Introduction to Anaerobic Biodigesters

UNIVERSITY of SOUTH FLORIDA

Objectives

Students will be able to…

- ★ Describe a sustainable energy choice and its impact on the environment by explaining the process of biodigesters
- ★ Explain how biodigesters contribute to a waste management system by describing the process of anaerobic digestion and its advantages

What does the cooking process look like for you?

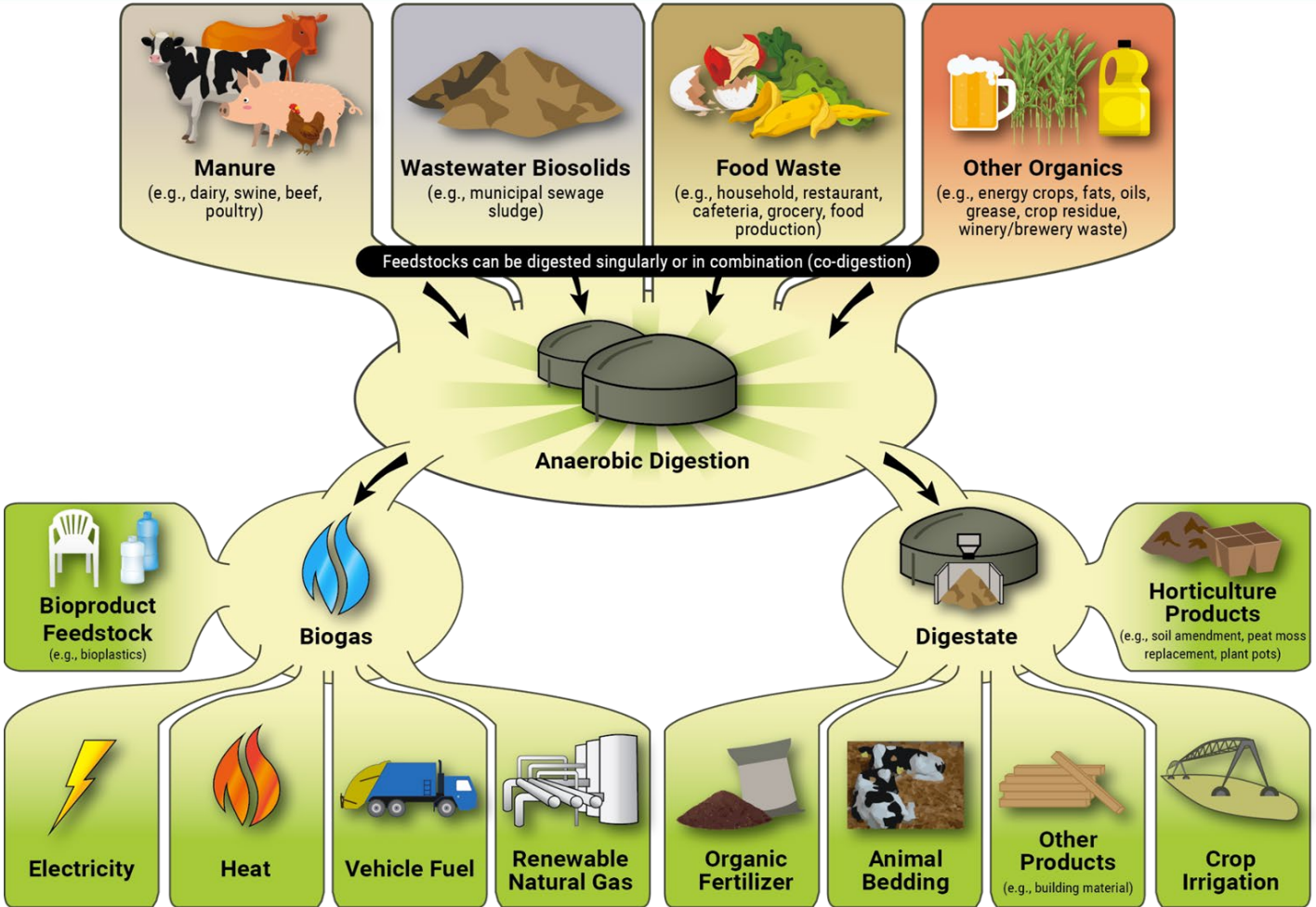
Energy sources from gas

Gas stovetop

Heater

Generator

Cogeneration plant


Manure
(e.g., dairy, swine, beef, poultry)
Wastewater Biosolids
(e.g., municipal sewage sludge)
Food Waste
(e.g., household, restaurant, cafeteria, grocery, food production)
Other Organics
(e.g., energy crops, fats, oils, grease, crop residue, winery/brewery waste)
Feedstocks can be digested singularly or in combination (co-digestion)
Anaerobic Digestion
Bioproduct Feedstock
(e.g., bioplastics)
Biogas
Digestate
Horticulture Products
(e.g., soil amendment, peat moss replacement, plant pots)
Electricity
Heat
Vehicle Fuel
Renewable Natural Gas
Organic Fertilizer
Animal Bedding
Other Products
(e.g., building material)
Crop Irrigation

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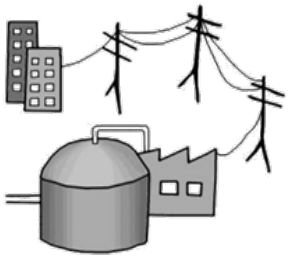
Types of Feedstock
Food waste
Sewage sludge
Wastewater
Livestock waste
Crop waste



Biogas Uses
Heat
Electricity
Cooking
Vehicle fuel

Digestate Uses
Fertilizer
Soil amendment
Livestock bedding

What is anaerobic digestion?

The breakdown of organic matter in an environment with no oxygen

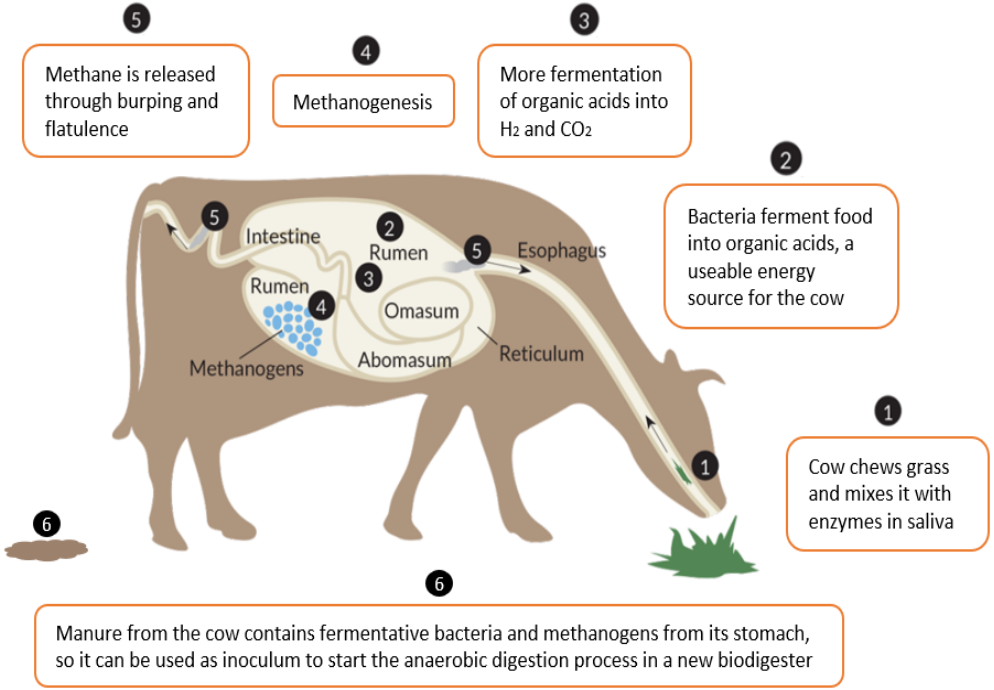
Organic waste → Energy

“an-” : without, no

“aerobic” : oxygen

organic matter: living or used to be living

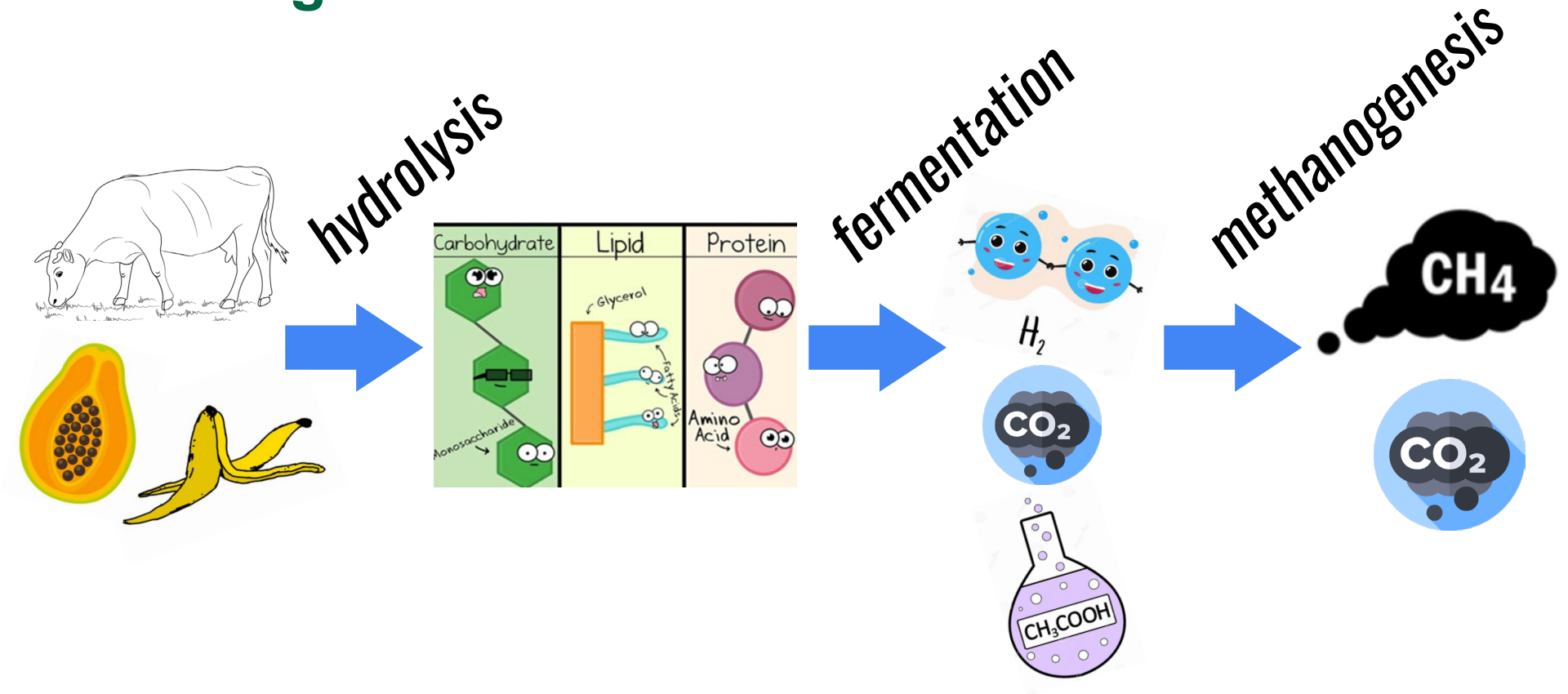
Microorganisms in Anaerobic Digestion



Natural sources of microorganisms are in cow and goat manure, or poop. (**inoculum** for anaerobic digestion)

Anaerobic conditions	No air should enter the system.
Inoculum	A solution with microorganisms to start the process, found in manure
Feedstock	Organic material, food for the microorganisms. Also called substrate
Biogas	The gas produced by anaerobic digestion, which is mostly made up of carbon dioxide and methane
Digestate	A high-nutrient product of anaerobic digestion

What goes in? What comes out?



What do these foods have in common?

Yogurt

Cheese

Bread

Pickles

How can Anaerobic Digestion solve problems?

Problem	**Solution**
Climate change caused by burning fossil fuels to create electricity	
Air pollution caused by cooking over a fire	
Poor sanitation - nowhere to put our human waste or food waste like kitchen scraps	
High cost and environmental damage of synthetic fertilizer	

How can Anaerobic Digestion solve problems?

Problem	**Solution**
Climate change caused by burning fossil fuels to create electricity	Use **anaerobic digestion** to produce clean energy without emissions
Air pollution caused by cooking over a fire	Use biogas, produced by **anaerobic digestion**, to cook instead of firewood
Poor sanitation - nowhere to put our human waste or food waste like kitchen scraps	Use waste as an input to the **anaerobic digester**, where it will be turned into valuable end products
High cost and environmental damage of synthetic fertilizer	Organic, nutrient-dense fertilizer is a product of **anaerobic digestion**

Let's look at **biogas uses** and **digestate uses** around the world…

Biodigesters around the world

China

Biodigesters around the world

Kenya: clean cooking in homes

Biodigesters around the world

South America: Sludge Treatment Plant

Biodigesters around the world

USA:
Sewage sludge digester

Biodigesters around the world

Costa Rica:
Biodigester in a tubular reactor

Benefits of using anaerobic digestion

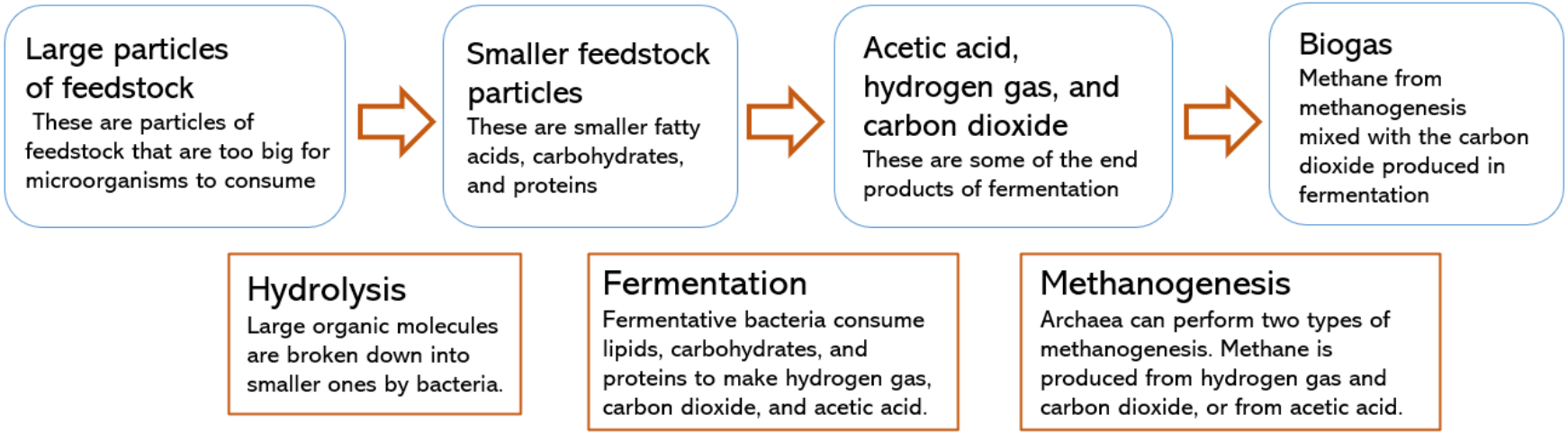
- Processing human waste and other organic waste
  - Minimizes odors and potential pathogens
  - Low energy is required than in aerobic digestion, since no aeration or air flow is needed
- Produce useful biogas
  - Vehicle fuels (cars, buses), electricity generation, cooking, or heating a home
- Producing nutrient-rich digestate
  - cheaper and better for the environment than synthetic fertilizer

Disadvantages of using anaerobic digestion

- The biodigester must operate correctly to keep the microbes happy
  - Correct amount of feedstock
  - No chemicals or heavy metals in the feedstock
- Some biodigesters need more monitoring
  - Correct temperature, pH, water content
  - Biogas must be burned - methane is a greenhouse gas
  - Leaks in the biodigester or gas pipes could harm air quality or water supply

Biodigester: How does it work?

Microorganisms like bacteria and archaea carry out chemical processes, converting feedstock particles into biogas. Digestate is also left over - it is the undigested food waste and the dead microorganisms.



Small-Scale Biodigester Model

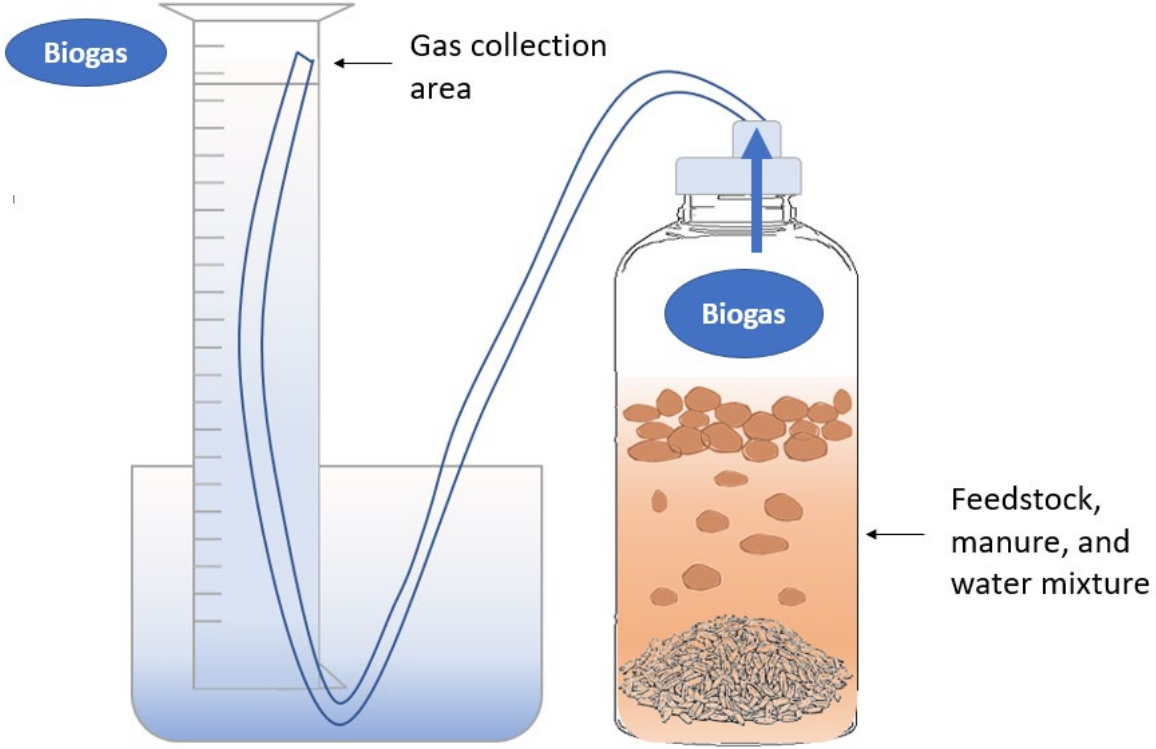
Biogas ($CH_4 + CO_2$)

Food Waste (substrate)

Goat Manure (Inoculum)

Digestate (fertilizer)

Small-Scale Biodigester Model

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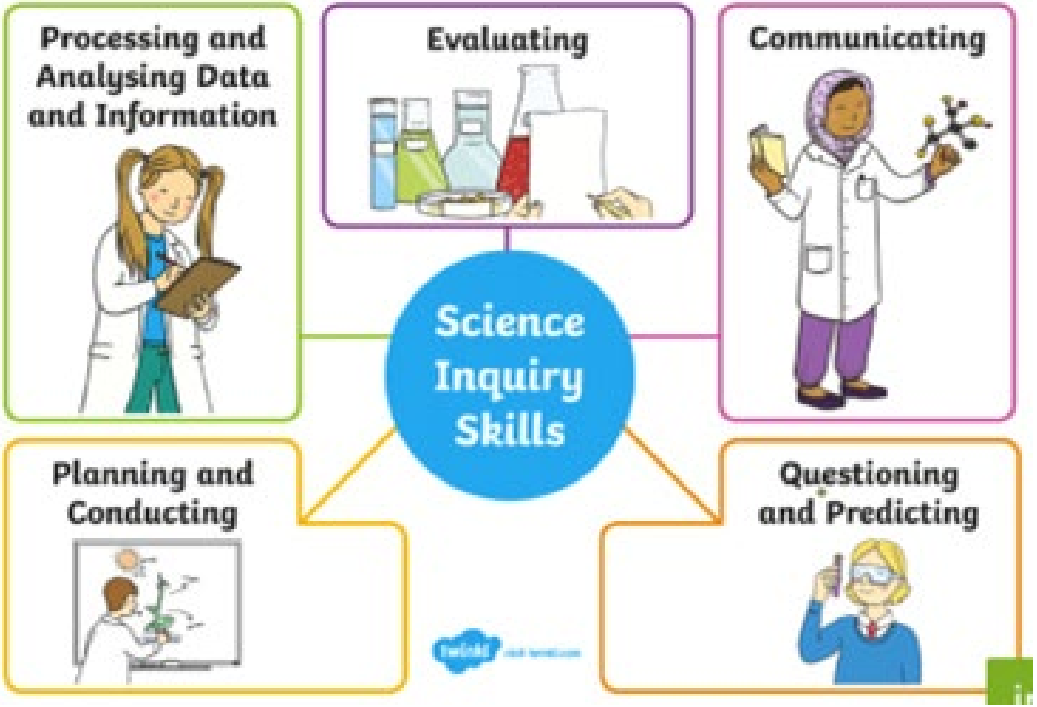
Science Process Skills



In this project, we will:

- Learn about biodigesters
- Form a hypothesis
- Build an experimental setup
- Take measurements
- Analyze data
- Share results

Questions?

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