

Mar 8th, 11:30 AM - 11:50 AM


Under graduate Curriculum Integration: Bringing Students Together Through Research

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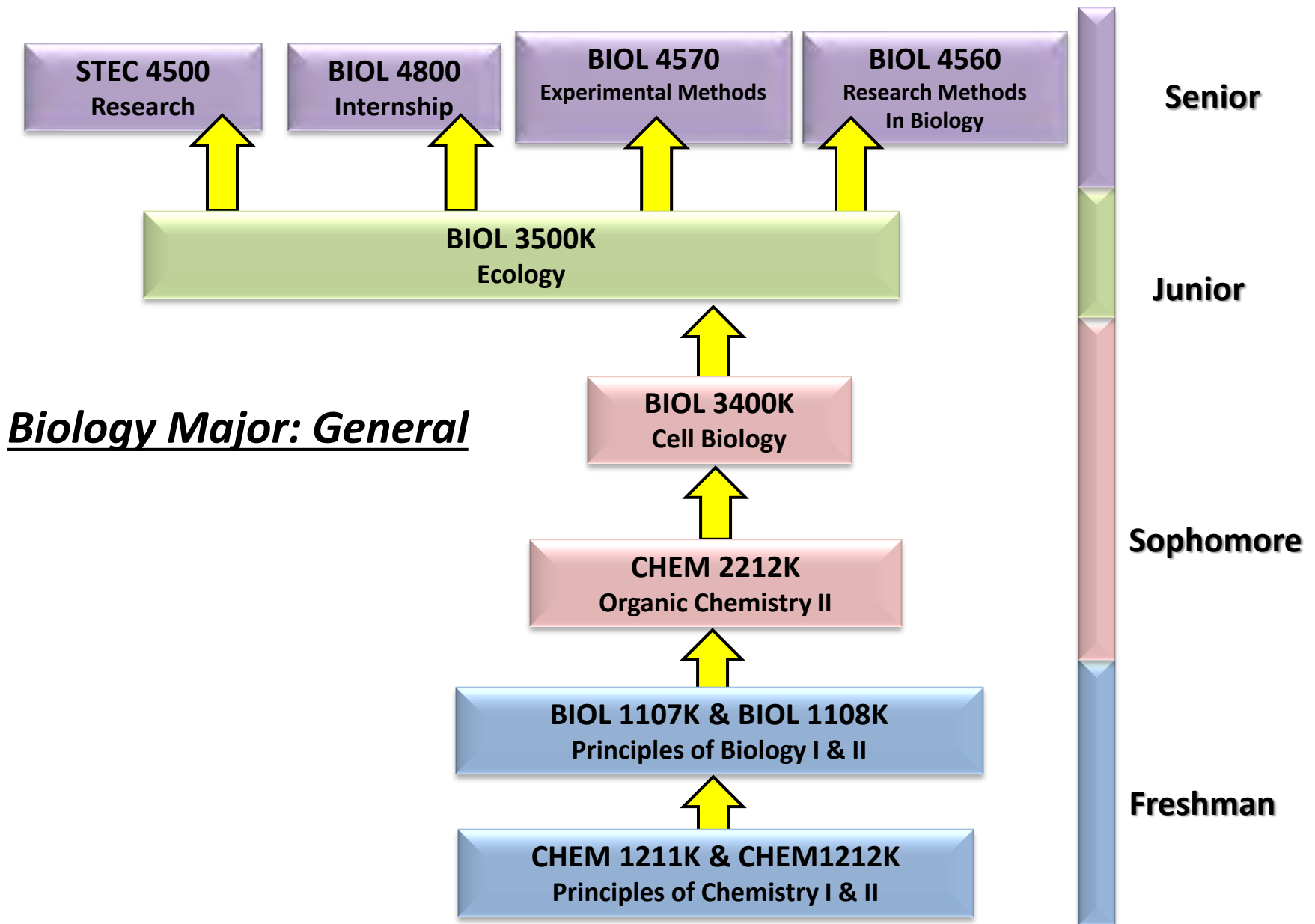
UNDERGRADUATE CURRICULUM INTEGRATION: BRINGING STUDENTS TOGETHER THROUGH RESEARCH

Clay Runck, James Russell, Allison D'Costa



Georgia Gwinnett College

4-Year Undergraduate Research Experience





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Imagery Date: 10/16/2011 1993

33°59'00.79" N 83°59'50.14" W elev 1002 ft

Eye alt 5546 ft

Principles of Biology

BIOL 1108

Biodiversity

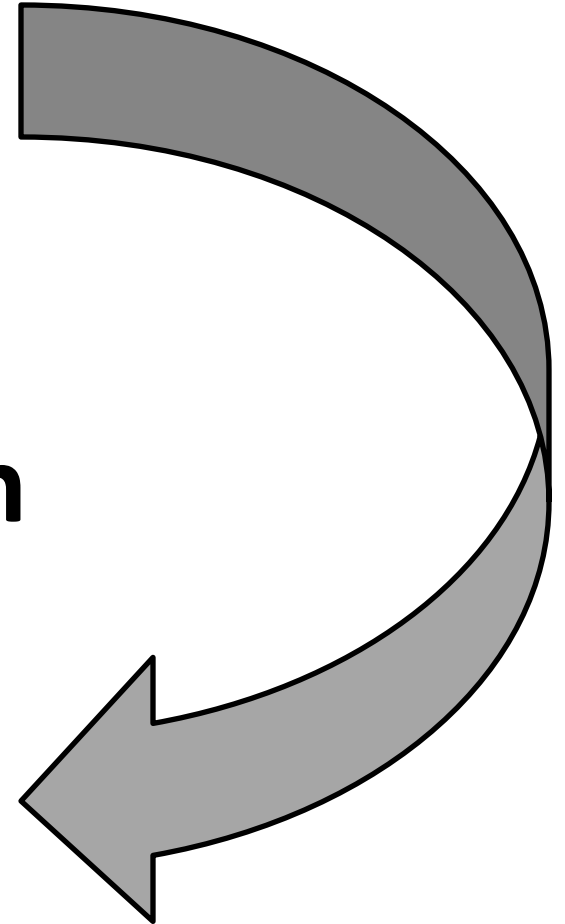
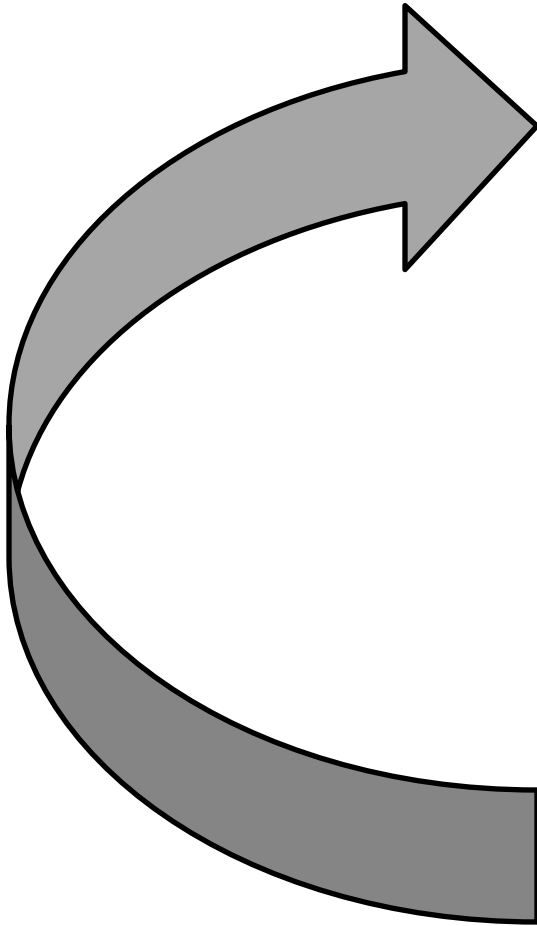
Species

Identification

DNA barcoding

Cell Biology

BIOL 3400







Fall 2011
Principles of Biology
BIOL 1108
Biodiversity



Principles of Biology

BIOL 1108

Biodiversity



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Key to the Orders of Hexapods

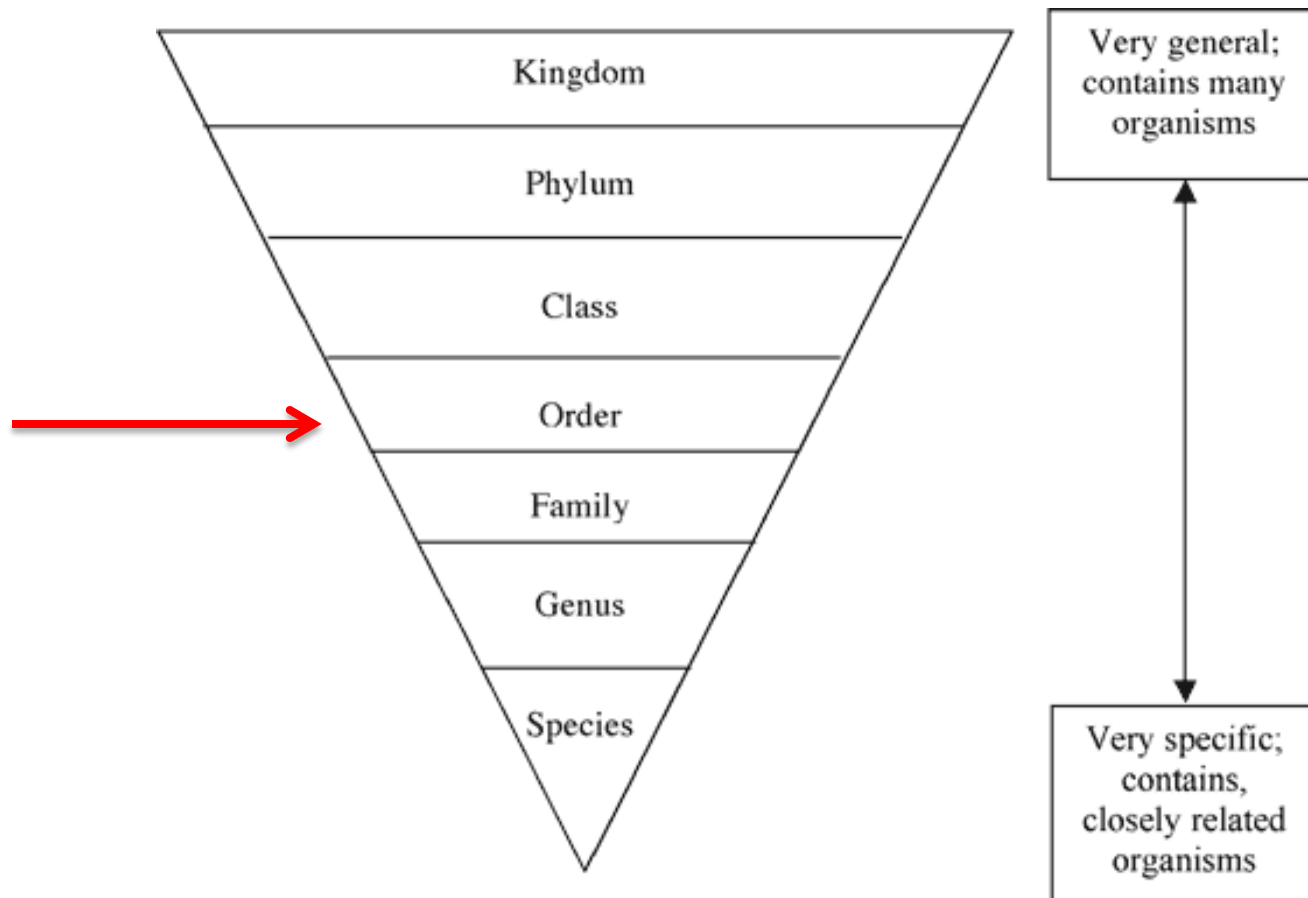
This key includes adults, nymphs, and larvae. The position of the key pointing nymphs and larvae should work for most specimens, but some very young or highly specialized forms may not key out correctly. The habitat is sometimes an important character in keying out larvae. Groups marked with an asterisk are unlikely to be encountered by the general collector.

- 1. With well-developed wings (adults) 2
- 2. Wingless or with wings vestigial or rudimentary (nymphs, larvae, and some adults) 10
- 3. Wings membranous, not hardened or leathery 4
- 4. Front wings hardened or leathery, at least at base (Figure 7-25). Hind wings, if present, usually membranous 24
- 5. With only one pair of wings 4



Identification/Classification of organisms

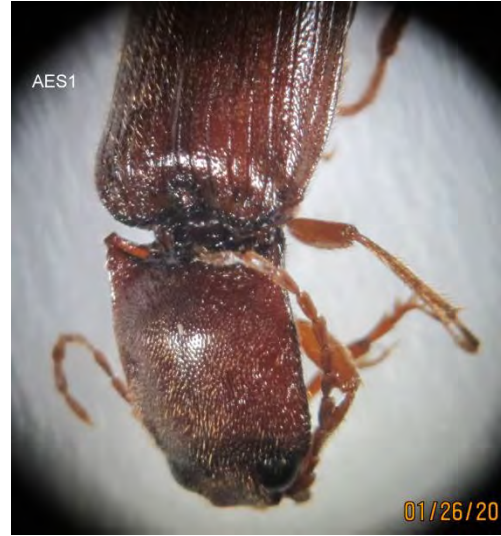
- Taxonomy: morphology



Principles of Biology

BIOL 1108

Biodiversity



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The DNA Barcoding Project

Welcome to the GGC's Biodiversity DNA Barcoding Project WIKI!

[What is Biodiversity?](#)

[What is DNA Barcoding?](#)

Here you'll find links to the specimens collected (by BIOL 1108 students) and DNA barcoded (by 3400 students) in Fall 2011

The Fall 2011 specimens are classified by Order.

[Coleoptera](#)

[Diptera](#)

[Homoptera](#)

[Hymenoptera](#)

[Lepidoptera](#)

The Spring 2012 specimens are classified by Order.

[Coleoptera](#)

[Diptera](#)

[Homoptera](#)

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Diptera

[Specimen: Johnny Rostas 2](#)

[Specimen 40: Patrick Smallwood 1](#)

[Specimen 46: Stephanie Sezonov 3](#)

[Specimen : Lee Moore 1](#)

[Specimen : JWR 2](#)

[Specimen : Nicole Bonacchi 3](#)

[Specimen : Nicole Bonacchi 4](#)

[Specimen : Jessica Wright 2](#)

[Specimen : Christopher Bligh 3](#)

[Specimen 57: Devon Lynch and Adell Doghaimat](#)

[Specimen 58: Francis Miah and Brigette Brown](#)

[Specimen 38: Matt Cooper 1](#)

[Specimen : Maryssa Baker 1](#)

[Specimen : Alvin Abraham and Sunny Gangwal](#)

[Specimen : Annalise Reagan 1](#)

[Specimen : Leanne Gilbert 1](#)

[Specimen : Nicole Cobb 1](#)

[Specimen : Arianna Singh 2](#)

Specimen : Jessica Wright 2

Location of collection: Beaver Pond/Shannon H value: 2.7

Date of collection: 9/2011



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Distinguishing morphological features of Order: only one set of wings, Eyes: large, Mouth parts: variable, Tarsis: 5 segmented

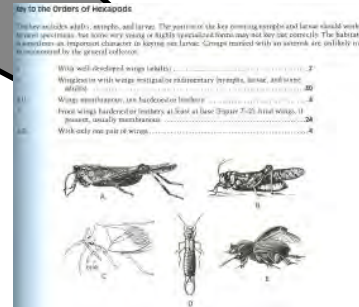
Geographical Distribution

Life cycle : (holometabolis) Overwintering/resting/diapause stage: embryo(egg), larva, pupa, adult/ Sexual dimorphism: the males initially 1 the opposite. This allows the male to mate while remaining upright

Principles of Biology

BIOL 1108

Biodiversity



DNA barcoding
**Cell Biology /
Biotechnology**
BIOL 3400 / 4300

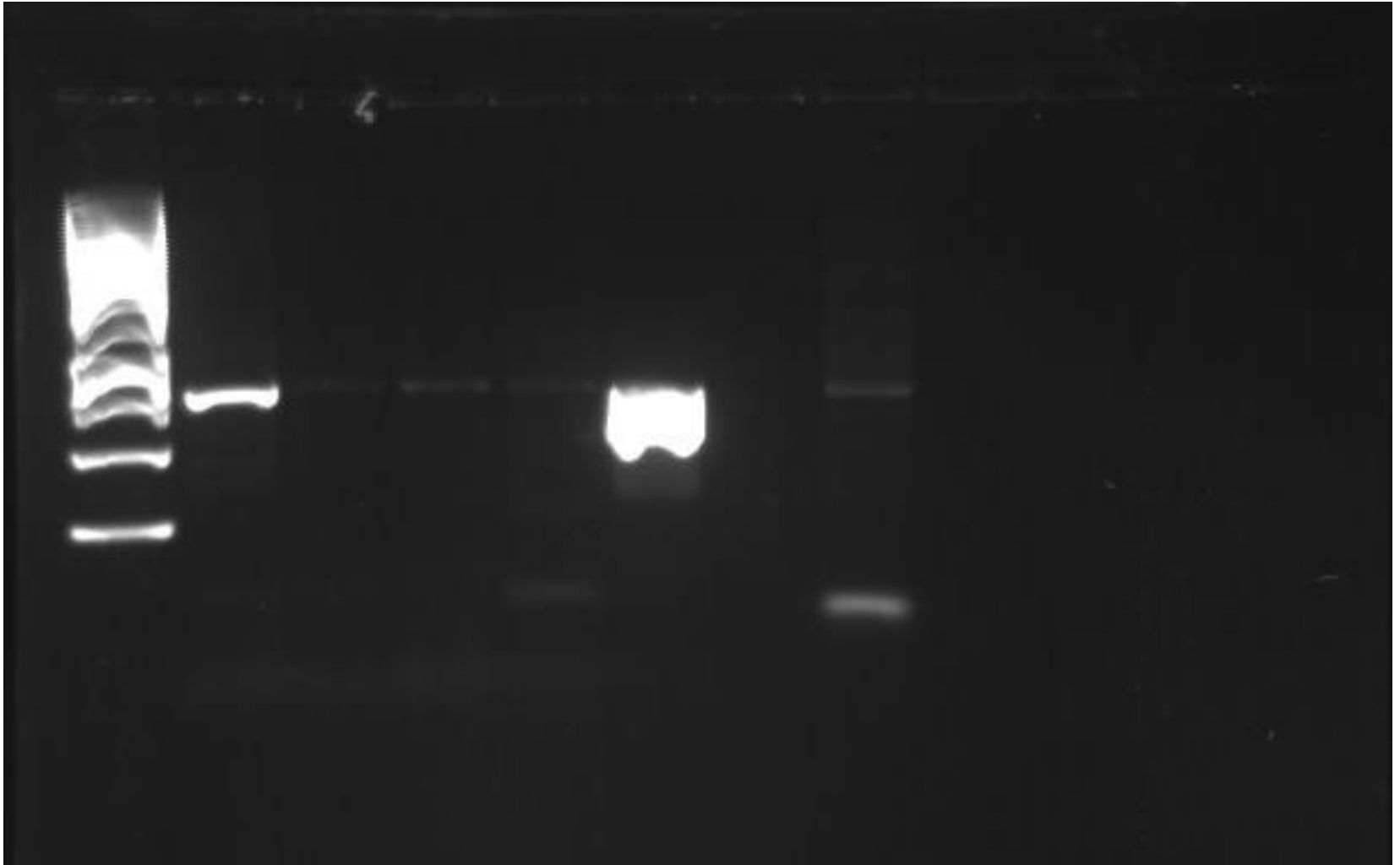


BIOL 3400 : DNA Barcoding

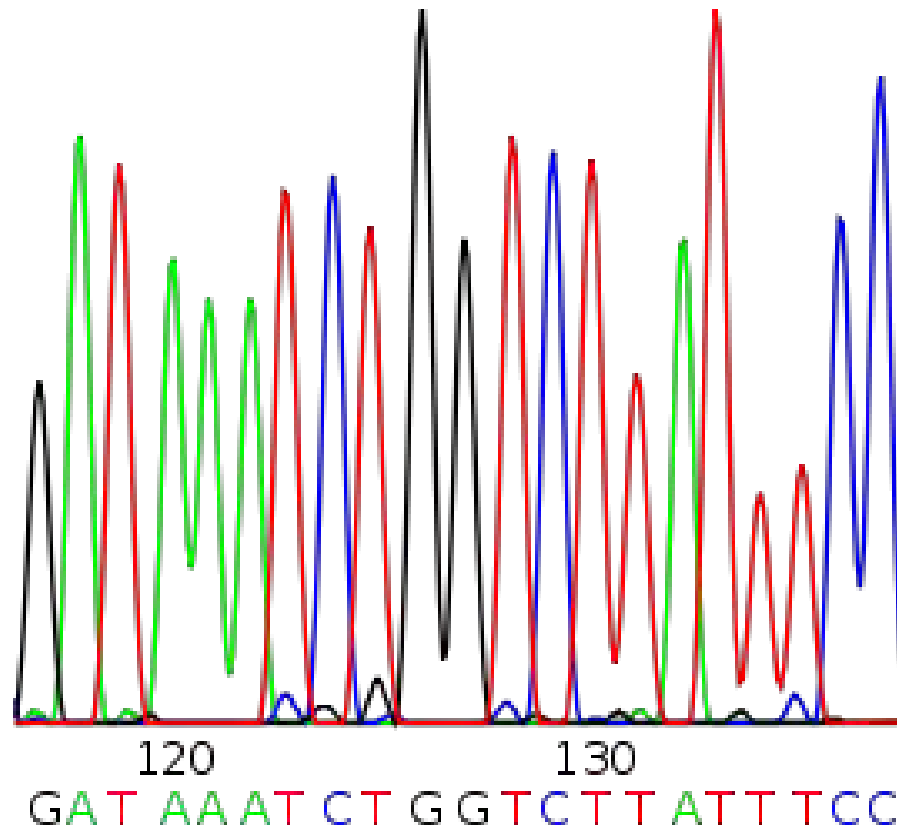
Step 1: DNA extraction



Step 2: Gene amplification (PCR)



Step 3: Gene sequencing



Step 4: Bioinformatics

The image shows the NCBI BLAST search interface. At the top, there is a navigation bar with the NCBI logo and the text "nucleotide-nucleotide BLAST". Below this, there are four tabs: "Nucleotide", "Protein", "Translations", and "Retrieve results for an RID". The "Nucleotide" tab is selected. The main search area contains a large text input field for the query sequence. Below the input field, there are fields for "Set subsequence" with "From:" and "To:" labels, and a "Choose database" dropdown menu currently set to "nr". At the bottom, there are buttons for "BLAST!" and "FASTA!".

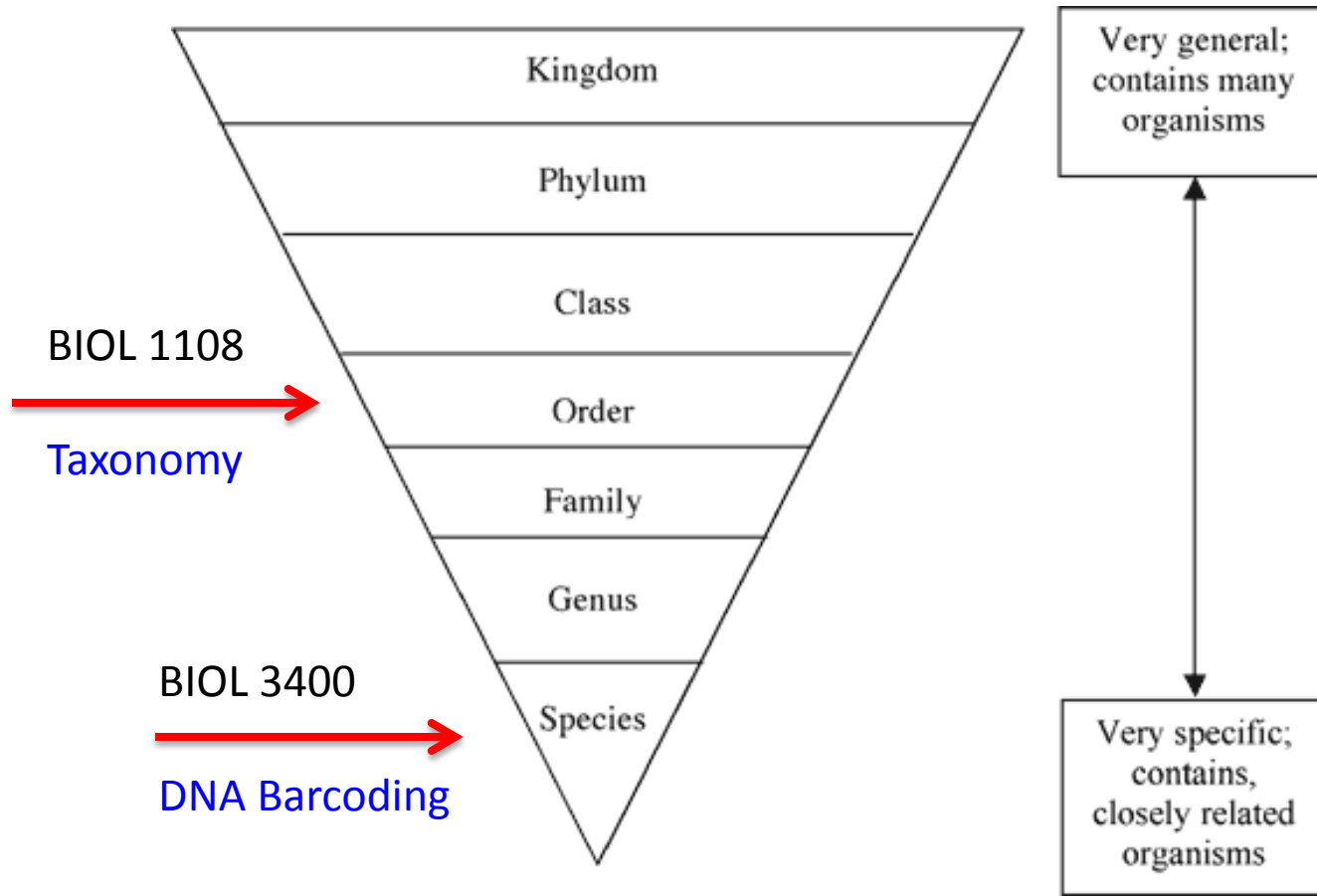
The image shows the homepage of the Barcode of Life Data Systems (BOLD) v2.5. The header features the text "BARCODE OF LIFE DATA SYSTEMS v2.5" and the tagline "Advancing species identification and discovery through the analysis of short, standardized gene regions". Below the header is a banner with five images: a forest, a bee, a flower, a butterfly, and a hummingbird. A navigation bar contains links for "Published Projects", "Taxonomy Browser", "Request an Account", "Identify Specimen", "FAQs", and "Document". The main content area includes a paragraph describing BOLD as an online workbench for DNA barcoding. Below this is a section titled "MANAGEMENT & ANALYSIS" with a sub-section for "BOLD-MAS" which provides a repository for barcode records. To the right of the text is a login form with fields for "Username" and "Password", a "Login" button, and links for "Request a new user account" and "Forgot your username or password?". A sidebar on the right contains a vertical list of links: "BARCODE", "Formal", "Total B", "Source", "GenBar", "Canadian", "Others", and "BO".

Species Identification

TOP 20 Matches :

Display option: default

Phylum	Class	Order	Family	Genus	Species	Specimen Similarity (%)
Arthropoda	Insecta	Diptera	Chironomidae	Ablabesmyia	<i>aspera</i>	94.87
Arthropoda	Insecta	Diptera	Chironomidae	Ablabesmyia	<i>aspera</i>	94.87
Arthropoda	Insecta	Diptera	Chironomidae	Ablabesmyia	<i>aspera</i>	92.95
Arthropoda	Insecta	Diptera	Chironomidae			92.95



Principles of Biology

BIOL 1108

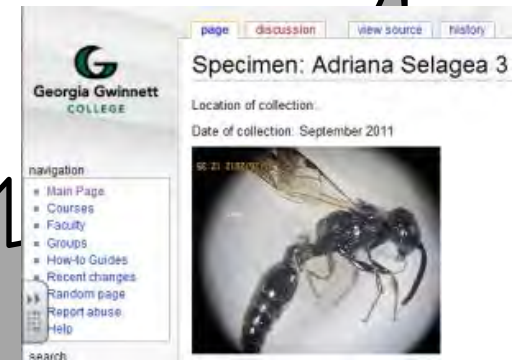
Biodiversity

Species Identification

DNA barcoding

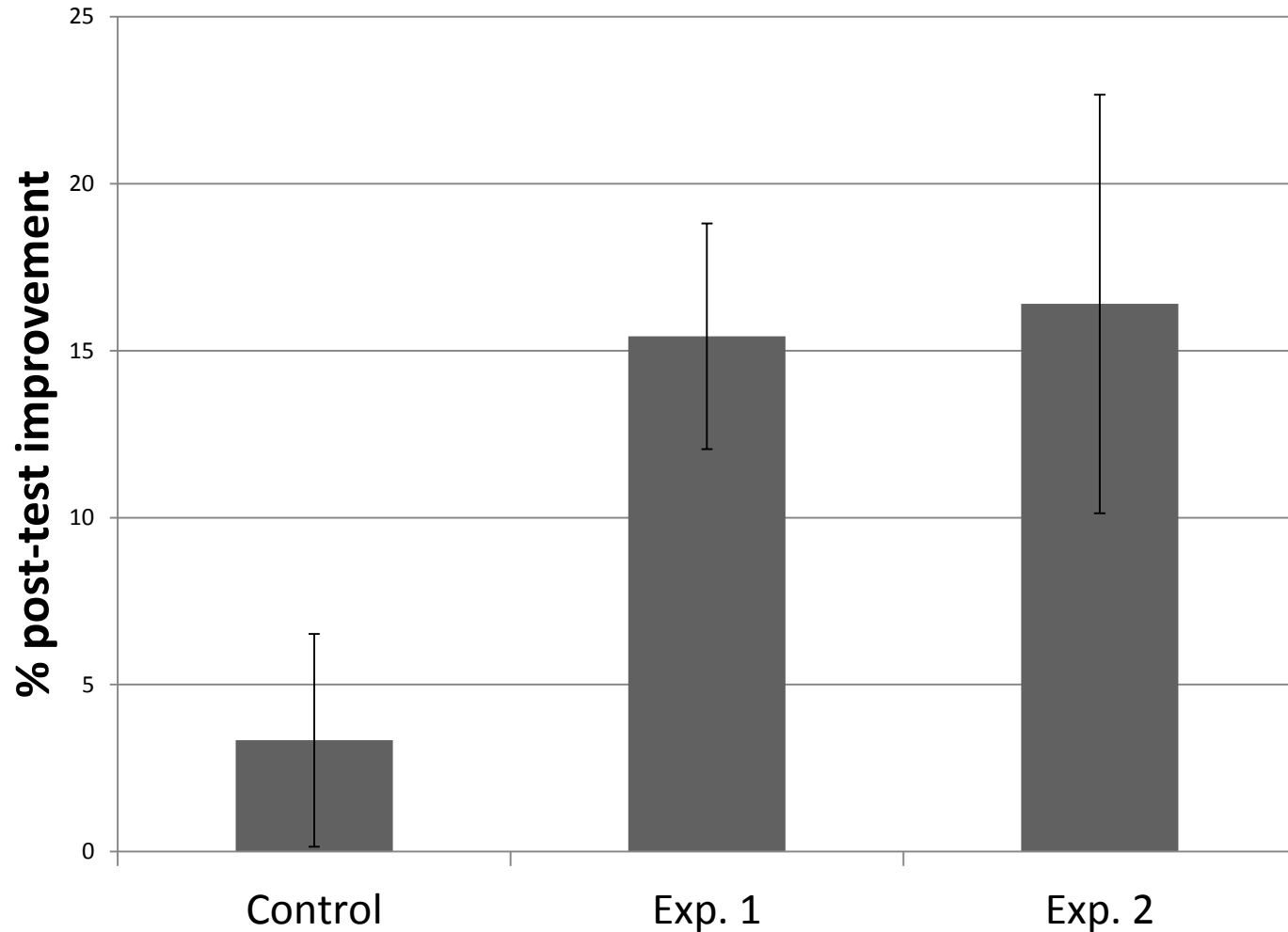
Cell Biology

BIOL 3400



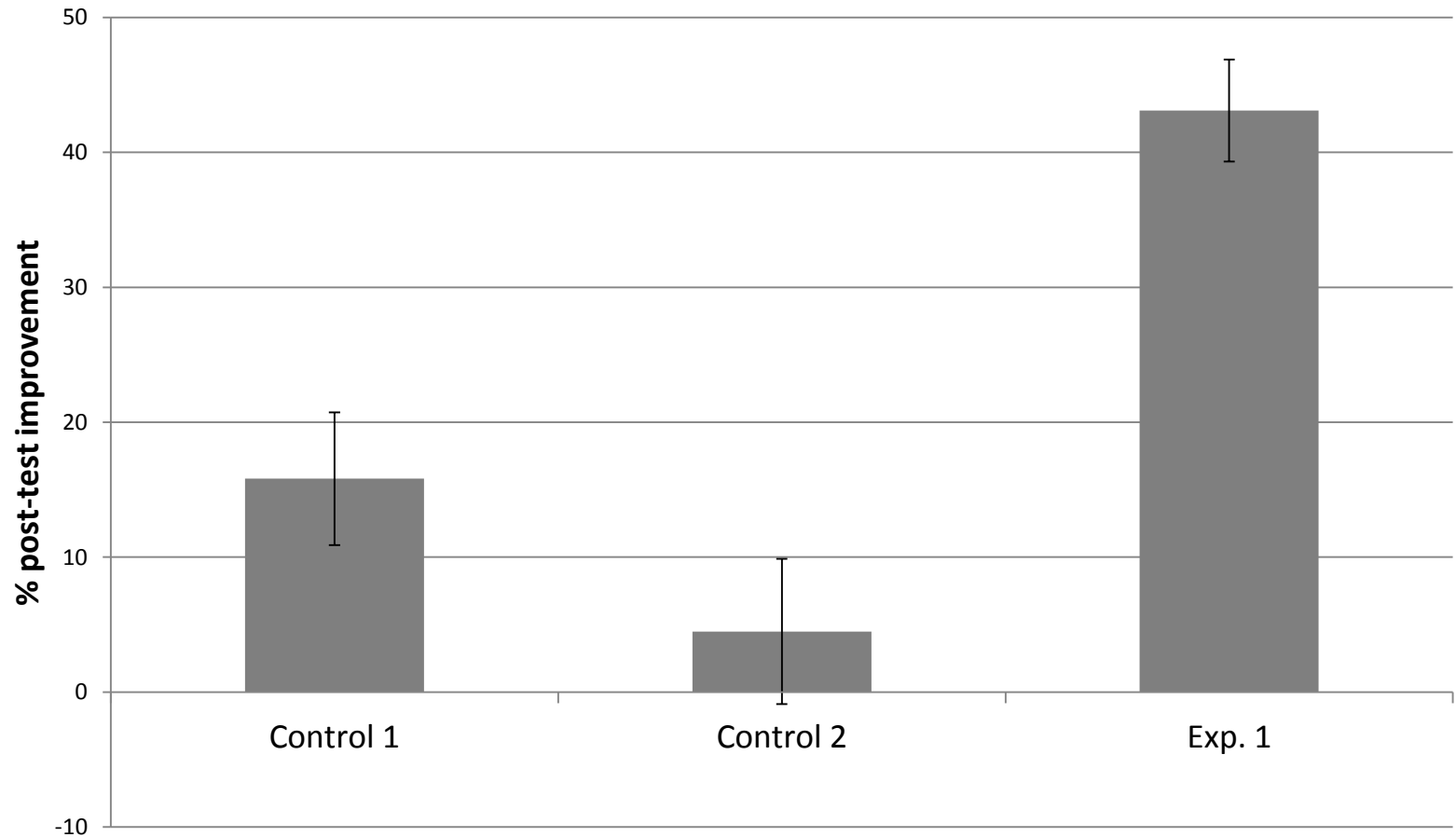
Biology 1108K

Content Assessment



Biology 3400K

Content Assessment



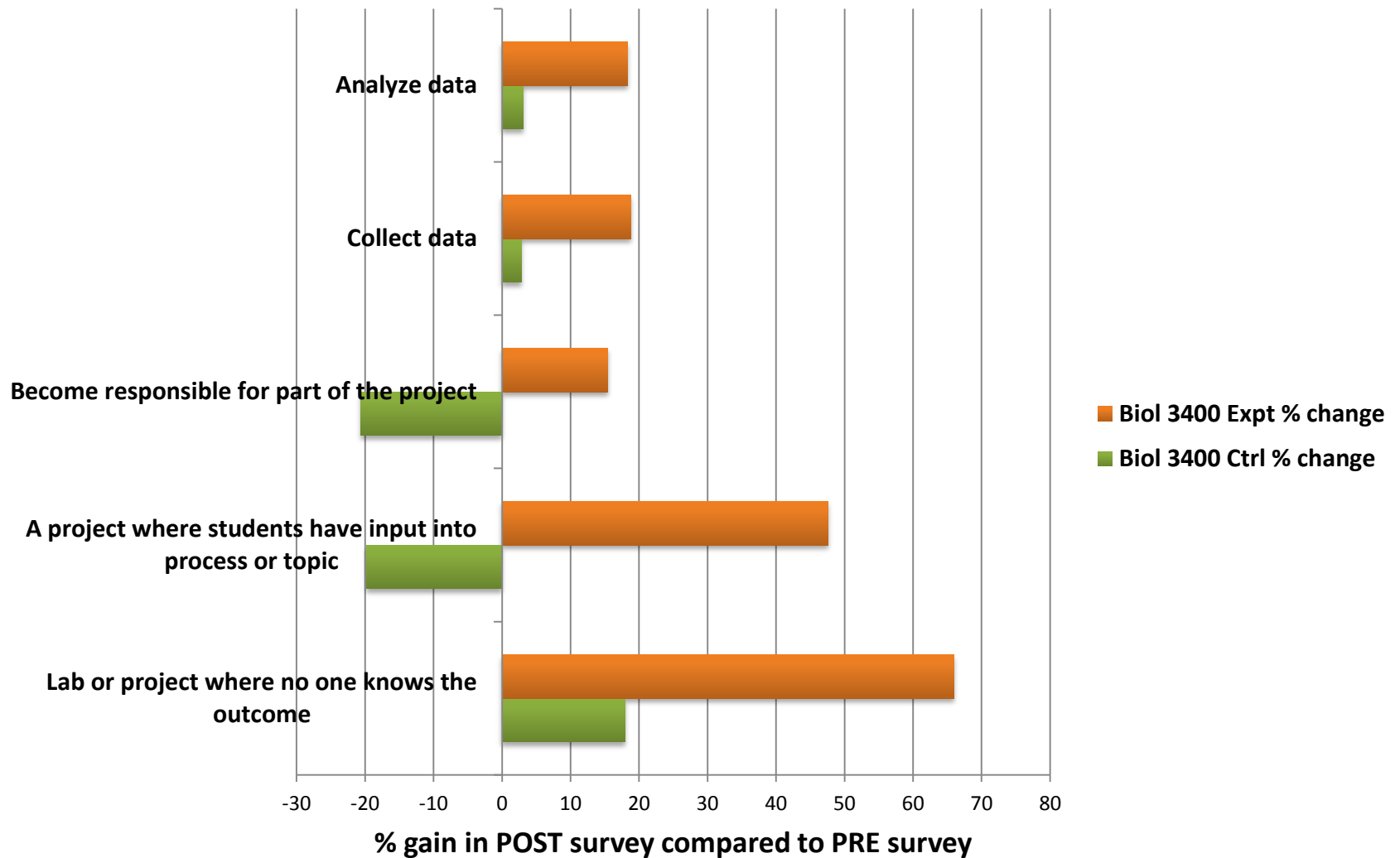
Amplify a region that is exactly 30 bps long and contains the underlined region below.

- a) Design 2 primers, each 6 nucleotides long
- b) Mark your primers on the diagram with their sequence and direction of extension, being sure to label the 5' and 3' ends.
- c) Using another colored pen, extend the primers (like you would in cycle 1)

5'TACAGTATTCGGCATCATGCTCGCGTGCTAGCAGGCCGAATTC 3'

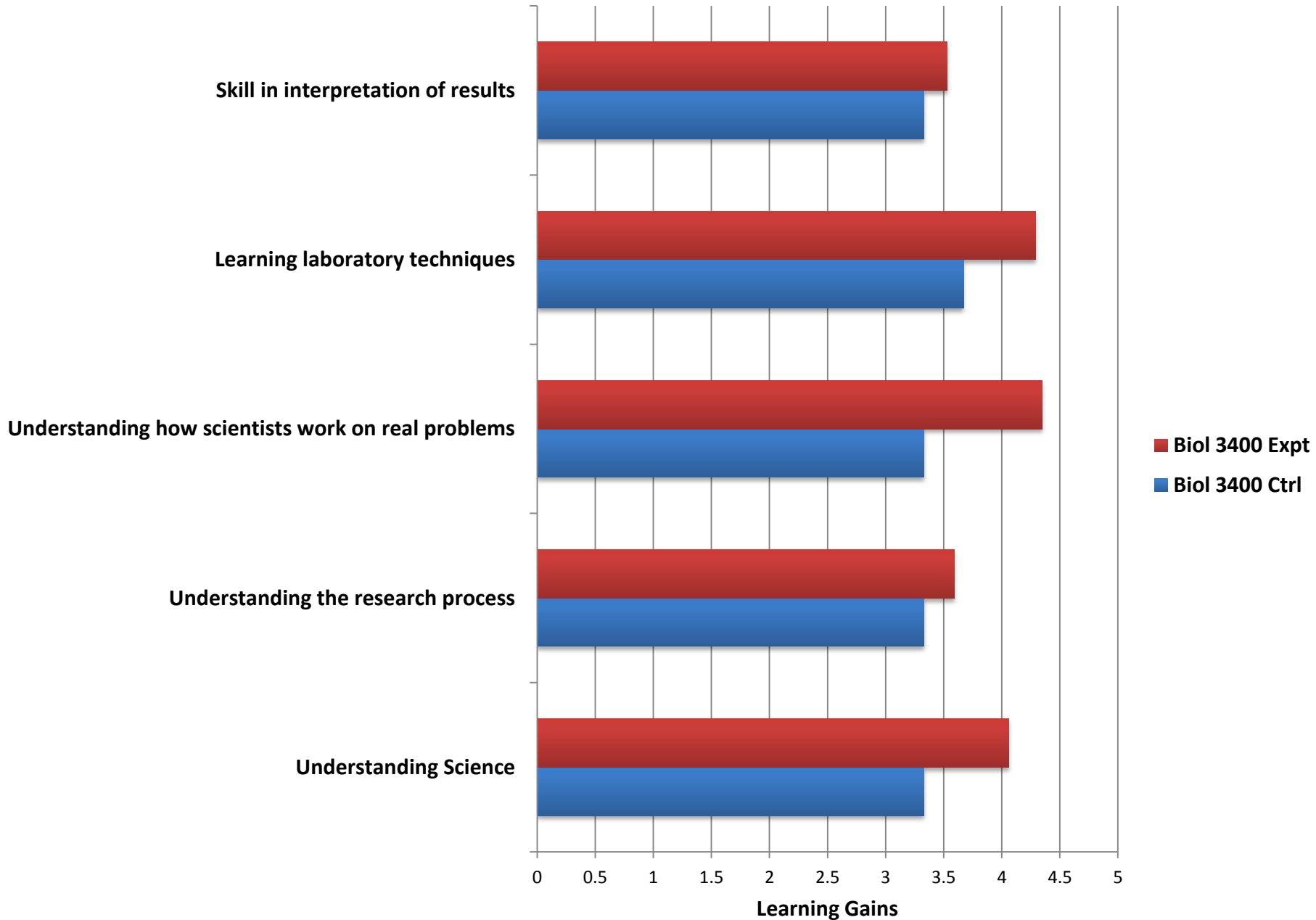
3'ATGTCATAAGCCGTAGTACGAGCGCACGATCGTCCGGCTTAAG 5'

BIOL 3400 % gains in Course Elements as assessed by the CURE survey



CURE SURVEY: *Linking student interests to science curricula.* Denofrio L.A., Russell B., Lopatto D., & Lu Y. 2007, *Science*, pp. 1872-1873.

BIOL 3400 Learning Gains as assessed by CURE survey



Student Comments

“Having the opportunity to participate in the DNA Barcoding firmed up my decision to continue in the sciences”

“I learned how different fields (or classes) of science can work together toward the same goal”

“The only downfall was having to do it so many times and still not having a sequence at the end”

“Although I failed to extract any DNA for sequencing, I learned that in the field of science there is a lot of trial and error during the process”

“I learned I am more interested in field work than lab work”

“I much prefer lab work to field work”

Accomplishments

Students learned:

- Nature of science
- Importance of collaboration in research
- Trouble- shooting

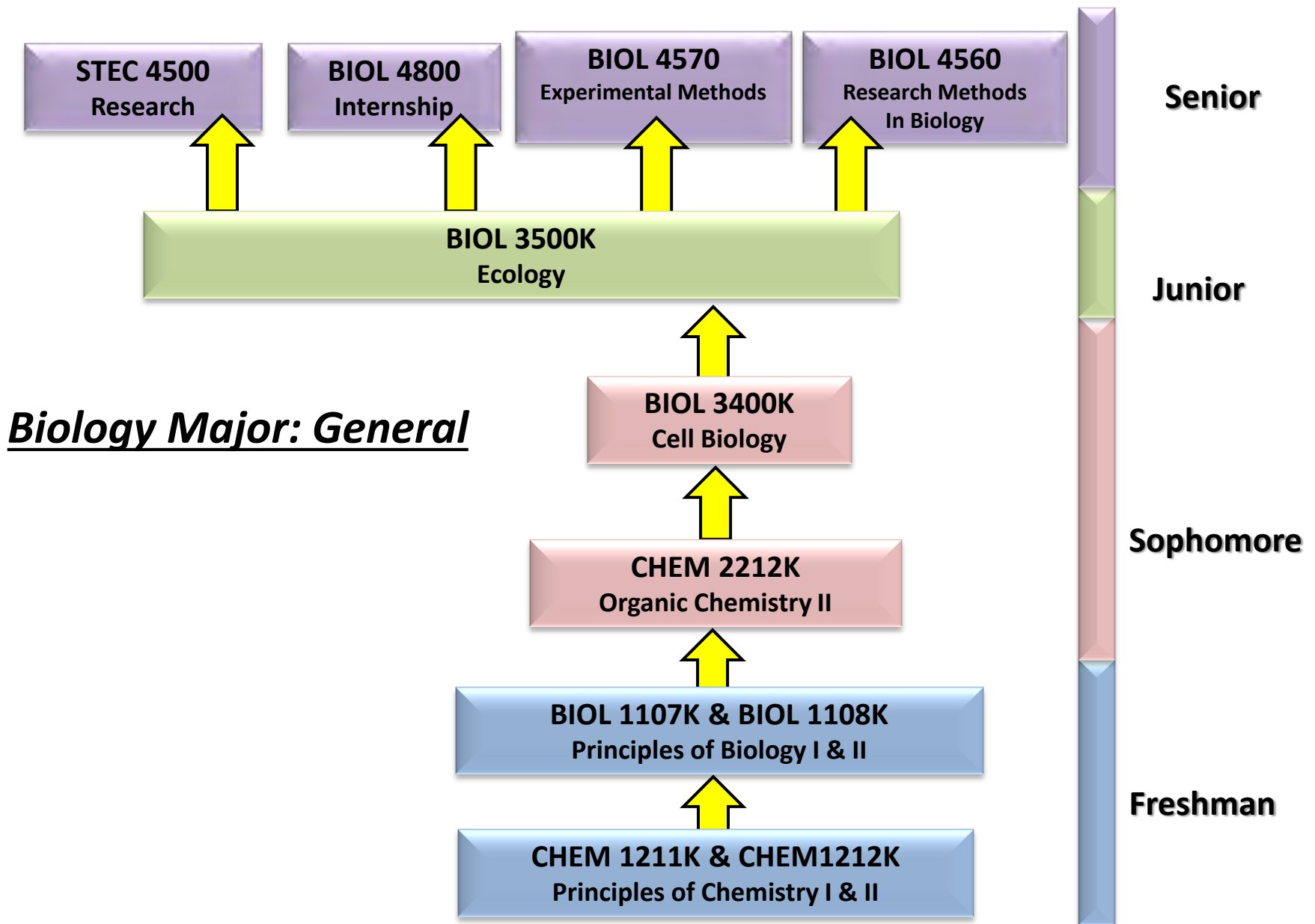
Biodiversity results:

- $\approx 60-70\%$ of students obtain a PCR product suitable for sequencing
- $\approx 2/3$ of these obtain a readable sequence
- >100 unique insects have been identified, but only $\approx 2/3$ of these have a barcode

Issues (we had plenty)

- Faculty buy-in (content v process) – **BIOL 1108**
- Resources
- Intra and inter course coordination
 - #sections/#instructors/part-time faculty
- Dual preparation – **BIOL 1108**
- Negative results
- Large variation in STEM competencies – **BIOL 1108**
- Statistical analysis of biodiversity data too complex for freshmen (**BIOL 1108**)

4-Year Undergraduate Research Experience



Ecology

BIOL 3500

*Biodiversity and
Environmental
Sampling*

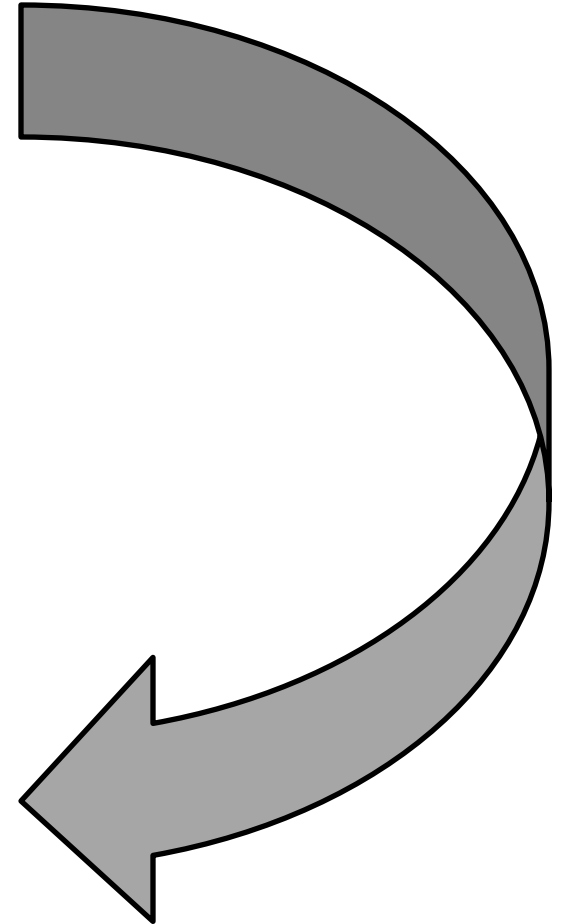
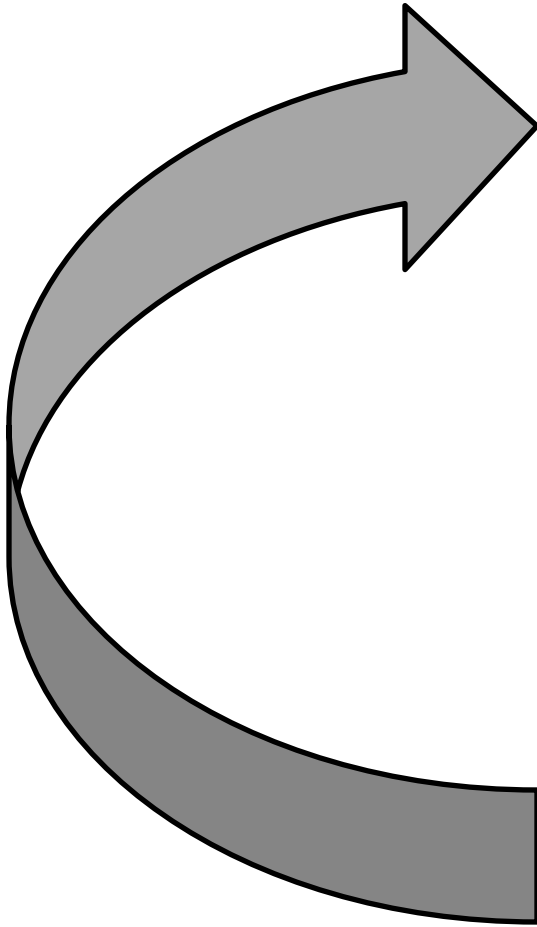
**Species
Identification**

Identification

DNA barcoding

Cell Biology

BIOL 3400



Fall 2012

- **Biodiversity component moved to Ecology (BIOL 3500)**
- **Less variability in student STEM competencies**
 - Wiki page (ITEC 2110 – Digital Media)
 - Spreadsheet competency (ITEC 1001 – Intro to Computing)
 - Zoology (BIOL 3600) and/or Botany (BIOL 3310) completed
 - Stats (MATH 2000) completed
- **Better fit for hypothesis-testing focus of BIOL 3500 labs (focus on process rather than content)**
- **Two sections** Fall and Spring; **one section** in Summer

Ecology (BIOL 3500)

Nangendo *et al.* 2002

$$H' = - \sum_{i=1}^s p_i \ln p_i$$

$$\text{var } H' = \frac{\sum p_i (\ln p_i)^2 - (\sum p_i \ln p_i)^2}{N} + \frac{s-1}{2N^2}$$

$$t = \frac{H'_1 - H'_2}{\sqrt{\text{var } H'_1 + \text{var } H'_2}}$$

$$d.f. = \frac{(\text{var } H'_1 + \text{var } H'_2)^2}{\frac{(\text{var } H'_1)^2}{N_1} + \frac{(\text{var } H'_2)^2}{N_2}}$$

$$E = \frac{H^1}{H_{max}} = \frac{-\sum_{i=1}^s p_i \ln p_i}{\ln s}$$

Ecology (BIOL 3500)

Table 1. Calculated biodiversity for each of four GGC sites.

Area	Species Count	Total Abundance	H'	H' _{max}	J'	var H'
GGC1	59	257	3.370489	4.07753744	0.826599095	0.00555266
GGC2	47	153	3.400	3.8501476	0.883004731	0.00748123
GGC3	29	69	3.034	3.36729583	0.901021912	0.01268275
GGC4	106	712	3.698995	4.66343909	0.793190392	0.00266935

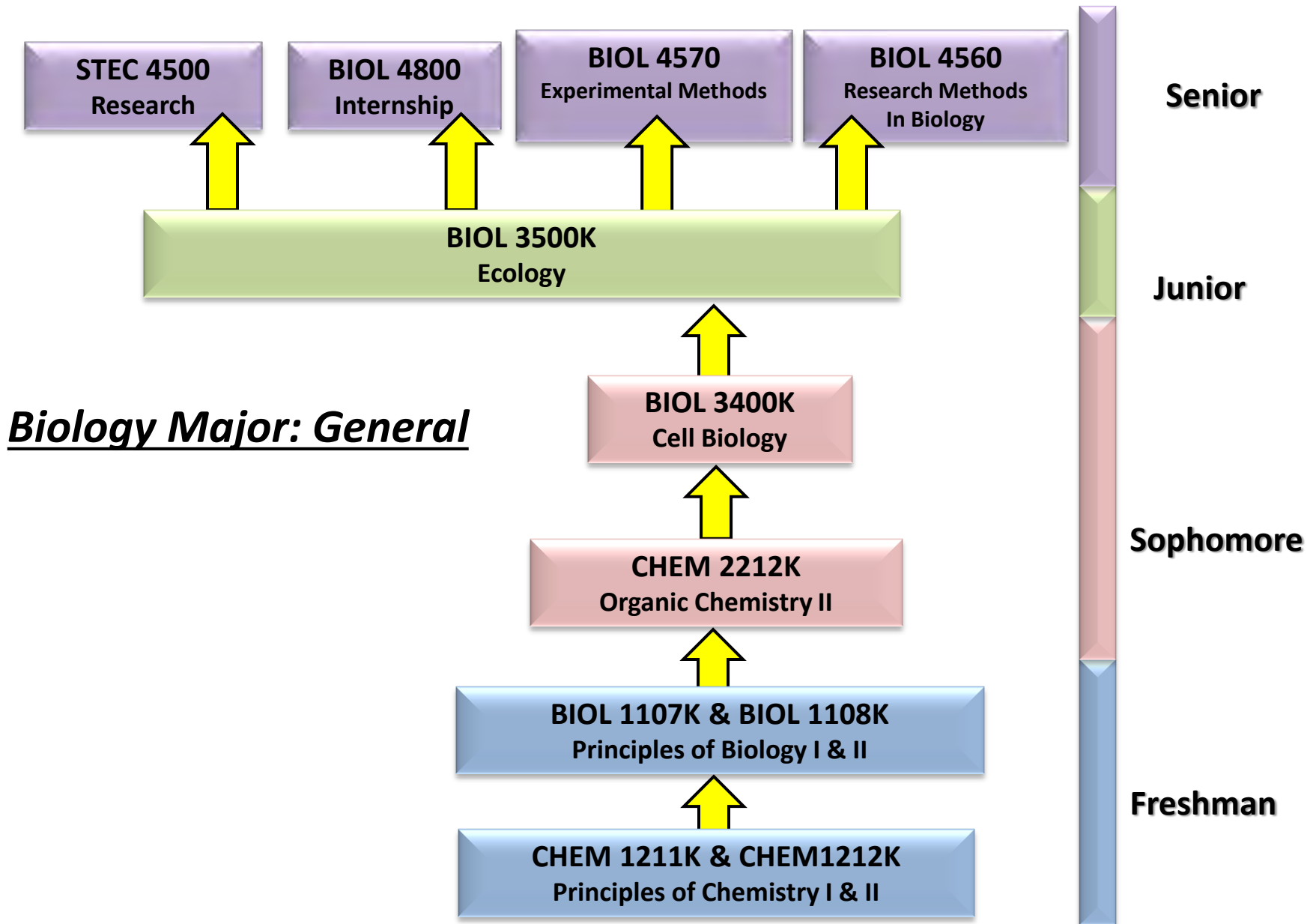
Table 2. Statistical comparisons of biodiversity between sites.

	t-Statistic	D.F.	p-Value
GGC1 to GGC2	-0.2558535	349.711693	>0.10
GGC1 to GGC3	2.49174341	135.6623534	<0.01
GGC1 to GG4	-3.6228878	520.1043798	<0.005
GGC2 to GGC3	2.5752916	150.7548993	<0.01
GGC2 to GGC4	-2.9706839	274.1608075	<0.005
GGC3 to GGC4	-5.3669773	100.6693247	<0.005

Recruitment of Ecology and Cell Biology students for STEC 4500 (Undergraduate Research Experience)



4-Year Undergraduate Research Experience





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Imagery Date: 10/16/2011 1993

33°59'00.79" N 83°59'50.14" W elev 1002 ft

Eye alt 5546 ft

A multi-section, multi-course collaboration!



Allison D'Costa



James Russell



Clay Runck



Mark Schlueter



Robert Haining



Alessandra Barrera



Erin Quinlan



David Barnes