Using Microalgae as a Platform to Study

Culture Techniques
Isolation of an Intracellular Product (oil)
Conversion of Extracted Oil to Biodiesel

BIOMAN 2013
Intermediate Track

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Microalgal Products

- Biofuels
  - JP-8 fuel
  - methane
  - removal of nutrients and metals
  - clean water
  - sequester/scrub CO₂
- Algae
- Food Additives
  - protein
  - omega fatty acids
  - antioxidants
  - animal feed
- High Value Products
  - biofertilizer
  - pharma- and nutraceuticals

The diagram illustrates the various products and applications of microalgae (Algae).
Structure of a Microalga

*Chlorella sp.*

Beal C., Mayer C., and Romanovicz D., 2010, University of Texas at Austin.
Structure of a Microalga – At the Membrane

- Cell wall
- PL Bilayer
- Lipid droplet
- A phospholipid: Phosphatidylcholine
  - Choline
  - Phosphate
  - Glycerol
  - Fatty acids
- Glycerol
- Palmitic acid (16:0)
- Oleic acid (18:1)
- Linolenic acid (18:3)

Other compounds:
- Cellulose
- Lignin-like compounds
- Algic acid
Structure of a Microalga – At the Membrane

A phospholipid
Phosphatidylcholine

Fatty acids

Glycerol

Choline

Phosphate

Biodiesel

Glycerol

Methyl esters of three fatty acid molecules

Triglyceride

Palmitic acid (16:0)
Oleic acid (18:1)
Linolenic acid (18:3)

Glycerol
Structure of a Microalga

Chlorella sp.

Beal C., Mayer C., and Romanovicz D., 2010, University of Texas at Austin.
Structure of a Microalga – Light Harvesting and Photoprotection

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• Carotenoids suppress damaging photochemical reactions, particularly those including oxygen, that can be induced by bright sunlight.
Algae Targets

• fatty acids and hydrocarbons – refine into biodiesel and gasoline

• carotenoids – nutraceutical products

• carbohydrates
  • food additives
  • ethanol

• protein – animal feed supplement

• biomass
  • methane
  • syngas
  • biofertilizer
Growth Systems

Algae Phototrophic Growth Scale-up
*density 200mg/L – 2 g/L

Algae Heterotrophic Growth
*density 2 g/L – 150 g/L
Biomass Scale-up

Metabolite Analysis + Engineering Support = Product and Process Optimization

Product Extraction and Biocrude Production

value-added products
biocrude

Biocrude Production Unit
University of Texas Product Recovery Unit
University of Texas Algae Concentration Unit
Today’s Lab – Establishing and scaling up a microalgae culture

1. Acquiring algae
2. Starting a 500ml culture in a photobioreactor
3. Monitoring growth kinetics (dry cell weight, spectrophotometry to measure chlorophyll, microscopy)
4. Troubleshooting (competing algae, predators, bacteria)
5. Transferring a starter culture to a working scale 2L photobioreactor system
6. Examining the effects of light quality on the accumulation of high-value products