Developing And Implementing Course Embedded Undergraduate Research Experiences (CUREs)

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GAME CHANGING

Georgia Gwinnett College
School of Science & Technology

Aims Of This Session

- Background
- CUREs
- Impact
- Successes & challenges
- Discussion

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Models of Undergraduate Research

- **Traditional:** Independent study
  - Selected students

- **CURE:** Course embedded Undergraduate Research Experience
  - Large number of students
  - Builds research skills
  - Builds confidence to do independent research.

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GGC's Model for Undergraduate Research

The 4YrURCE model: 4-year Undergraduate Research & Creative Experience

All **STEM majors participate in research and creative activities** ***all 4 years*** **of their undergraduate career.**

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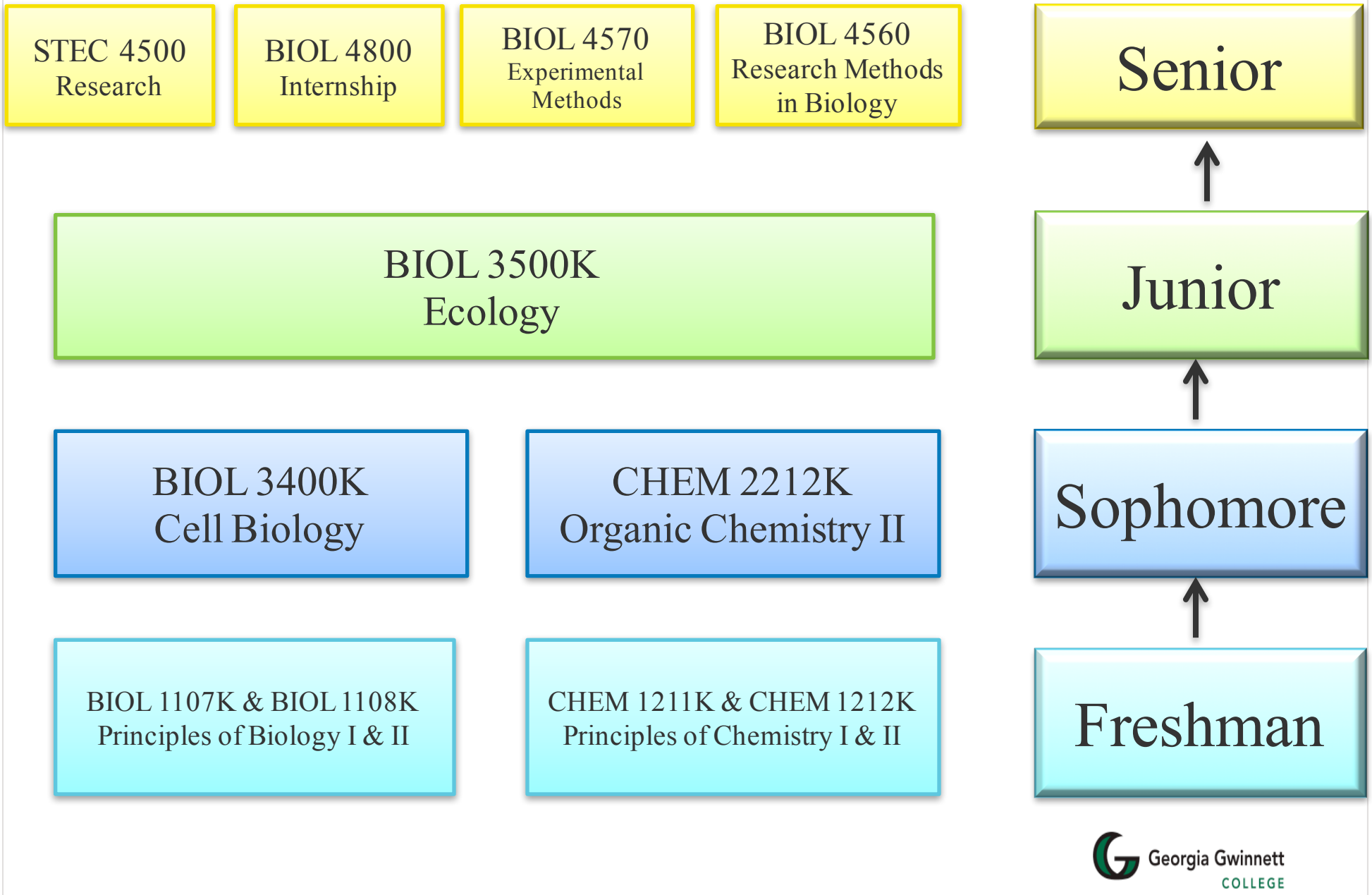
The 4YrURCE model: General Biology Track



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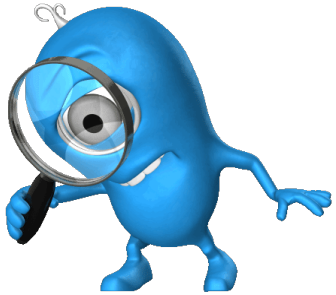
Research & Creative Experiences

- Research is novel to the students
- Multiple research experiences build problem solving & critical thinking skills
- Build confidence for faculty mentored research
- Graduate with STEM skills and competencies



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Developing and Implementing CUREs

- Funding from USG STEM Initiative II
- **Internal Mini-grant Program**
- Encouraged faculty buy-in to redesign courses
- Stimulated faculty to be innovative and creative in designing CUREs
- Incentivized faculty to get involved in STEM SoTL

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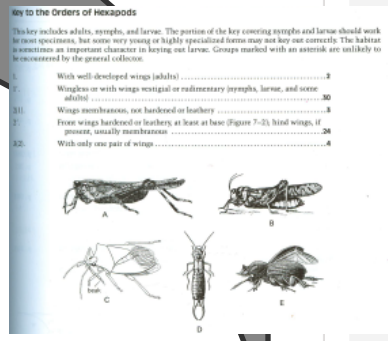
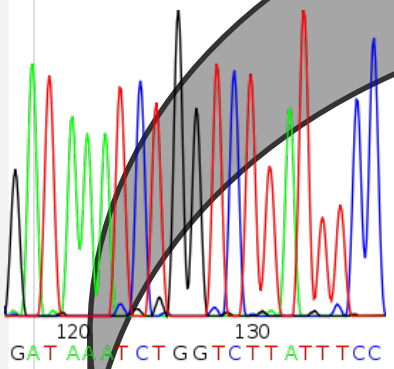
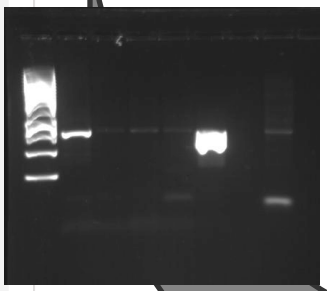
Integrated CURE: Biology Barcoding Project

Principles of Biology
BIOL 1108
Biodiversity





Species Identification



DNA Barcoding
Cell Biology
BIOL 3400

Integrated CURE: Biology Barcoding Project

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Specimen 408: Irina Cedeno & Ju Young Park

Location of collection: GGC-1

Date of collection: November 2012

Shannon-Wiener Index of Biodiversity: 2.82522

Photo: 408

Biodiversity wiki page: Contains information on 386 insect specimens.

Documented and uploaded by students.

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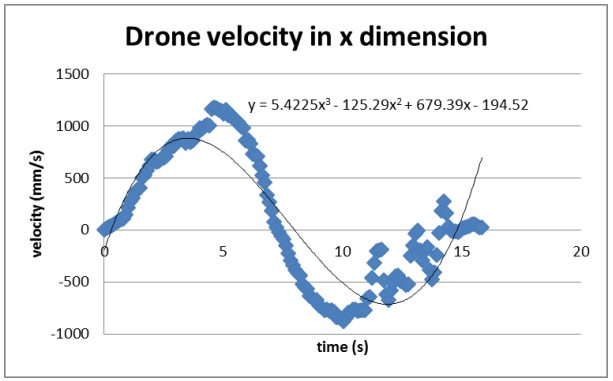
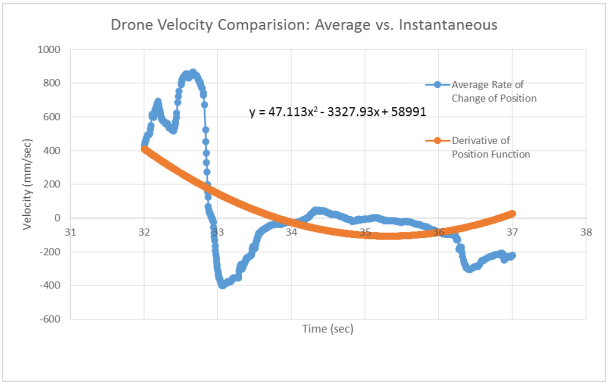
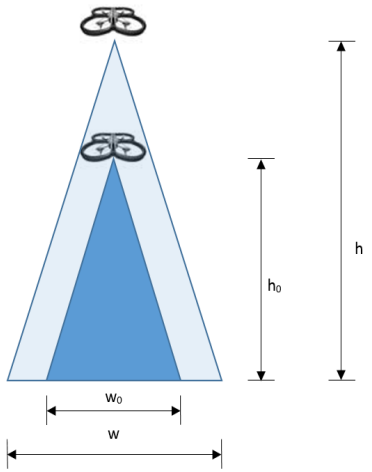
CURE: Calculus, Programming, & Drones

Calculus I (MATH 2200)

Students fly drones and collect data, and use derivatives and integrals to investigate relationships among position, velocity, and acceleration







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CURE: Calculus, Programming, & Drones

Programming Lab (ITEC 2120)

ITEC students hack away at code to program autonomous flights

- **Simple Function Calls**

```
from ggc_drone import *

drone = GGC_Drone()

drone.takeoff()

# Move Forward For 4 Seconds
drone.move(1, 0, 4)

drone.land()
```

- **Complex Loops**

```
f_step = -0.25
r_step = 0.25
move_time = 0.5 * step
for i in range(n):
  drone.move(f, r, move_time)
  f += f_step
  r += r_step
  if f >= 1 or f <= -1:
    f_step *= -1
  if r >= 1 or r <= -1:
    r_step *= -1
```

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CURE: Organic Chemistry Synthesis Project

Before CURE

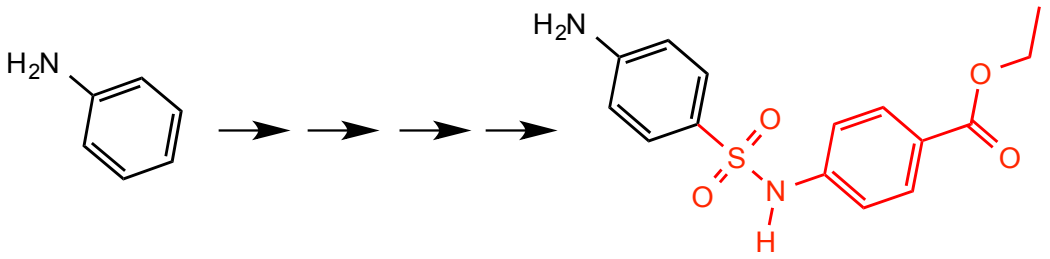
- ✓ Organic I Lab: build lab skills
- ✓ Organic II Lab: apply skills in ~ 7 standard named rxns, 2 weeks/rxn

With CURE

- ✓ Organic I Lab: same
- ✓ Organic II Lab: apply skills in a semester-long, student designed, synthesis project, culminating in a journal style article

CURE: Synthesis Project Outline

students issued 2 mL



students select from a library of 13 targets

students determine all the details

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CURE: Organic Chemistry Synthesis Project

Students' perspective

- ✓ *Applied existing lab skills to new experimental situations*
- ✓ *Value of the literature*
- ✓ *Uncertainty and decision making*
- ✓ *Soft skills development*
- ✓ *Experienced the excitement and disappointment of doing "real" science*
- ✓ *Enhanced "critical thinking" ability by developing experiments, evaluating results, and adjusting to reach the ultimate goal of synthesizing a sulfa drug*

Typical Lab Section

Instructors' perspective

- ✓ *Sacrificed traditional content*
- ✓ *Gave up control to students*
- ✓ *Safety the major responsibility*
- ✓ *Operate lab like a graduate group*

Typical Instructor

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SST's 4-YURCE Model

Program Assessment

Four Components:

1. ***Student attitudinal surveys***
2. ***Course content assessment***
3. ***Faculty Attitudinal Survey***
4. ***Student Performance Data***

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Cumulative Impact

Number of proposals submitted	**189**
Number of mini-grants funded	**138**
CUREs	87
SoTL	20
STEC 4500	28
SST Special Initiatives	2
Number of courses impacted	**54**
Freshmen level	14
Sophomore level	10
Junior level	19
Senior level	12
Number of faculty participating in mini-grants	**161**
Number of students impacted *Unduplicated head count	**12,298***
Number of STEM sections	**921**
Faculty presentations & posters	**237**
Student presentations	**129**
Published Manuscripts	**8**

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Successes

- Faculty led and driven
- Collaboration among faculty
- Faculty are incentivized & energized
- Innovative and creative ideas and projects
- Work counts as scholarship
- Scholarly products
- Administrative commitment to sustainability

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Challenges

- Assessment
- Time commitment
- Faculty leadership, coordination/integration in multi-section courses
- Faculty knowledge, skills, and ability to embed research experiences in courses
- Concerns about loss of content from “cook-book” labs
- Concerns about publishing work

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Discussion

Questions?

Comments?

Examples of similar approaches?

Other undergraduate research models?

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STEM Initiative Committee

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Backup Slides

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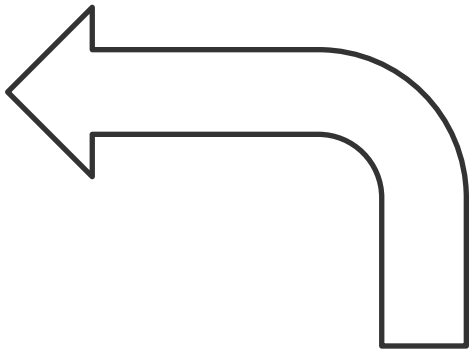
CURE: Organic Chemistry Synthesis Project

GGC IEE Goals are to demonstrate/apply:

1. *written and oral communication*
2. *creativity and critical thinking*
3. *effective use of information technology*
4. *collaboration in diverse and global contexts*
5. *human and institutional decision making*
6. *moral and ethical principles*
7. *leadership principles*
8. *quantitative reasoning*

Synthesis Project Goal:

enhance organic synthesis capability



Synthesis Project Objectives:

1. *research primary literature - IEE 1 & IEE 3*
2. *report results and findings (oral & written) - IEE 1*
3. *design & troubleshoot synthetic path to target - IEE 2*
4. *maintain documentation to replicate experiments - IEE 2*
5. *collaborate with peers in research - IEE 4 & IEE 7*
6. *collect and analyze quantitative data - IEE 8*

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