



RENEWABLE & SUSTAINABLE  
ENERGY STUDIES



Stellenbosch University  
SOUTH AFRICA

# ***Genetic Engineering (GM) and Biofuels Production***

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**Johann Görgens**

## ***Content***

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- ◆ Context: Bio-energy production
- ◆ What is Genetic Engineering (GM)?
- ◆ Applications of GM
- ◆ GM in biofuels production

## ***Types of Bio-Energy***

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### **1. Electricity**

Major CO<sub>2</sub> emitter in SA

Lots of interest in renewable energies: Solar, wind, biomass (IPPs)

### **2. Transportation**

Second only to electricity as CO<sub>2</sub> emitter in SA (Sasol)

Liquid fuels have high energy density (MJ/kg storage)

SA has industrial biofuels strategy

### **3. Low quality thermal energy (heat)**

Unsuitable for electricity production

Industrial/domestic applications

## ***Biomass for Energy***

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### **◆ “First generation” crops**

– Vegetable oils, starch grains, sugar

– Food and non-food crops

### **◆ Lignocellulosic biomass (“second generation”)**

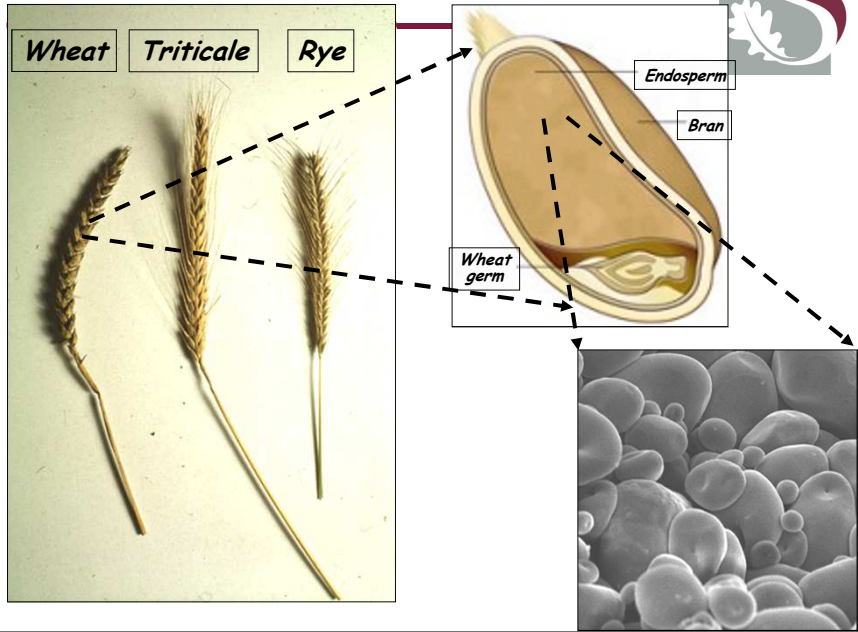
– Pulp wood, timber, construction

– Residues and energy crops

### **◆ Municipal solid waste**

### **◆ Algal biomass (“third generation”)**

## Starch crops



## Lignocellulose sources



maize stover



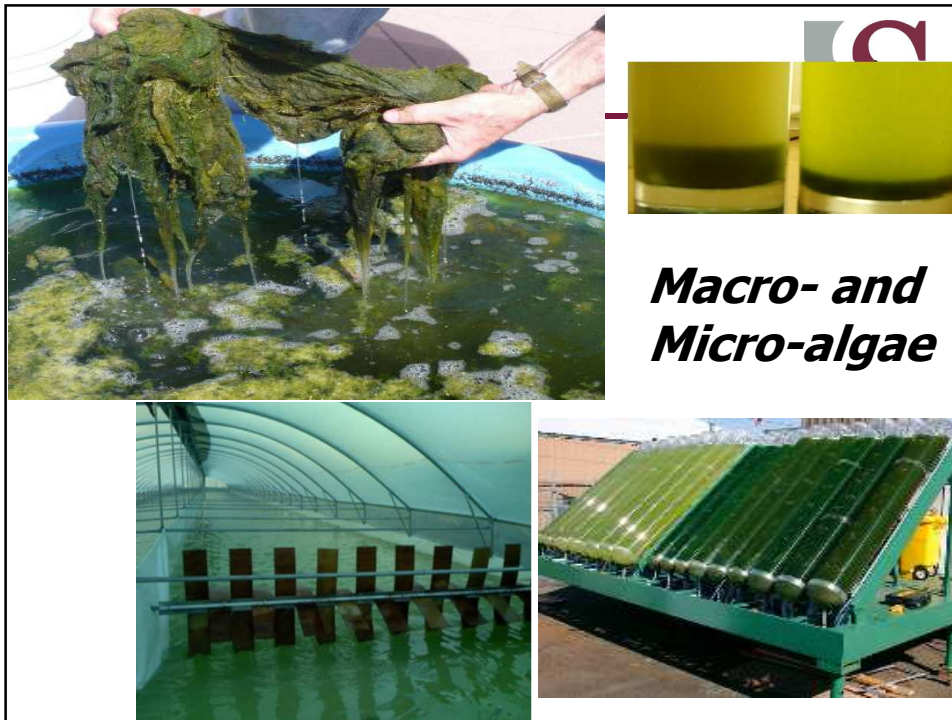
bagasse



woodchips



Miscanthus as energy crop



## ***Macro- and Micro-algae***

## ***What is GM?***



- ◆ Classical breeding (“crossing”)
  - Intra-species method of genetic manipulation that is based on selection of preferred traits in crosses between genetically distinct versions of the same species
  - Performed with plants, animals, microbes for centuries; DNA manipulated inside of living cells
- ◆ “Genetic engineering (GM)” is manipulation of DNA outside of living cells, since early 1980’s
  - Allows transfer of genetic material between completely different types of organisms (commonality in DNA structures)
    - » Inter-species transfer of genetic material
  - Allows creation of completely new genes/proteins for inclusion/production in living organisms
  - Can be done with plants, microbes, animals (GMOs)

## ***Examples of GM Applications***

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- ◆ Production of insulin for diabetes
  - GM yeast produces human-like insulin to replace porcine (pig) insulin
  - All insulin produced/used in the world for +25 years has been produced with GMOs
- ◆ Human vaccines by producing viral proteins in microbes
  - Hepatitis B: Efficacy and cost; +25 years
  - Human papillomavirus (HPV): Only technical option
  - Proteins do not contain viral DNA and are therefore inactive

## ***Examples of GM Applications***

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- ◆ Mainstay of GM technology has been pharma
  - 25% of new pharmaceutical products are from GMOs
  - Mainstay of GM technology has been pharma
  - Stringent clinical testing (7 years) and monitoring after release of pharmaceuticals and vaccines produced with GM technology
  - Extensive proof of safe GM technology; products injected into blood stream
- ◆ Production of industrial enzymes
  - 90% of products from GMOs
  - Use in washing powder, food products, textiles, etc.

## Examples of GM Applications



- ◆ Most controversial application of GM has been in food production
  - Engineering new traits into food crops
  - Concerns over safety of GM technology, etc.
- ◆ Key discussion point: Control of food crop distribution by companies supplying GM crops
  - GM technology allows widespread patent protection of innovations in the engineering of food crops
  - Comparison of commercial strategies of GM crops with non-GM crops protected by breeder rights

## GM in Biofuels Production



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