory for synthesis of starch which can be set up in the worst of climate conditions.
 3. The process of artificial synthesis of starch is much more effective than photosynthesis:
 - Artificial synthesis of starch requires 11 steps while photosynthesis requires 60 steps⁵.
 - The overall efficiency of artificial starch is 8.5 folds that of photosynthesis in crops like maize⁵.
- By substituting medical use starch with synthetic starch in the near future⁶ and even creating artificial food with synthetic starch in the far future (supplementing food crops for source of starch in meal replacements⁷), more food can be produced to combat world hunger.

References:

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- ** : See reference 2