BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024,
Tamil Nadu, India.

Programme: M.Sc., Marine Biotechnology

Course Title : Marine Biotechnology

Course Code: 21EC3a

Unit-I
Marine Bioenergy

Dr. S. Rajakumar
Associate Professor

Marine BioEnergy

•Marine BioEnergy is developing an open ocean cultivation system for macroalgae biomass. The macroalgae, giant kelp, is one of the fastest growing sources of biomass, and the open ocean surface water is an immense, untapped region for growing kelp.

kelp : *any of various large marine brown algae that are large seaweeds (order Laminariales) growing in cool waters.*

•However, kelp needs nutrients that are only available below the thermocline or near shore, but not at the surface.

•An build inexpensive underwater drones that will tow long-lines, to which the kelp is attached.

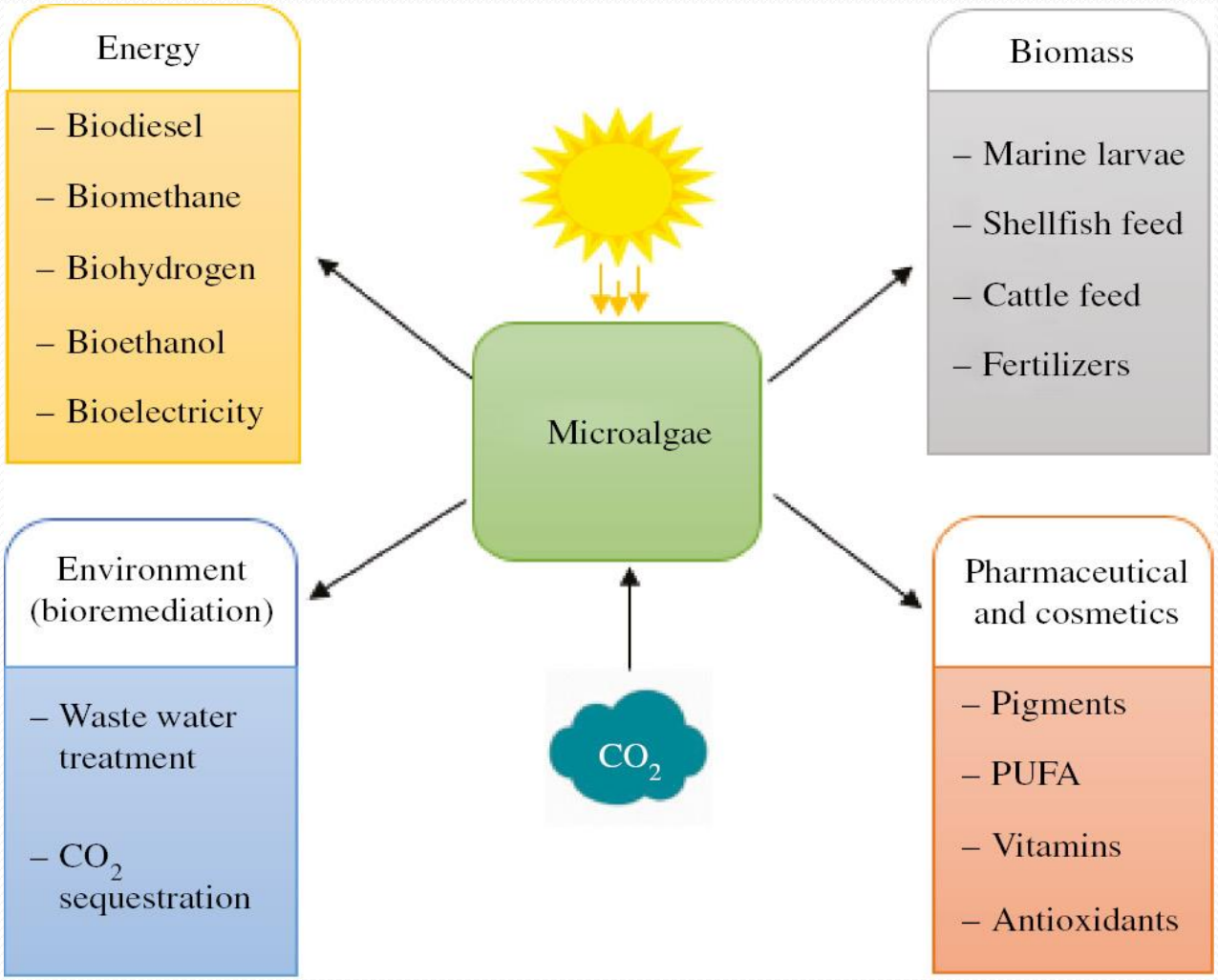
•These drones will tow the farms from sunlit-rich surface water during the day to nutrient-rich deeper water during the night, and will submerge to avoid storms and passing ships.

•Working with researchers at the University of Southern California, Marine BioEnergy, Inc has developed and deployed first-of-kind technology to assess this unique concept of depth-cycling kelp.

• The depth-cycled kelp produced 4x more biomass when compared to the controls located adjacent to a native kelp bed.

•To replace 10% of liquid fuels currently consumed in the U.S., Marine BioEnergy needs 220,000 square kilometers under cultivation.

•This is the size of Utah. There is room in the Pacific Ocean for 705 “Utahs.”



Algal based Bio Energy

The interest of microalgae in this context appears for several reasons:

•Microalgae cultures are characterized by **very high growth rates**;

•Microalgae constitute a **biomass rich** in lipid, carbohydrates and also renewable proteins, thus non-fossil, and transformable by chemical means into fuels.

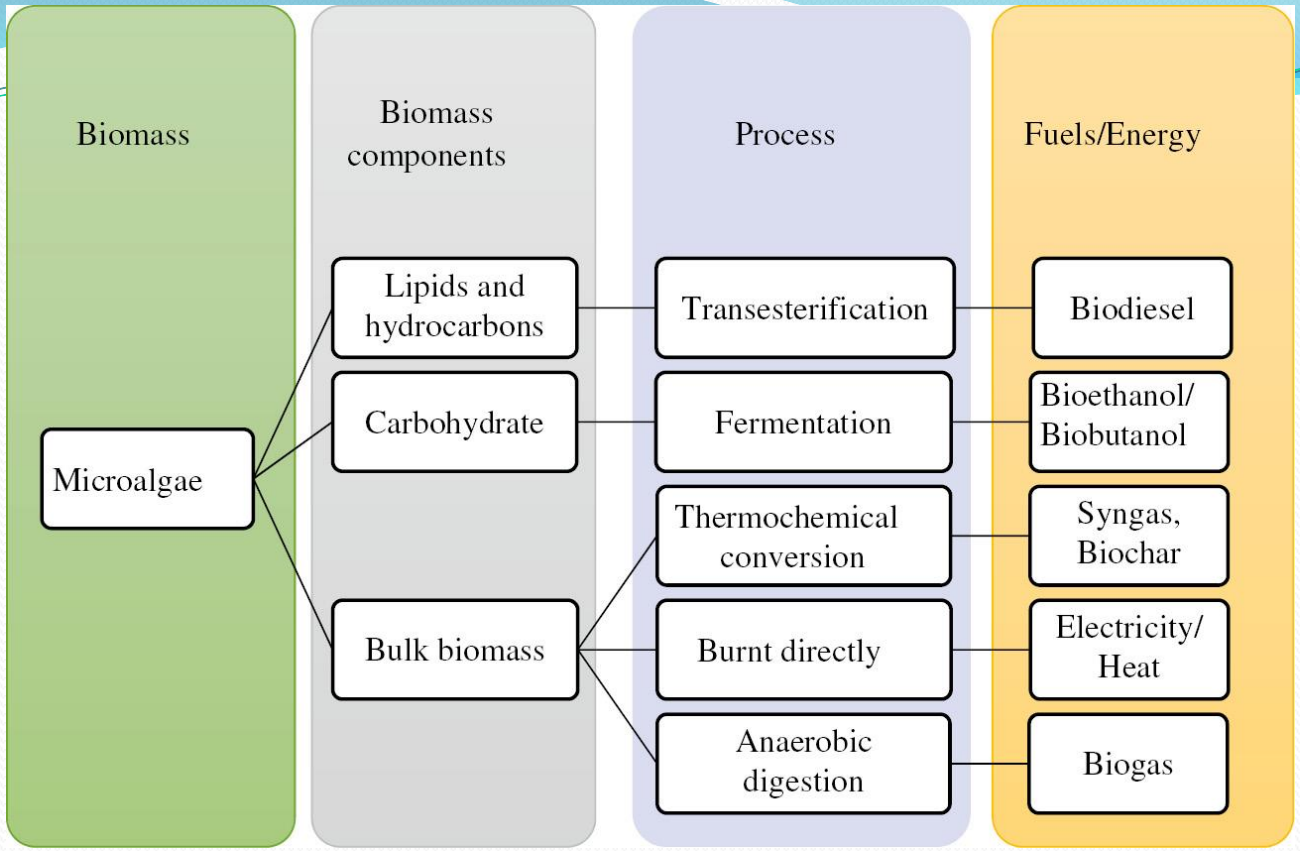
•The **consumption of CO_2** for their culture.

•At present, it can be said that after the development of **agrofuels (first generation) produced from maize or sugarcane** and ***second-generation biofuels obtained by converting lignocellulose***, the **conversion of microalgae into biofuels is a third generation** whose interest must be confirmed.

• Microalgae have achieved remarkable attention as a sustainable feedstock for production of biofuel in answer to the depletion of fossil fuels reserves, revolutionary energy crisis, and climate change.

•Unfortunately, micro algal based biofuels production does not satisfy the economic aspects related to costs of extraction and operations in Indian context.

•To promote the overall socioeconomic impacts, an advanced microalgae bio-refinery model are evaluated with the production of broad range valuable products delivery.



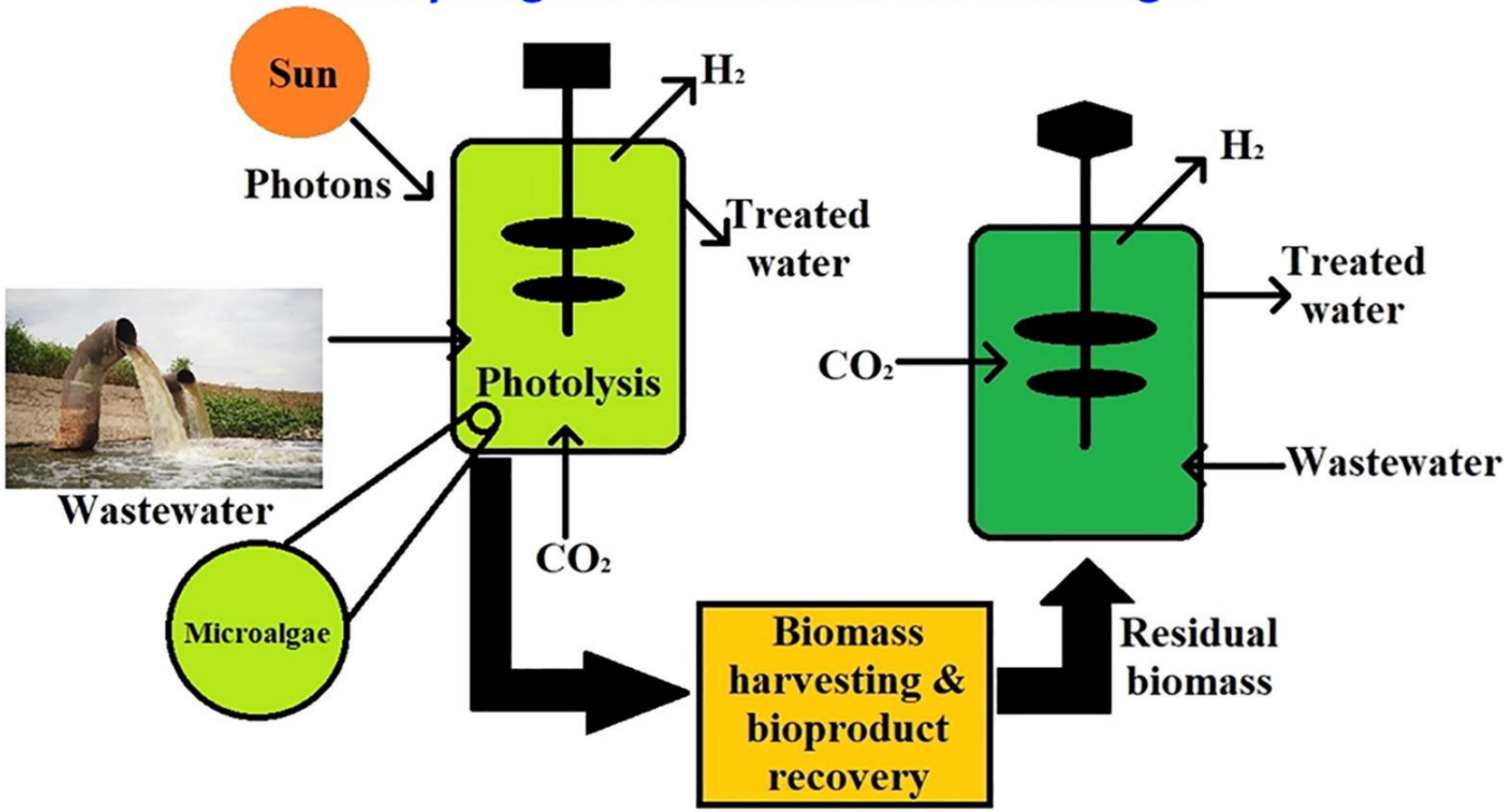
https://www.degruyter.com/document/doi/10.1515/reveh-2018-0052/html

•Since microalgae are perennial along with **excellent tolerance towards pH changes, their current demand is skyrocketing**.

•The generation of biohydrogen, biomethane, and bioelectricity using microalgae as the primordial constituents, gains most attention.

- **Biohydrogen production using microalgae:**
  - Biohydrogen, a highly attractive energy source, has the potential to supersede conventional fuels, as its conversion yields pure water as a by-product and thus provides us with an opportunity to eliminate the problems currently caused by conventional fuels like petrol.
  - Greenhouse gases (GHG) like carbon dioxide and methane are produced by the burning of conventional fuels like petrol, which contributes to increasing global warming at an alarming rate.
  - Hence using biohydrogen as an alternate

Biohydrogen Production from Microalgae



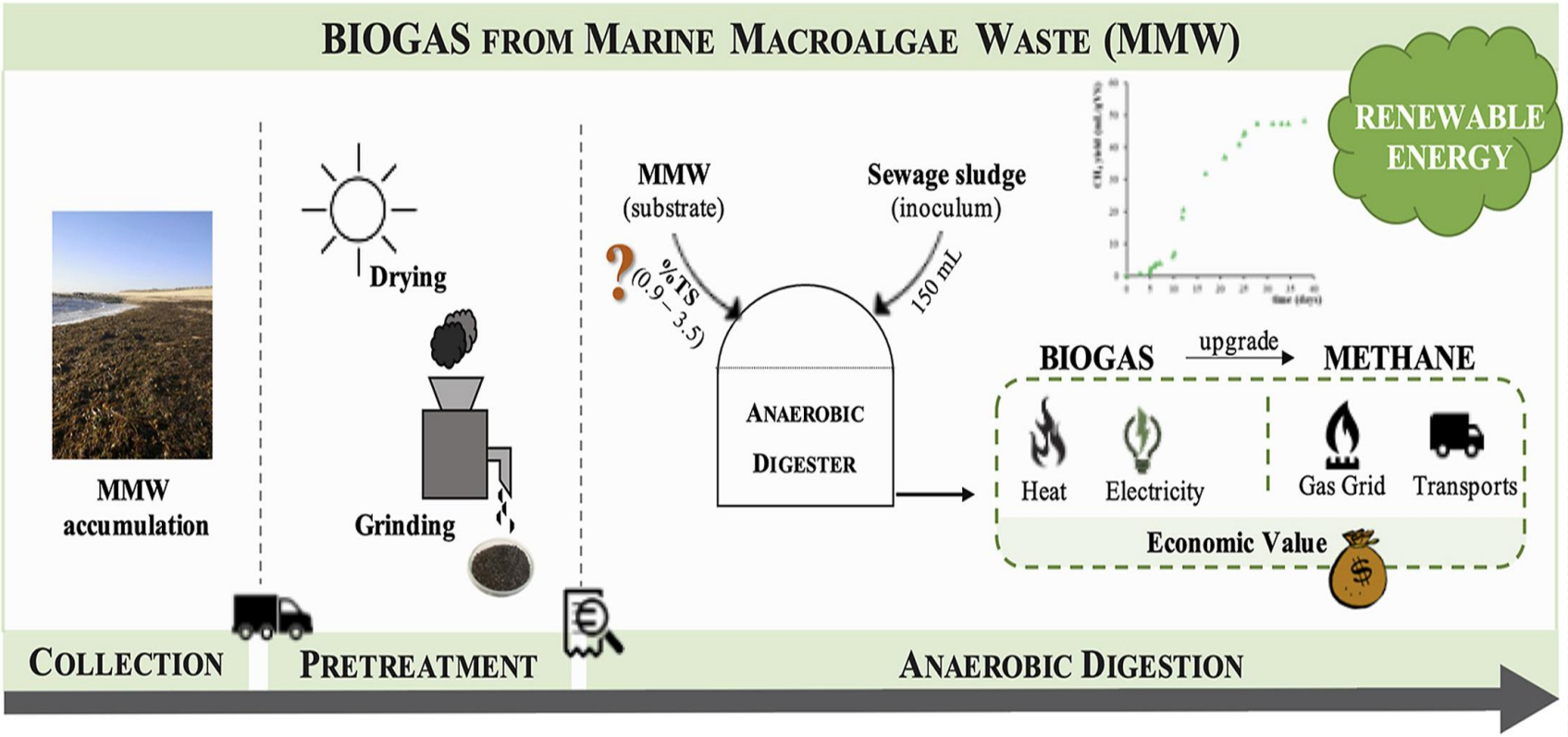
•Biomethane production using microalgae

•Biomethane is a renewable and versatile fuel produced mainly by the anaerobic digestion of biomass.

•Biomethane is one of the major sources of methane, having negligible amounts of carbon dioxide thus it can be considered the cleanest biofuel known to us.

•Biogas (Natural Gas) containing carbon dioxide and methane is upgraded by eliminating carbon dioxide and increasing the concentration of biomethane to make it commercially viable.

•Biomethane has the potential of lowering the stress on fossil…


BIOGAS FROM MARINE MACROALGAE WASTE (MMW)
RENEWABLE ENERGY
MMW accumulation
Drying
Grinding
MMW (substrate)
Sewage sludge (inoculum)
% TS (0.9 – 3.5)
150 mL
ANAEROBIC DIGESTER
BIOGAS
upgrade
METHANE
Heat
Electricity
Gas Grid
Transports
Economic Value
COLLECTION
PRETREATMENT
ANAEROBIC DIGESTION

•Bioelectricity production using microalgae

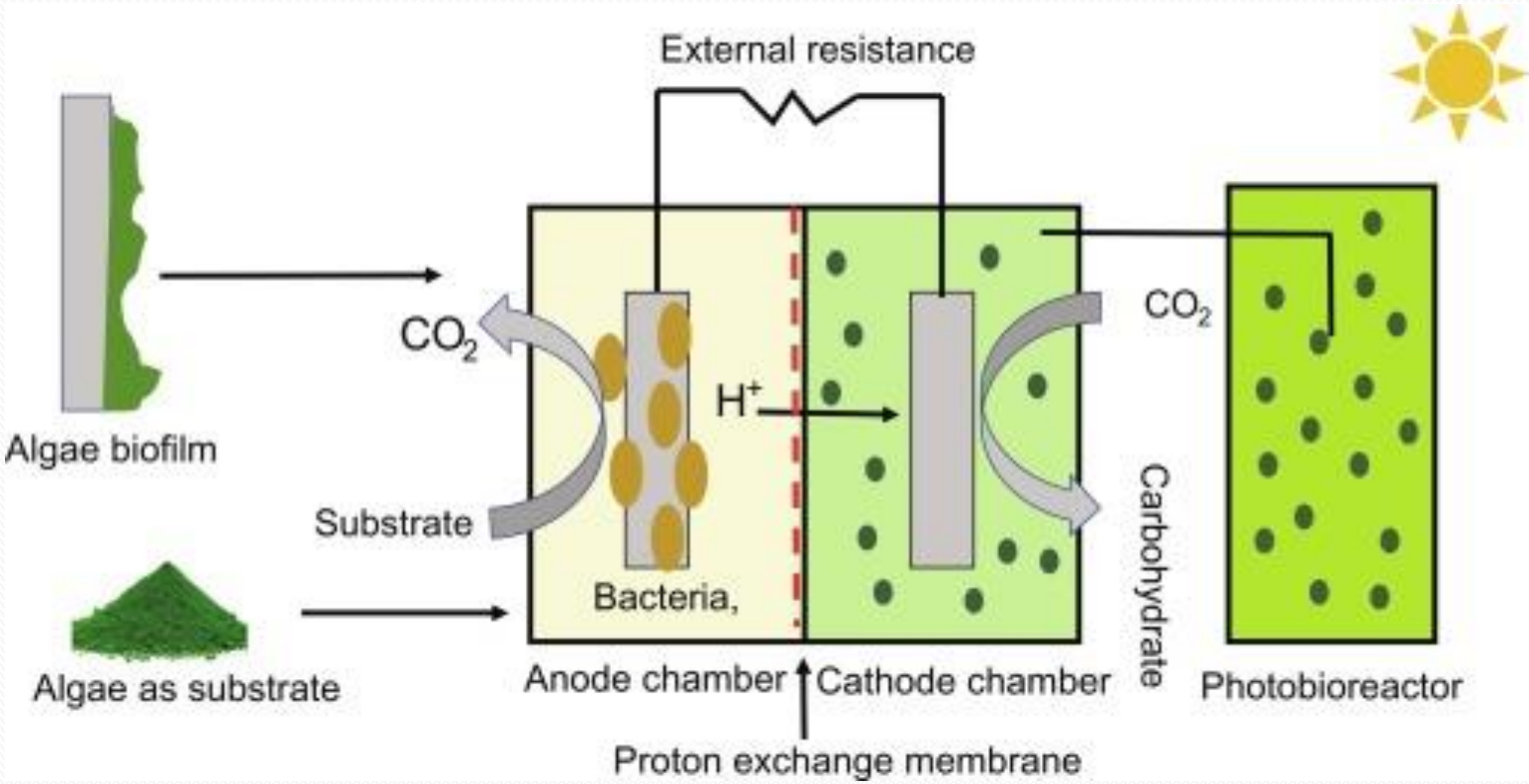
•Photosynthetic microbial fuel cells (PMFCs) are an efficient and sustainable approach to simultaneously generate bioelectricity,

•Since a few decades ago, the need for energy has been growing, forcing us to explore for alternate energy sources.

•The fast use of these fossil fuels has also contributed to a number of other issues, such as rising pollution, global warming, etc., which collectively have made it uncertain if future generations will be able to survive.

•The necessity to discover and adopt new clean and green energy sources has once again been highlighted by the mounting strain that our planet's fossil fuel

•**Bioelectricity production using microalgae**



•Bioethanol production using microalgae

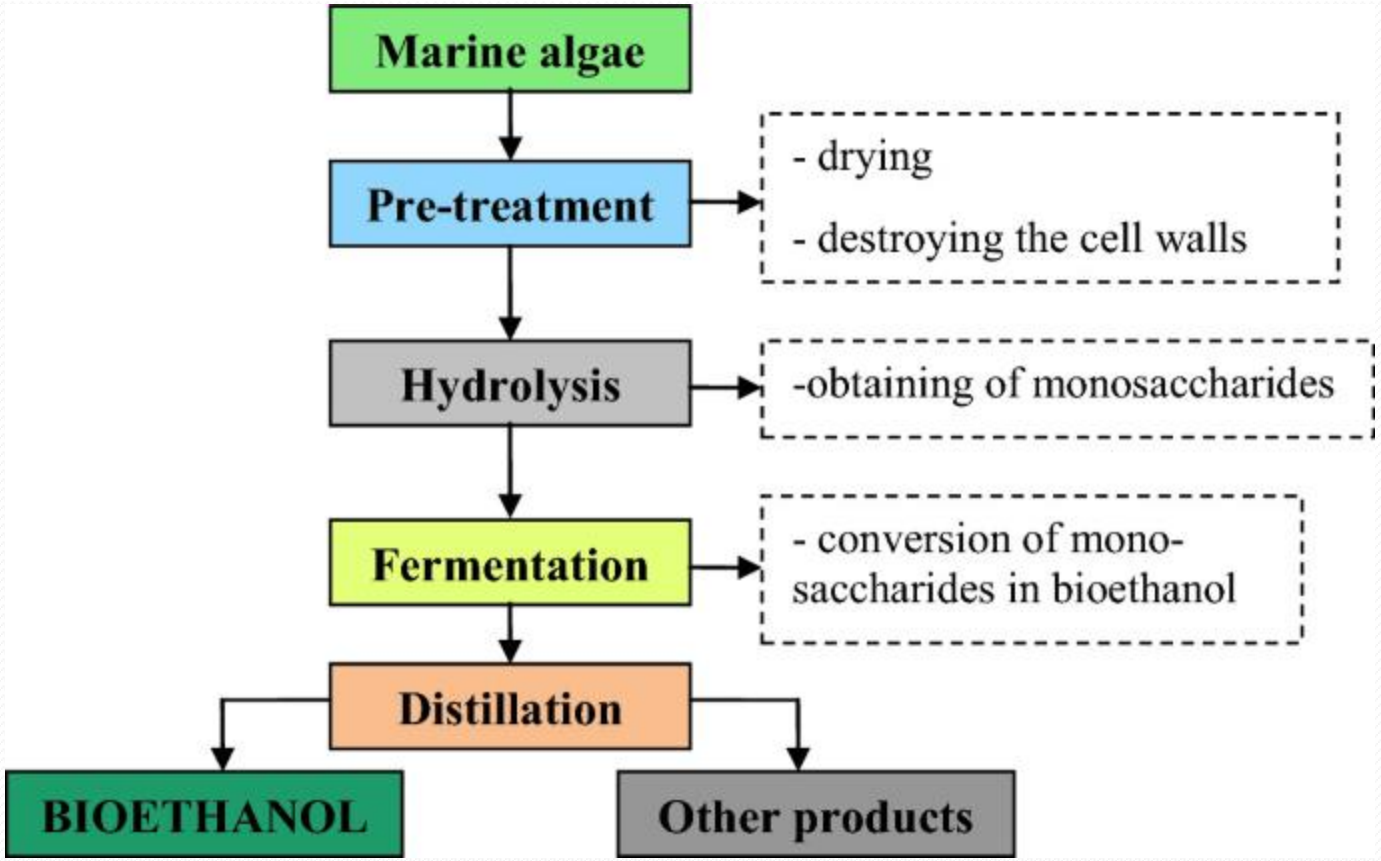
•Ethanol is made chemically from ethylene or fermented from a variety of biomass sources.

•Ethanol, a colorless transparent liquid, is used as a solvent in medicine, cosmetics, cleaning supplies, and chemistry, as well as a fuel in cars, and is produced by the synthesis of various organic compounds.

•Because it is bio-based and renewable, bioethanol made from biomass is a viable alternative to bioethanol made from fossil fuels.

•It may be used in the engine either directly or in a proportionally…..

•**Bioethanol production using microalgae**



•**Bioreactors for the production of algal biomass**

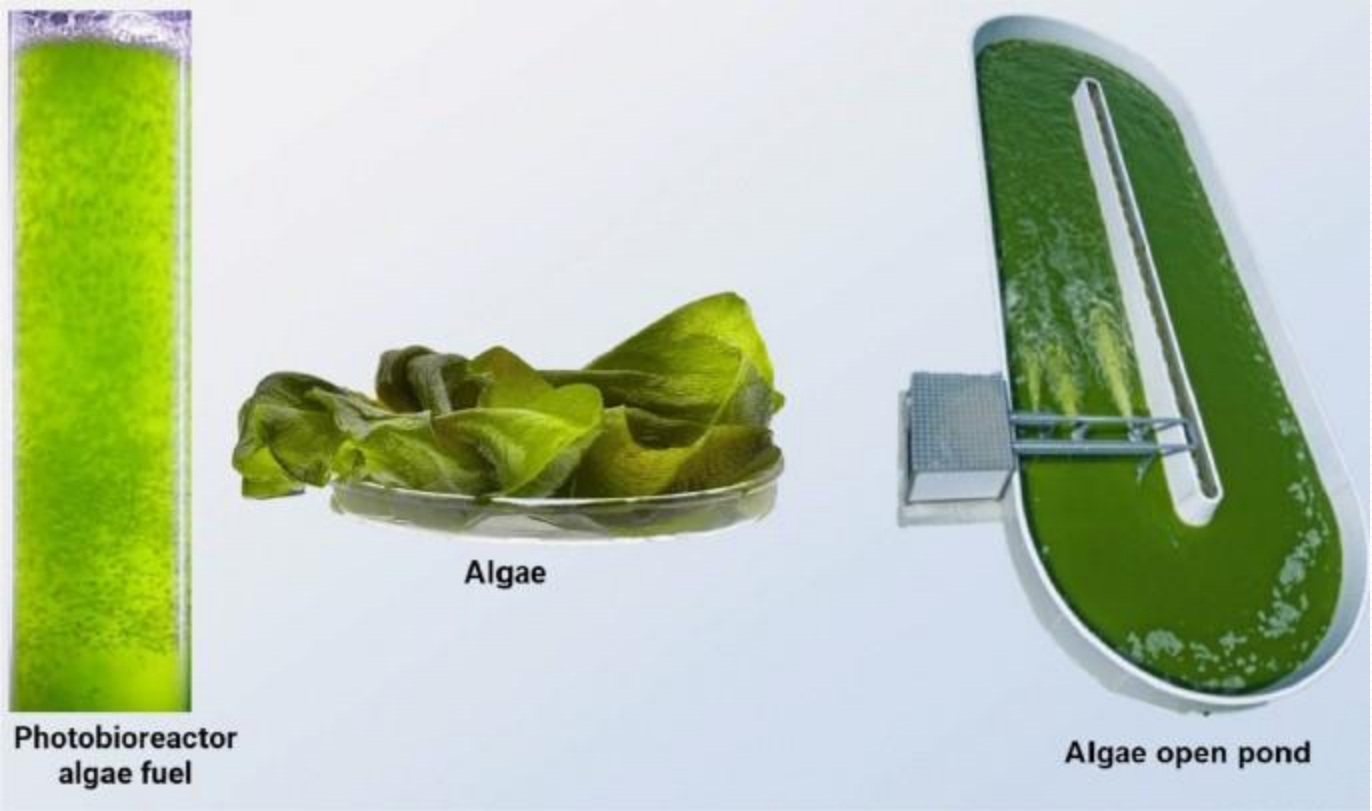
•Photobioreactors (PBRs) are the most common systems for large-scale production of algal biomass.

•Due to the high cost of construction and operation, closed systems are mostly used for the production of high-value products.

•Some processing parameters such as nutrient supply can easily be controlled in a closed reactor.

•Solar radiation is more difficult to regulate. In dense cultures, a large number of cells impede light penetration and absorption. This phenomenon is known as **“self-shading.”.**

•**Bioreactors for the production of algal biomass**



Marine Biodiesel

•Marine microalgae are currently considered to be **one of the most promising alternative sources for biodiesel** (Sheehan et al. 1998).

•Their high photosynthetic rates, often ascribed to their simplistic unicellular structures, enable microalgae **not only to serve as an effective carbon sequestration platform but also to rapidly accumulate lipids in their biomass** (up to 77% of dry cell mass).

•Even using a conservative scenario, microalgae are still predicted to produce about 10 times more biodiesel per unit area of land than a typical terrestrial habitats

•The majority of biomass used for biofuel production is from terrestrial sources.

•The increasing energy demand for public transport and the rise in oil prices are an intensifying interest in using green fuel for a sustainable future.

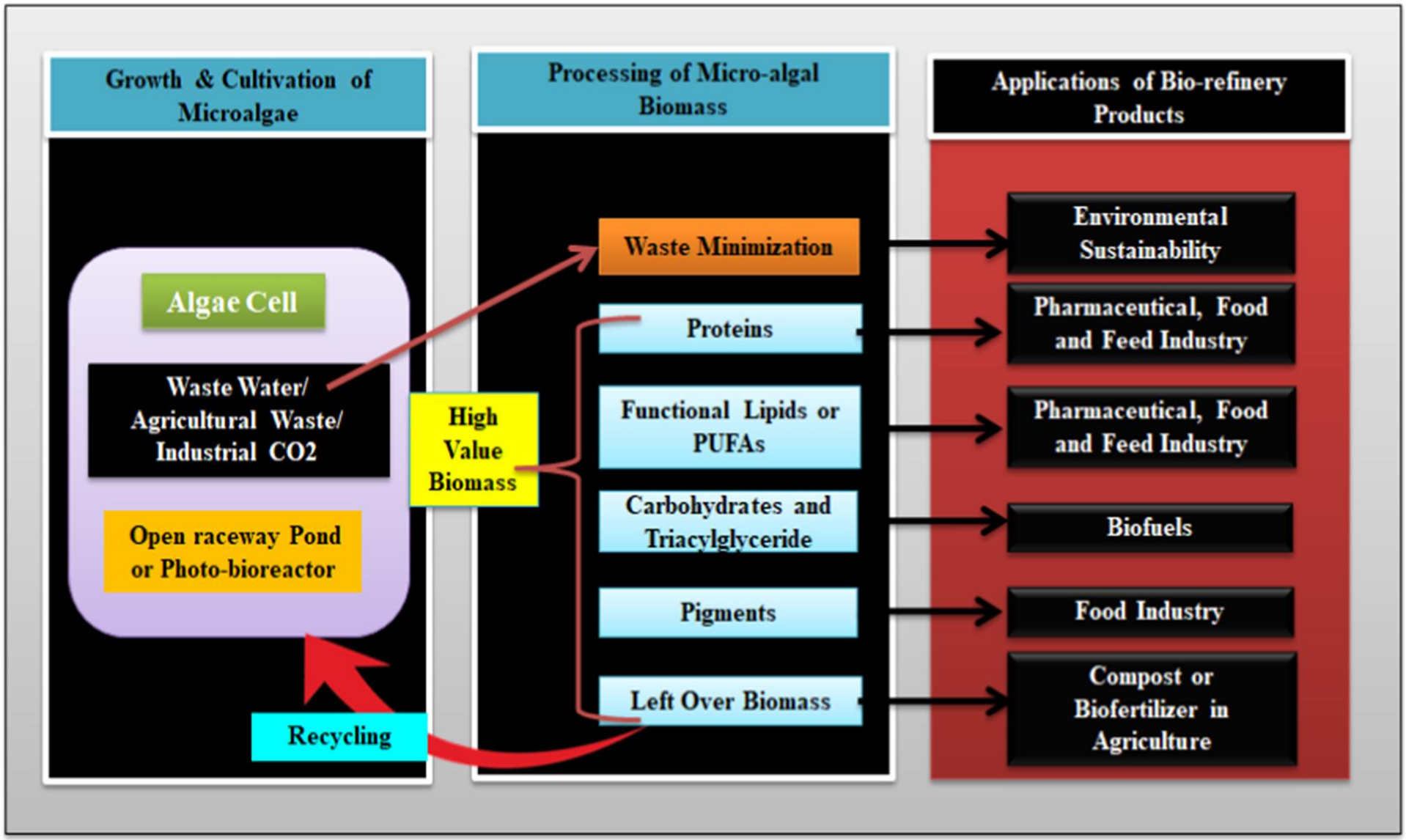
•The most common biofuels are ethanol produced from corn or sugarcane and biodiesel produced from a variety of oil crops such as soybeans and oil palm.

• Another potential type of biomass is marine biomass, which has the additional benefit.

•Microalgae are considered as one of the promising and potential biorefinery candidates to obtain biodiesel from high saturation triglycerides, bio-alcohols from the carbohydrate fraction and dietary products such as omega-3 and omega-6 from PUFAs.

•These products have numerous applications in fuels, food, and pharmaceutical industries .

•In addition to this, microalgae reproduce as renewable source of biomass and reflect rapid growth, decreased competition with food and feed industry, decreased environmental consequences, high product delivery, waste minimization and management etc.



Concept of bio-refinery using microalgae.

Reference:
https://globalresearchonline.net/journalcontents/v34-2/35.pdf

End of Slide

Thank You