Building a Biotechnology Workforce to Address Climate Change

Introducing Claflin University’s Online Degree Program for a Master’s of Science in Biotechnology to address Climate Change

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Claflin University
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We have some Big Problems ahead of us...
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Expected evolution of drought differs by region in Africa, with the most affected areas in the north and south.

Share of decade spent in drought, † %

Today 2030 2050

Based on RCP 8.5
We have some Big Problems ahead of us...

Expected evolution of drought differs by region in Africa, with the most affected areas in the north and south.

--- drought will affect food supply
Increasing Food Insecurity

*Drop in cereal productivity*

- Models predict 30% rise in price
Countries with high levels of hunger are often also highly vulnerable to climate change, and have a low capacity to adapt.

- price spikes leave the poorest households (urban poor & rural food-buyers) most vulnerable,
- with the urban poor spending up to 75% of their total budget on food alone
Studies show that higher CO₂ reduces protein, zinc, and iron content of crops.

By 2050:

~175 million more people could have zinc deficiencies (more susceptible to illnesses)

~122 million more people could be protein deficient.

Communities relying largely on plant harvests for their nutrition will feel this most acutely.
Projections on Zinc deficiencies worldwide:

- Biofuels - metabolic pathway design - fermentation
- Genetically Engineered Crops - Drought resistance - Heat tolerance
- Emerging Diseases - identify / sequence

- Hits African countries hardest
Climate Change Impacts:

Crops grown in high-drought areas that are then moved into humid storage facilities are vulnerable to fungal infections or pests.
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-These are Targetable by Biotechnology
Nutritional Quality of Food Decreases

Cereal and forage crops show lower protein concentrations under elevated CO$_2$ conditions.
Nutritional Quality of Food Decreases

Cereal and forage crops show lower protein concentrations under elevated CO$_2$ conditions

→ This is targetable by Biotechnology
Benefits of Biotechnology

Biotechnology can:
• increase the crops yield through introducing high-yielding varieties resistant to biotic and abiotic stresses;
• reduce pest– associated losses; and
• increase the nutritional values of foods which is a very important factor in rural areas or developing countries.
Biotechnology landscape controlled almost exclusively by:

- the private sector
- large corporations / agribusiness
- defined by patent protection
Most of us hope that when the real climate crisis comes,

*Some Scientific Discovery Will Save Us*
Plan for Biotech Workforce Development

We Need to Train those Scientists now

In Africa...

In Asia...

Everywhere...
Plan for Biotech Workforce Development

We Need to Train those Scientists now

Build a Biotechnology workforce
That has the skills to meet the challenges in 20 years
Target Skills for Workforce Development

- Genetic engineering of crops to withstand drought
- Development of Bio-fuels & sustainable energy production
- Vaccine & therapeutics development, drug design
- Biotechnology in Environmental Management
Master of Science In Biotechnology for Climate Change

A Masters of Science Degree Program specifically designed to teach how to use the science of Biotechnology to mitigate/adapt to the impacts of Climate Change

→ Will be the only Biotechnology program that targets climate change!
Master of Science In Biotechnology for Climate Change

Masters of Science Degree Program specifically designed to teach how to use the science of Biotechnology to mitigate/adapt to the impacts of Climate Change.

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Biggest Concern with Online Biotech Courses

• No Hands-on scientific experience
Biggest Concern with Online Biotech Courses

• Hands-on scientific experience
• Teach Fully in Virtual Reality in year 3
• Full Biotech Laboratory in VR
We have high expectations

Teaching & Learning in “XR”
Course Delivery

• Fully Online
  - available EVERYWHERE
  - available this August (2022)
  - Easy to use Learning Management system + Zoom

• Asynchronous
  - optional synchronous lectures / activities

(Lectures will be presented synchronously and recorded for asynchronous learners)
The Students We Are Recruiting:

US and International graduates with a Bachelors of Science Degree in Biology, Chemistry, Environmental Science or related field.

Full time or Part time

Inclusive of all genders and nationalities
Program Structure

10 Courses (30 Credit Hours)

+ Capstone Project
Introduction to Climate Change

Keystone course
taken in the 1st semester
3 Credit Hours

Create a common understanding of modern climate change
- Set the stage for each of the other courses
Genetic Engineering

Advanced molecular biology techniques including

gene cloning

gene modification

CRISPR gene editing
Protein Structure & Design

Throughout the course, various protein structures are explored
- active sites detailed
- structure-function relationships explored

- Proteins may be selected from other courses in the curricula
## Plant Biotechnology

<table>
<thead>
<tr>
<th>Measure</th>
<th>Biotechnology</th>
<th>Application</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change mitigation:</td>
<td>Engineering herbicide resistance to reduce spraying</td>
<td>GM soy beans GM canola</td>
<td>Fawcett and Towery, 2003; Brimmer et al., 2004; Kleer et al., 2008</td>
</tr>
<tr>
<td>Reduced use of fertilizer</td>
<td>Engineering nitrogen fixation</td>
<td>Genetic improvement of <em>Rhizobium</em>; inducing N-fixation to non-legumes</td>
<td>Zahr, 2001; Yan et al., 2008</td>
</tr>
<tr>
<td>Carbon sequestration</td>
<td>Green energy</td>
<td>GM energy crops</td>
<td>Lybert and Summer, 2010</td>
</tr>
</tbody>
</table>

| Adaptation to biotic and abiotic stresses | Molecular marker-assisted breeding for stress resistance | GM Arabidopsis, Tobacco, maize, wheat, cotton, soybean | Hong et al., 2000; Jaglo et al., 2001; Yamanouchi et al., 2002 |
| Engineering drought tolerance | Engineering salt tolerance                   | Drought resistant Pearl millet GM tomato, rice   | Hsieh et al., 2002; Jaglo et al., 2001; Zhu, 2001 |
Food Security
Emerging Diseases

Global Examples of Emerging and Re-Emerging Infectious Diseases

- Antimicrobial-resistant threats
  - CRE
  - MRSA
  - *C. difficile*
  - *N. gonorrhoeae*
- H3N2 influenza
- Cyclosporiasis
- *E. coli* O157:H7
- Measles
- Human monkeypox
- Listeriosis
- Bourbon virus
- 2009 H1N1 influenza
- Adenovirus 14
- Anthrax bioterrorism
- Chikungunya
- Hantavirus pulmonary syndrome
- Human African trypanosomiasis
- West Nile virus
- Enterovirus D68
- Powassan virus
- *E. coli* O104:H4
- Cryptosporidiosis
- Ebola virus disease
- Drug-resistant malaria
- Diphtheria
- MERS-CoV
- Aichmota virus
- Rift Valley fever
- Typhoid fever
- SFTSV bunyavirus
- *E. coli* O157:H7
- H1N1 influenza
- H7N9 influenza
- H5N1 influenza
- SARS
- Nipah virus
- Hendra virus
- Enterovirus 71
- Human monkeypox
- Ebola virus disease
- HIV
- Plague
- Zika virus

Newly emerging
Re-emerging/resurging
“Deliberately emerging”
Students present a detailed Scientific Proposal to use a biotechnological application to mitigate a specific Climate Change related problem.

Proposal must address indigenous regulations, policies, and politics.

This proposal may be done independently or in partnership with a program professor, home institution, industry sponsor, or in conjunction with their current employer if applicable.
<table>
<thead>
<tr>
<th>Semester</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Fall I</td>
<td>Introduction to Climate Change</td>
<td>3</td>
</tr>
<tr>
<td>Fall I</td>
<td>Genetic Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Fall I</td>
<td>Research Ethics</td>
<td>2</td>
</tr>
<tr>
<td>Spring I</td>
<td>Emerging Diseases</td>
<td>3</td>
</tr>
<tr>
<td>Spring I</td>
<td>Protein Structure, Function, &amp; Design</td>
<td>3</td>
</tr>
<tr>
<td>Spring I</td>
<td>Plant Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>Fall II</td>
<td>Mitigation of Climate Change</td>
<td>3</td>
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<tr>
<td>Fall II</td>
<td>Data Science</td>
<td>3</td>
</tr>
<tr>
<td>Spring II</td>
<td>Environmental Policy &amp; Management</td>
<td>3</td>
</tr>
<tr>
<td>Spring II</td>
<td>Food Security &amp; Safety</td>
<td>3</td>
</tr>
<tr>
<td>Spring II</td>
<td>Capstone Experience</td>
<td>1</td>
</tr>
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Ambitious Goals

- Lectures & Labs in XR (Year 3)
- Modules for hands-on laboratories & simulations
- Virtual Worlds, Landscapes, Habitats, & Climate affected areas
Admission Requirements

B.S. in Biology, Chemistry, Environmental Science or related disciplines
Min 3.0 GPA
Official Transcripts
TOEFL or IELTS in cases where official language is not english
300-500 Word essay
Resume or CV
Three letters of recommendation
Claflin University

U.S. News and World Report Best Colleges 2022 Rankings

Top 10 Best HBCU
– Ranked among 78 HBCUs, however, Claflin is the #1 HBCU in South Carolina.

3rd Best Top Performers on Social Mobility
– Institutions who advance social mobility by enrolling and graduating large portions of disadvantaged students awarded Pell Grants.

Visionary Leadership
Mentoring leaders, problem solvers, & agents of change
What Sets Claflin Apart

As an HBCU We Excel in Pedagogy

- Especially for non-traditional learning styles
- Research based methods in Teaching & Learning
- Know How to foster inclusive environments
  - Social justice
- Experience with a worldwide audience
Enrollment Projections

20 Students in first year
40 students second year (2x20 student cohorts)

Cost to students:
$1,000/credit hour

Projected Revenue:
$340,000 1st yr  $600,000/yr after 1st
Thank You!

Questions?
Certificate of Expertise in Use of Biotechnology for Applications
For Climate Change

For successful completion of 12 hours of courses
Partnership with Africa University

Builds on a Partnership with Africa University in Zimbabwe

Multiple Exchange Visits to and from Africa University in STEM
Multiple Collaborative Activities between CU and AU
  - Seminars
  - Workshops
  - Research Projects

Commitment to providing students for the Online Masters Program

→ Provided a seed grant of $35,000 for course development & animations