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

Under graduate Curriculum Integration: Bringing Students Together Through Research

Clay Runck
Georgia Gwinnett College

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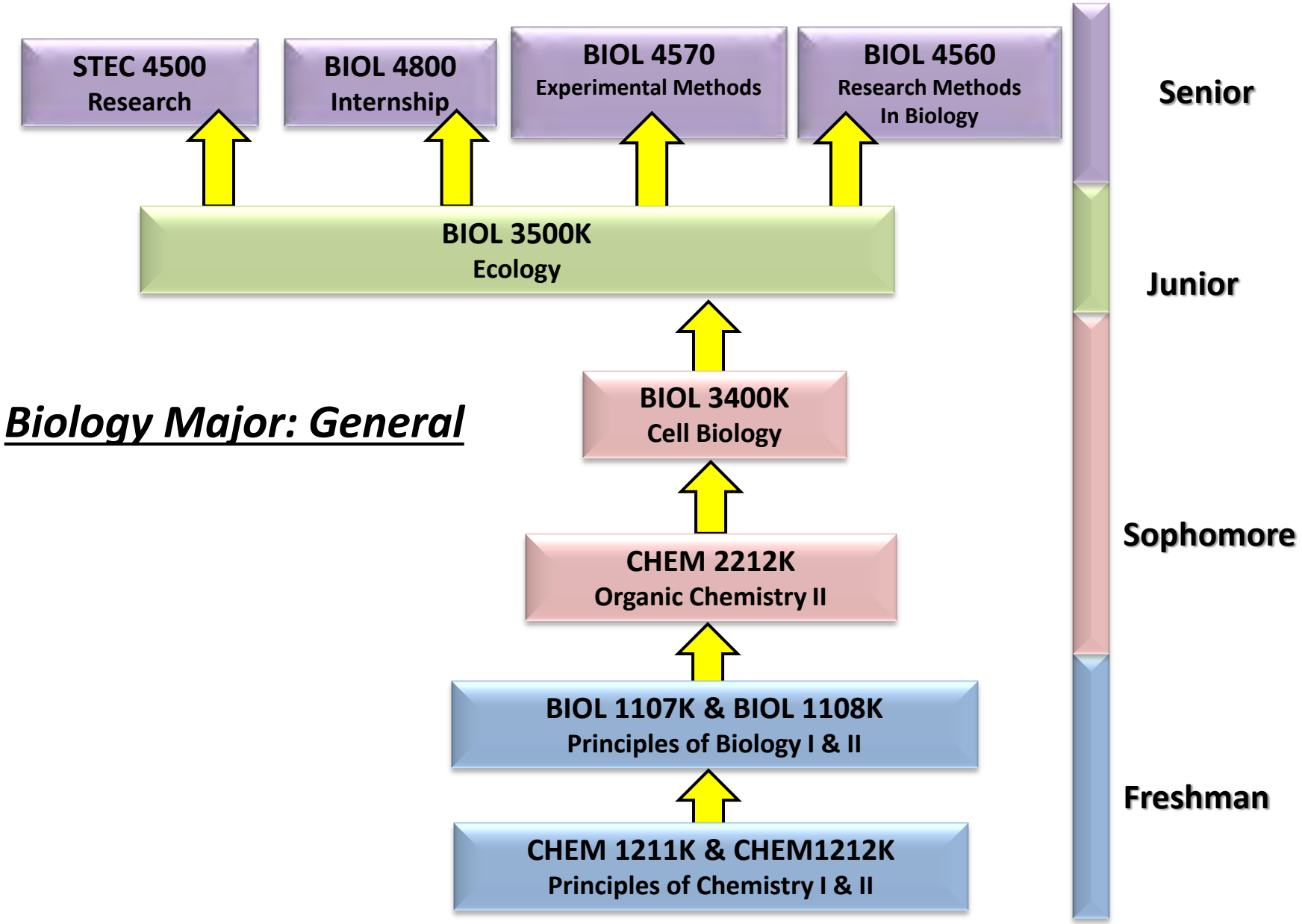
UNDERGRADUATE CURRICULUM INTEGRATION: BRINGING STUDENTS TOGETHER THROUGH RESEARCH

Clay Runck, James Russell, Allison D'Costa

Georgia Gwinnett College

4-Year Undergraduate Research Experience



Biology Major: General


GGC3
GGC2
GGC1
GGC4
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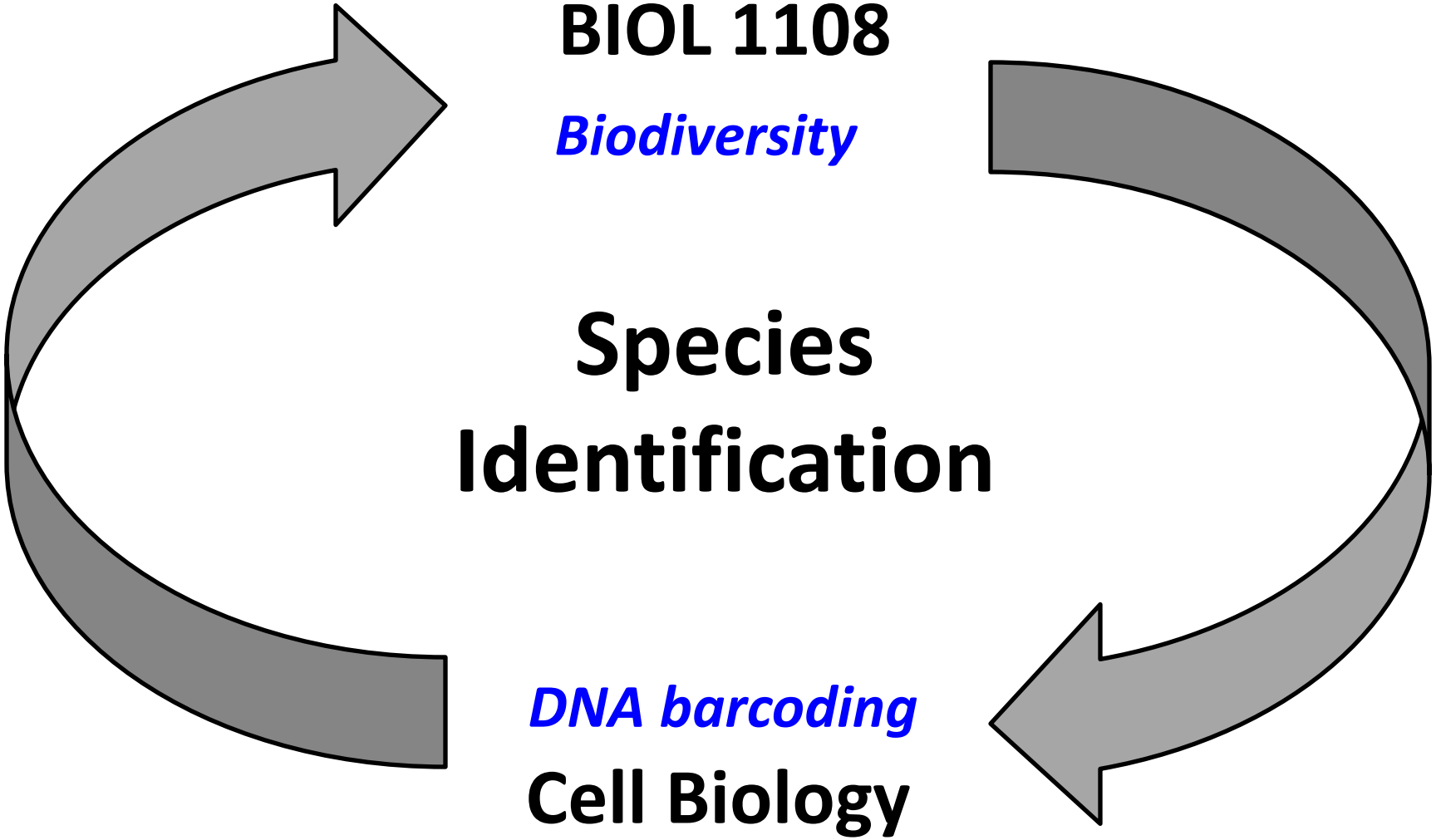
1993
33°59'00.79" N 83°59'50.14" W elev 1002 ft
Eye alt 5546 ft


Principles of Biology
BIOL 1108
Biodiversity
Species
Identification
DNA barcoding
Cell Biology
BIOL 3400


GGC3
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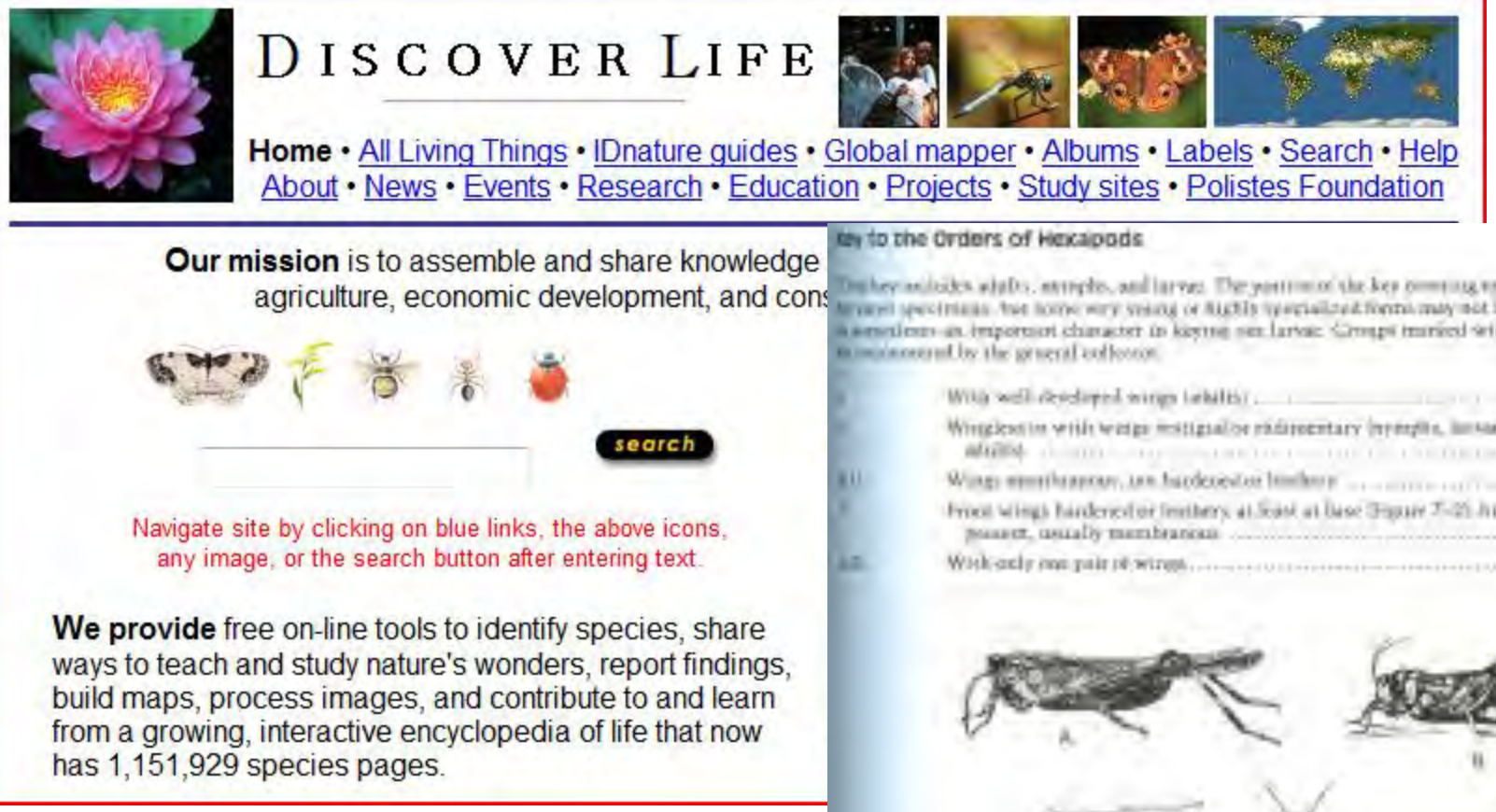
GRIZZLIES

Fall 2011
Principles of Biology
BIOL 1108
Biodiversity

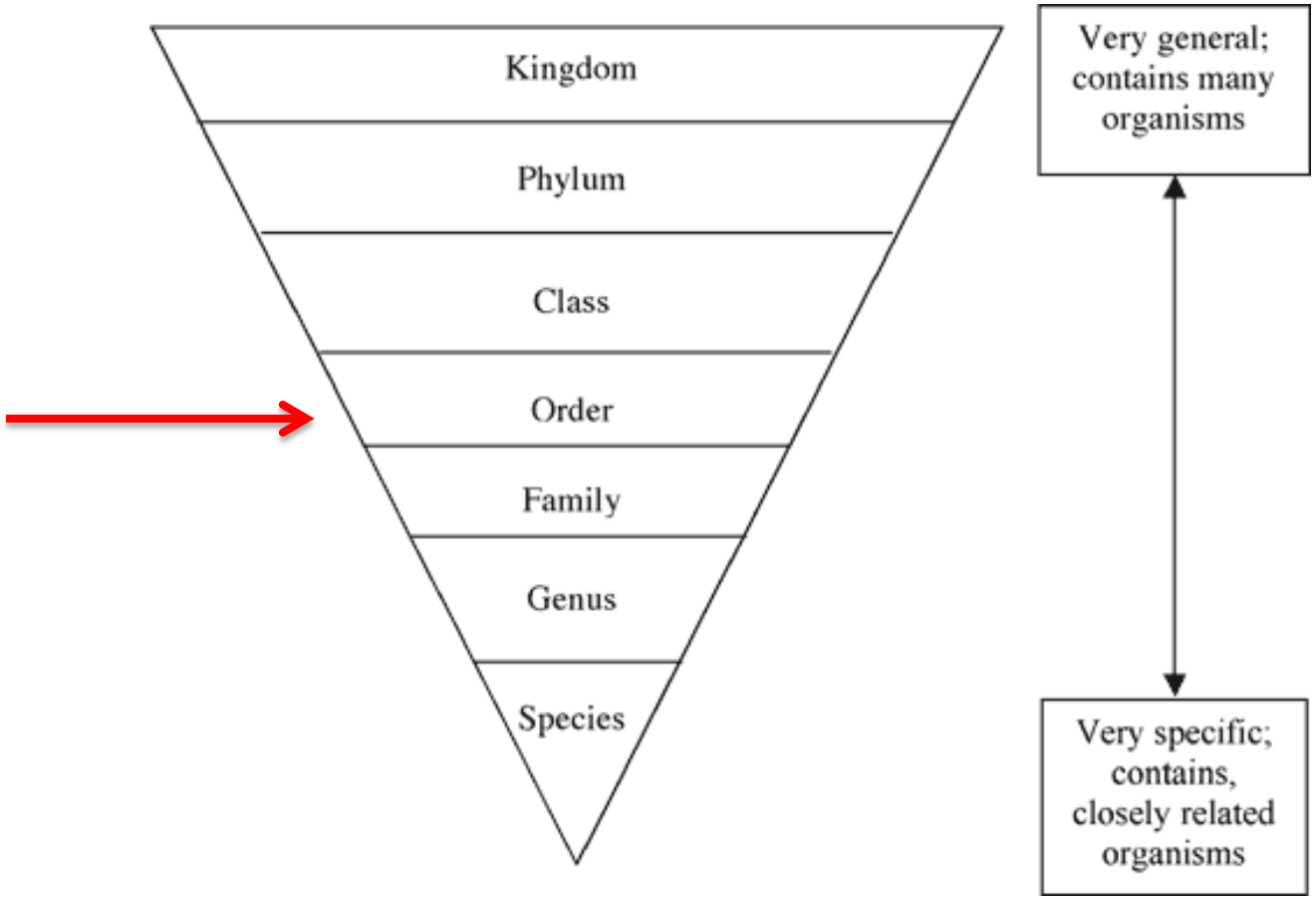
Principles of Biology
BIOL 1108
Biodiversity



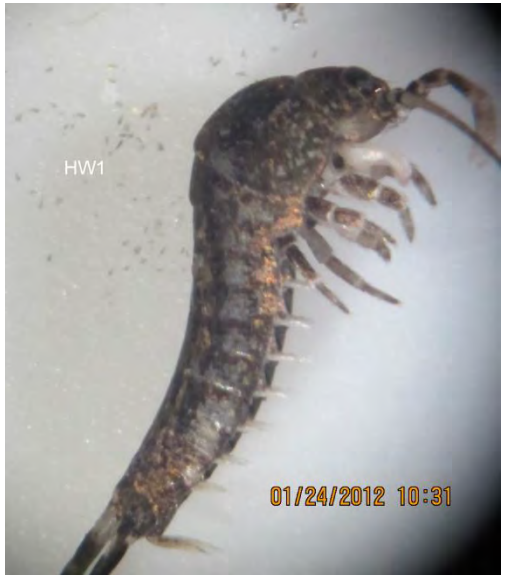
http://www.discoverlife.org/

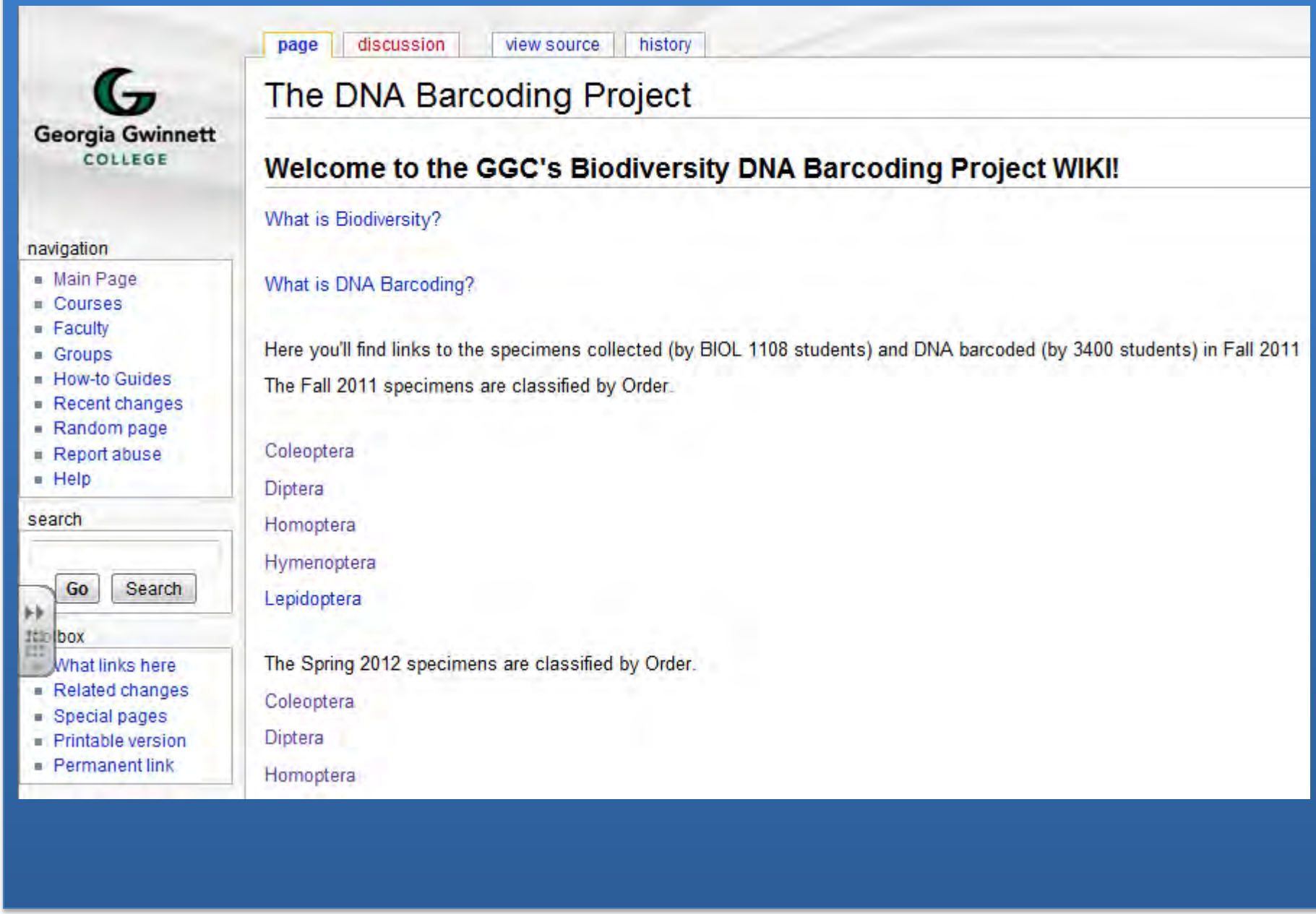
Identification/Classification of organisms

- Taxonomy: morphology



Principles of Biology
BIOL 1108
Biodiversity

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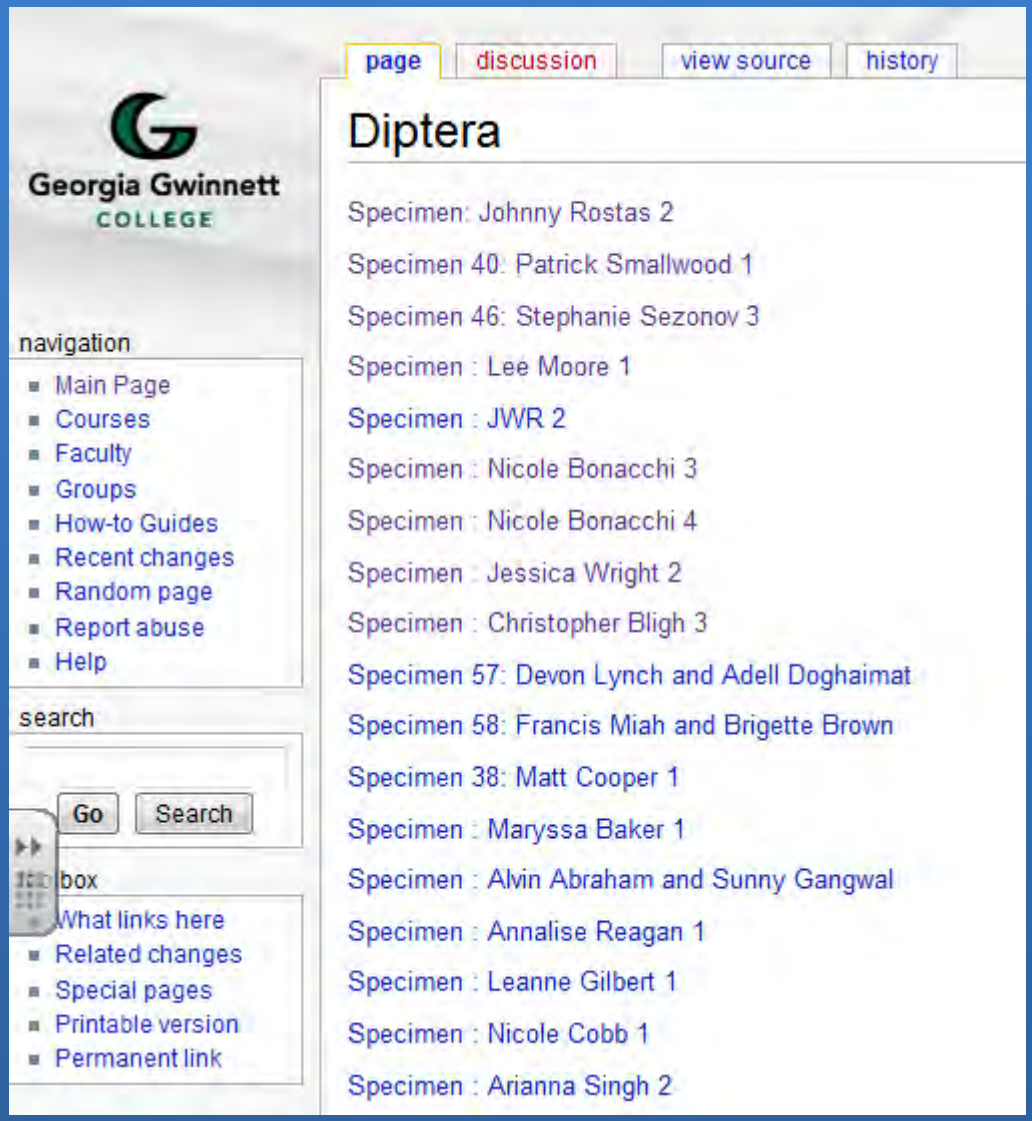
The DNA Barcoding Project
Welcome to the GGC's Biodiversity DNA Barcoding Project WIKI!
What is Biodiversity?
What is DNA Barcoding?
Here you'll find links to the specimens collected (by BIOL 1108 students) and DNA barcoded (by 3400 students) in Fall 2011
The Fall 2011 specimens are classified by Order.
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

Georgia Gwinnett COLLEGE

Specimen : Jessica Wright 2

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

Date of collection:9/2011

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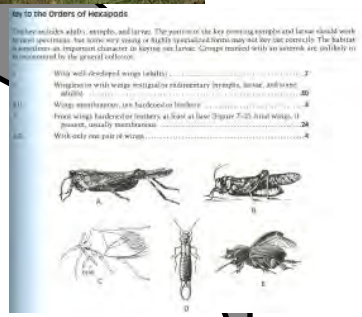
Distinguishing morphological features of Order: only one set of wings, Eyes: large, Mouth patrs: varible, Taris:5 segmented

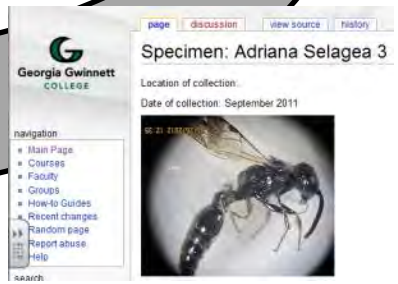
Geographical Distribution

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

Principles of Biology
BIOL 1108
Biodiversity



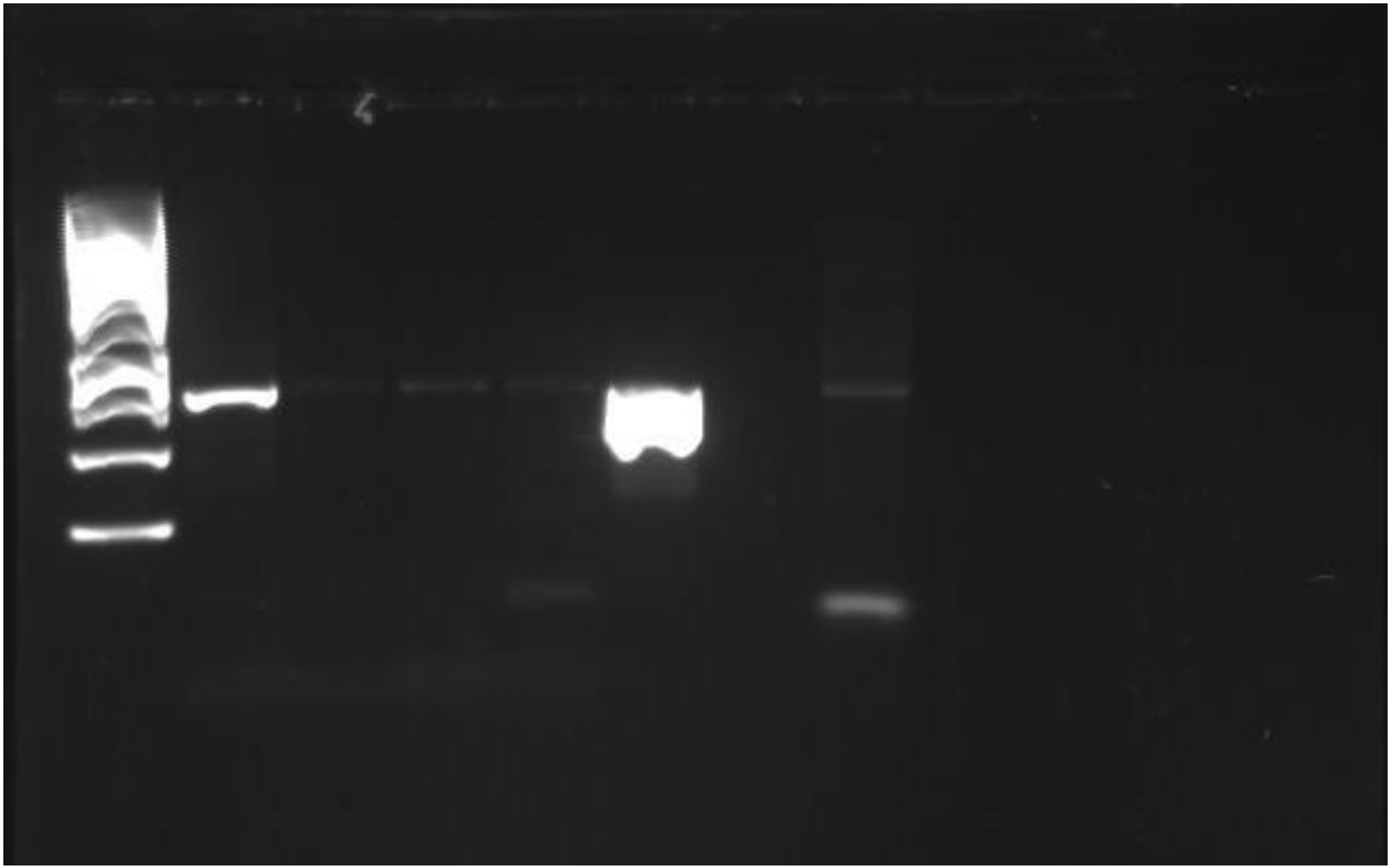
DNA barcoding
Cell Biology / Biotechnology
BIOL 3400 / 4300



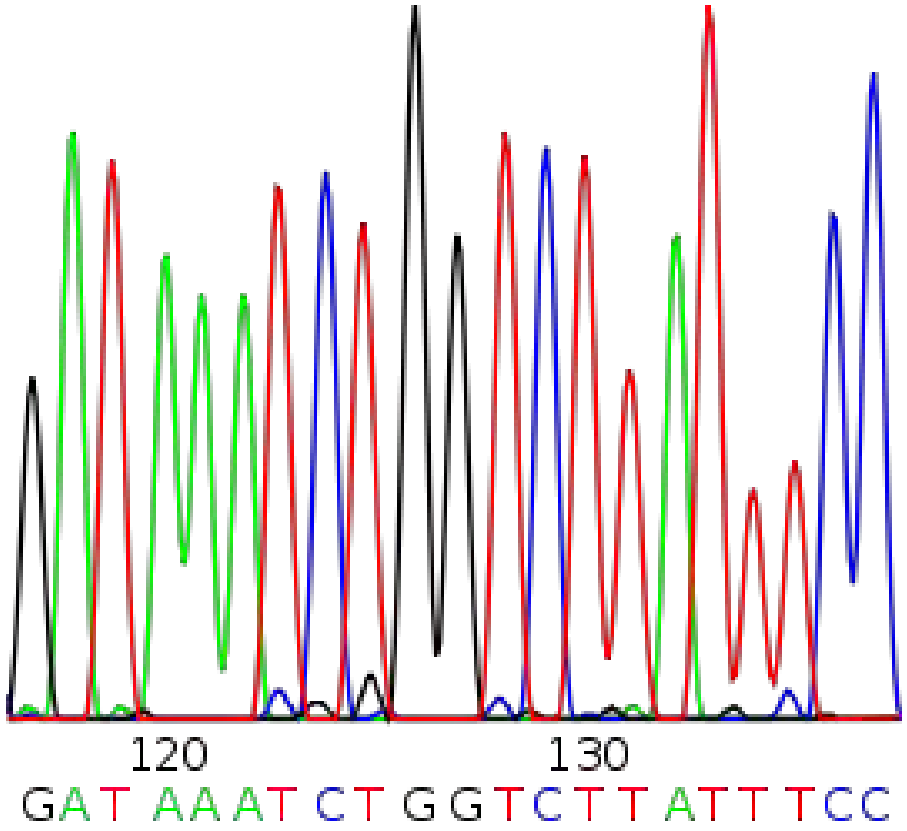
BIOL 3400 : DNA Barcoding

Step 1: DNA extraction

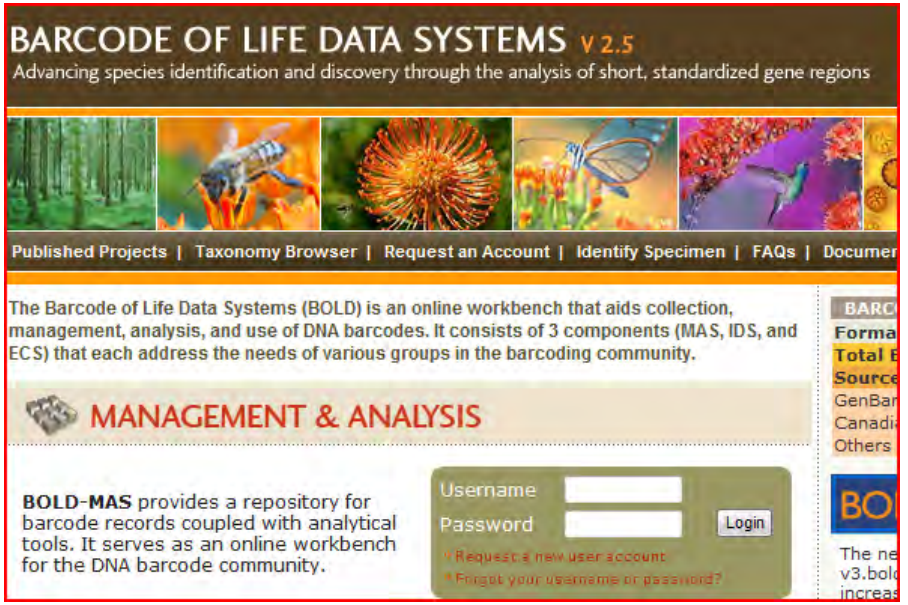
Step 2: Gene amplification (PCR)



Step 3: Gene sequencing



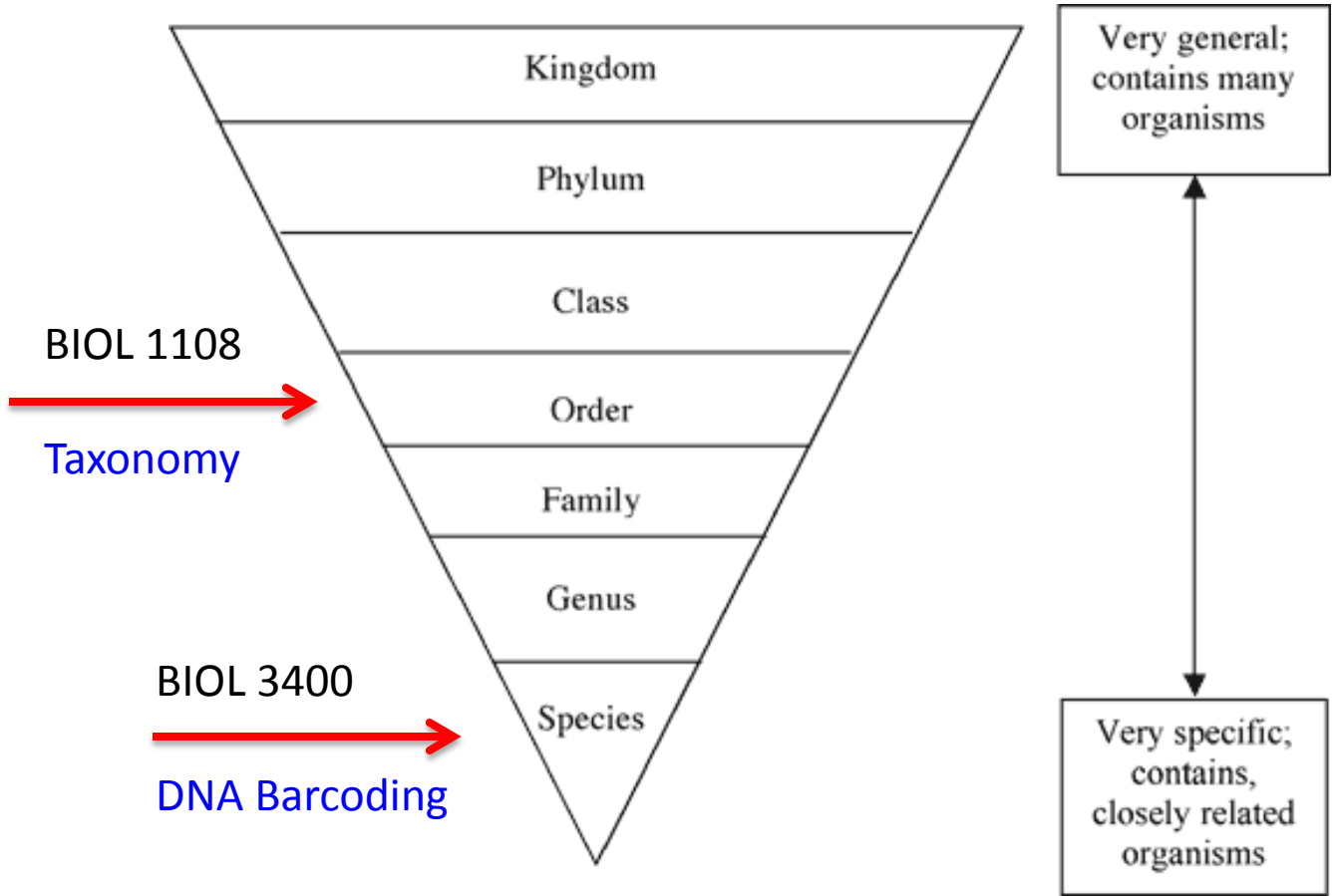
Step 4: Bioinformatics



Species Identification

TOP 20 Matches : Display option: default

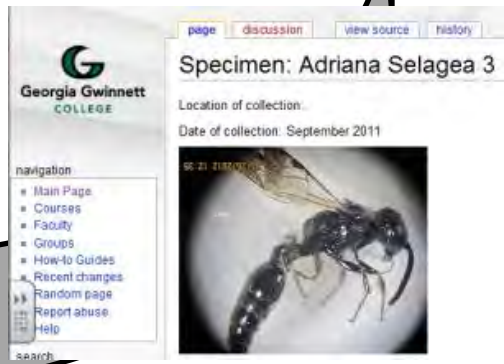
Phylum	Class	Order	Family	Genus	Species	Specimen Similarity (%)
Arthropoda	Insecta	Diptera	Chironomidae	Ablabesmyia	*aspera*	94.87
Arthropoda	Insecta	Diptera	Chironomidae	Ablabesmyia	*aspera*	94.87
Arthropoda	Insecta	Diptera	Chironomidae	Ablabesmyia	*aspera*	92.95
Arthropoda	Insecta	Diptera	Chironomidae			92.95



Principles of Biology
BIOL 1108

Biodiversity

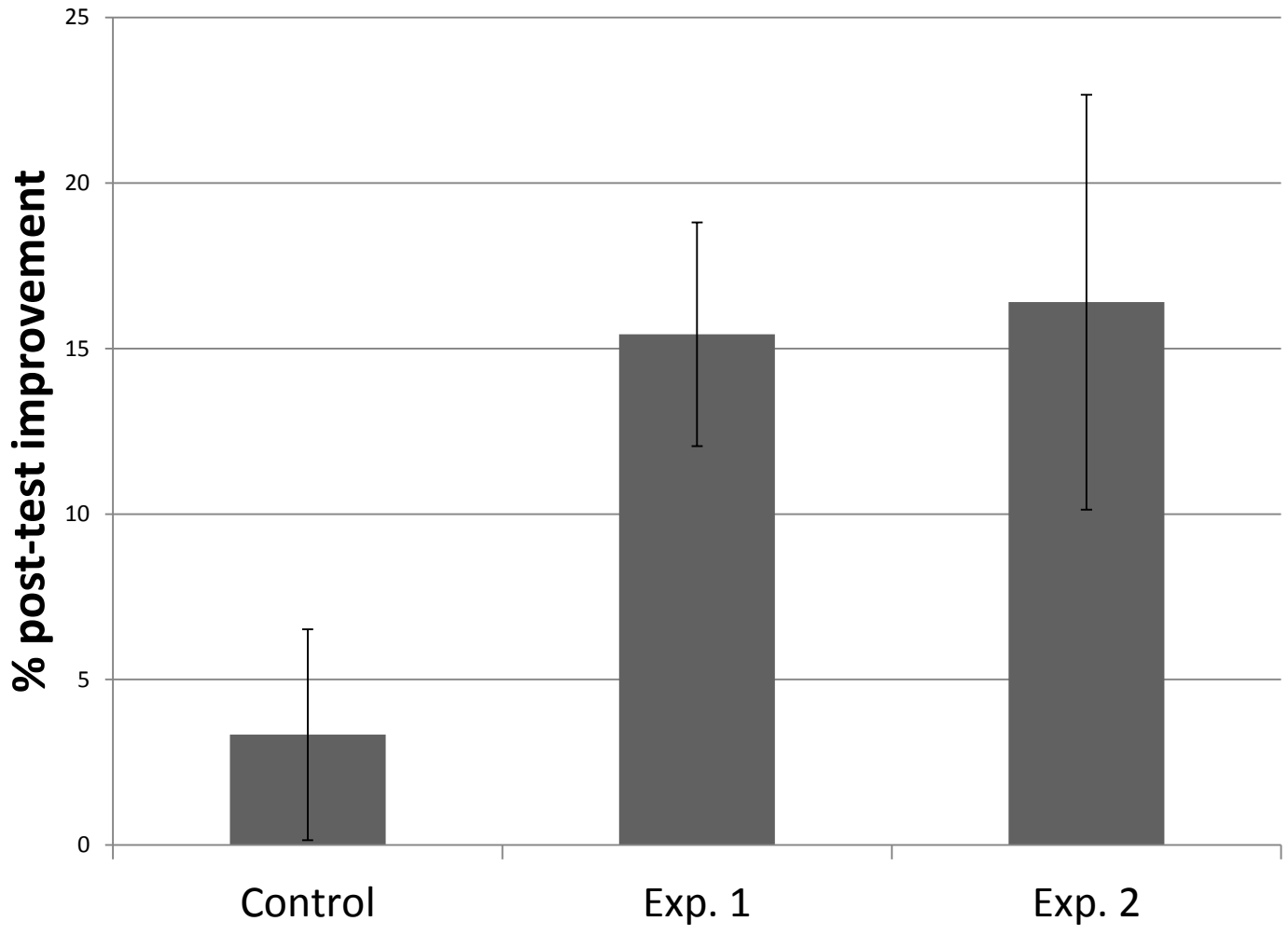
Species Identification



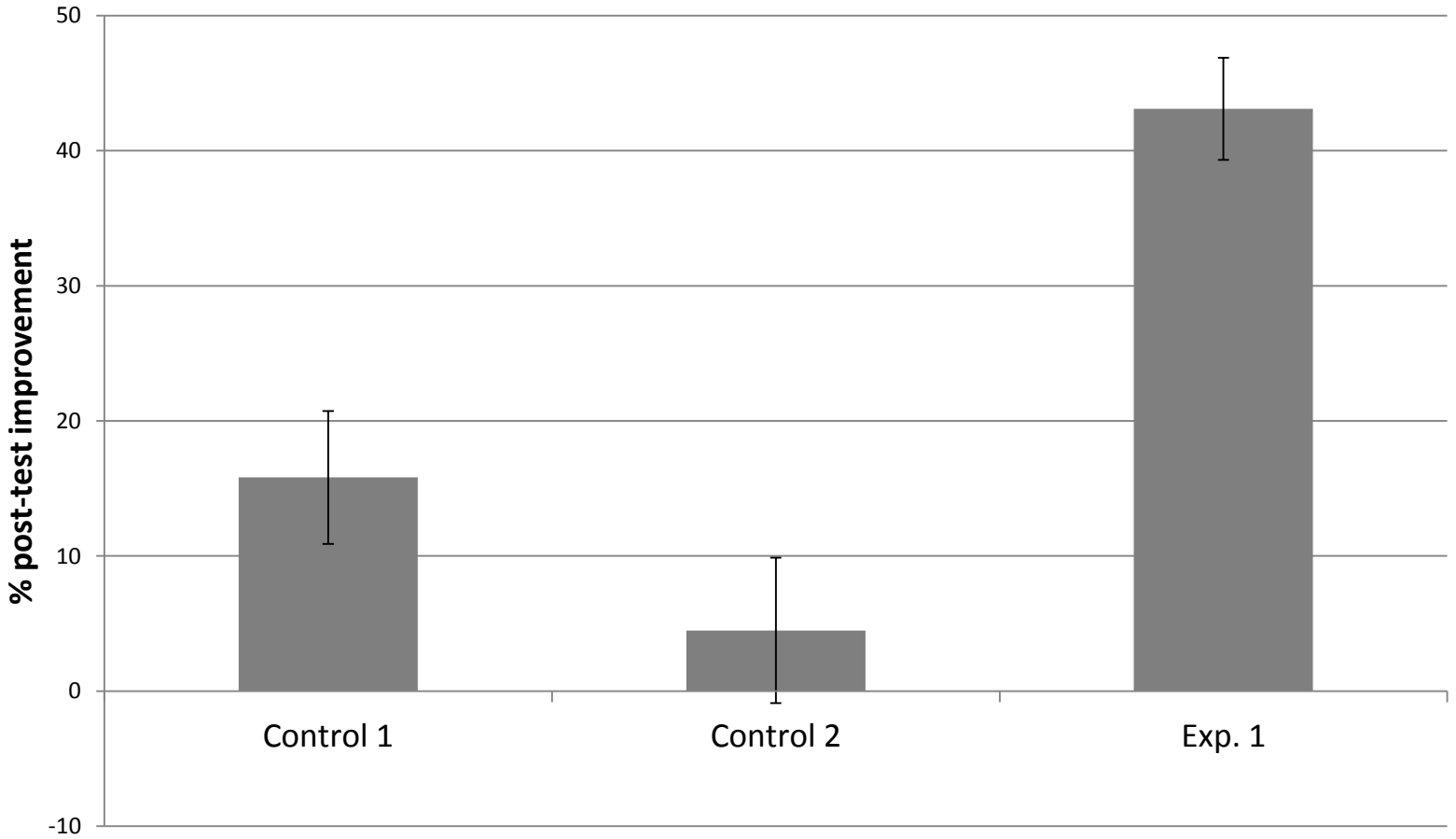
DNA barcoding

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.

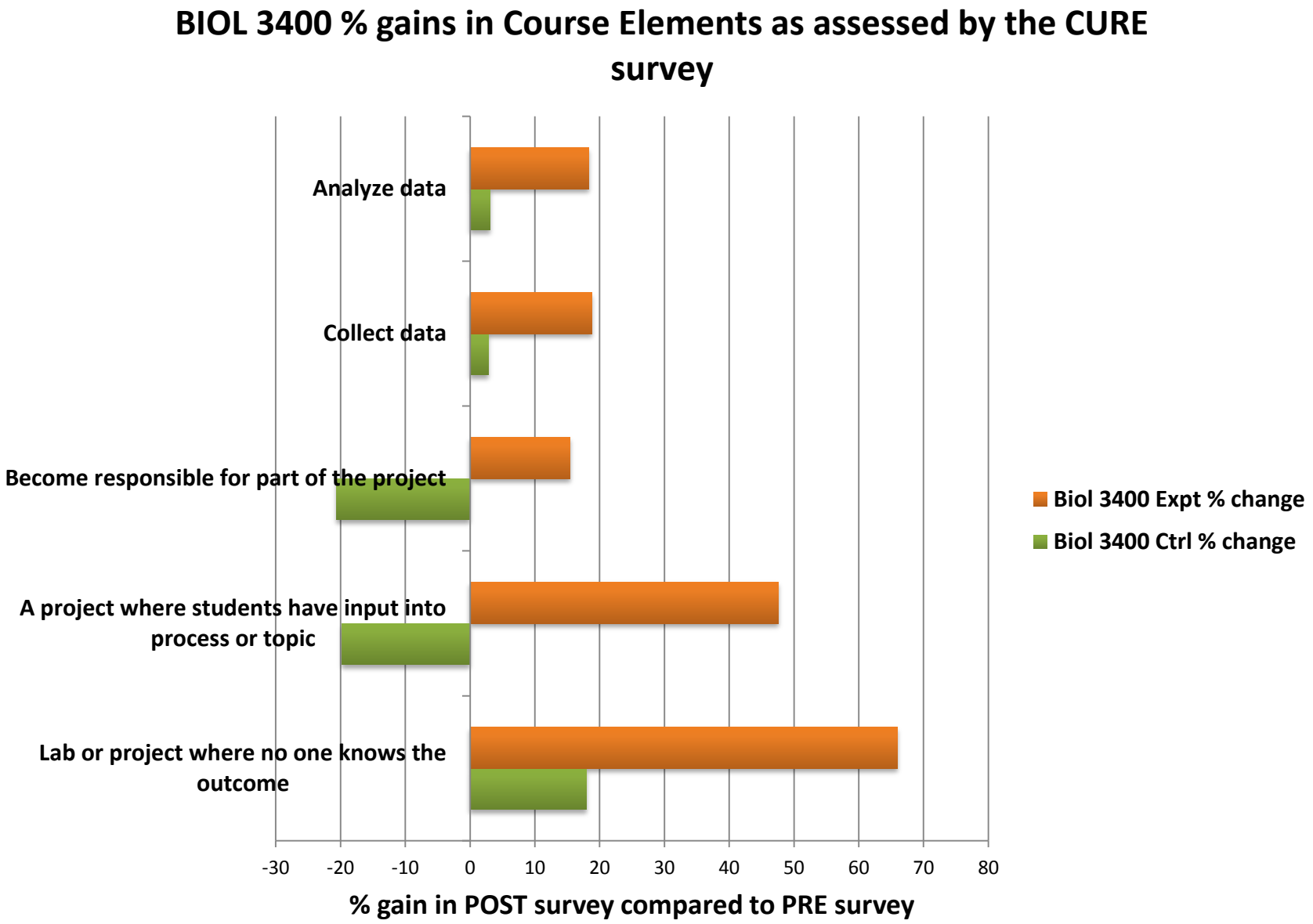
a) Design 2 primers, each 6 nucleotides long

b) Mark your primers on the diagram with their sequence and direction of extension, being sure to label the 5’ and 3’ ends.

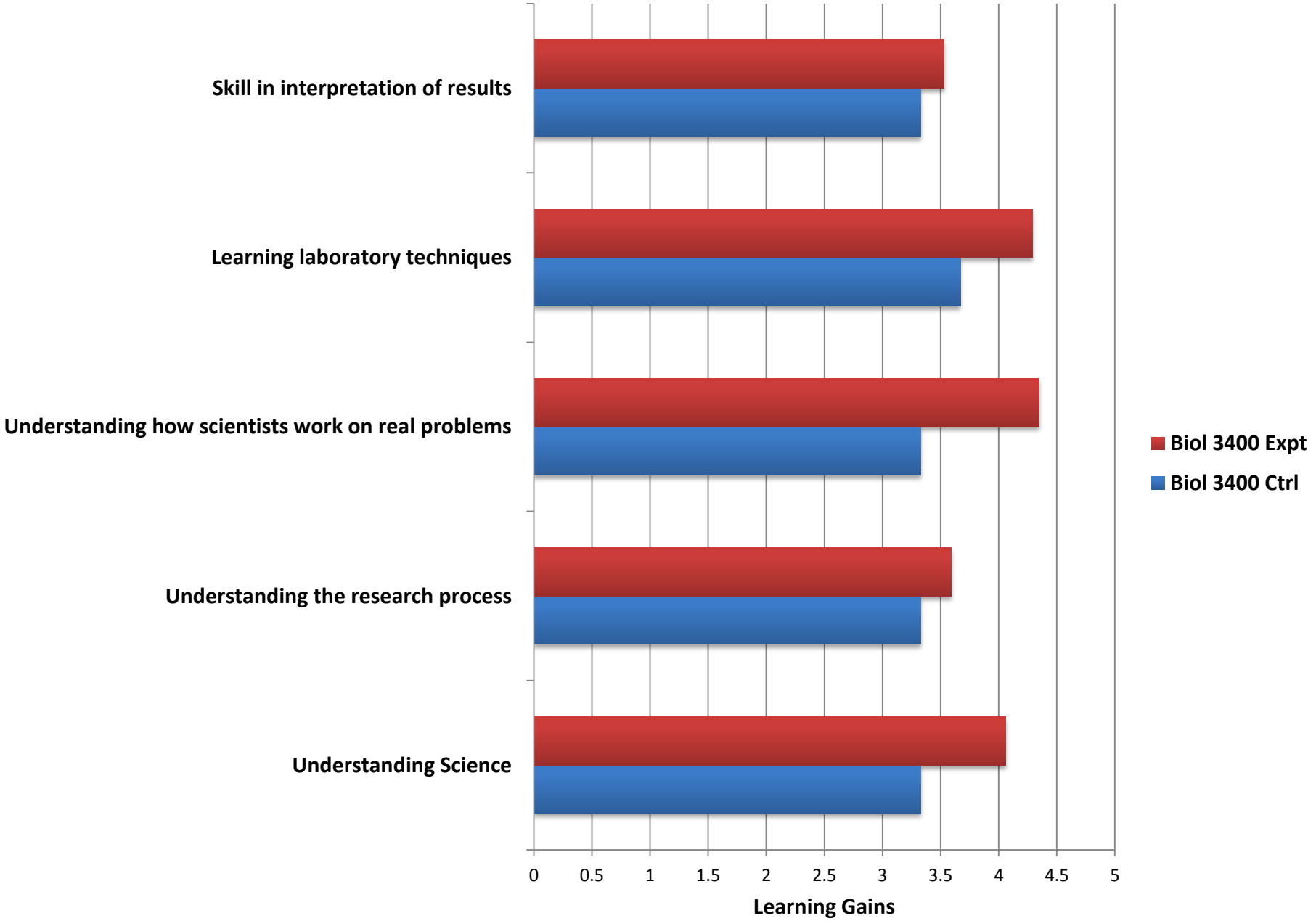
c) Using another colored pen, extend the primers (like you would in cycle 1)

5’TACAGTATTCGGCATCATGCTCGCGTGCTAGCAGGCCGAATTC 3’

3’ATGTCATAAGCCGTAGTACGAGCGCACGATCGTCCGGCTTAAG 5’



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
Skill in interpretation of results
Learning laboratory techniques
Understanding how scientists work on real problems
Understanding the research process
Understanding Science
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Learning Gains
Biol 3400 Expt
Biol 3400 Ctrl

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

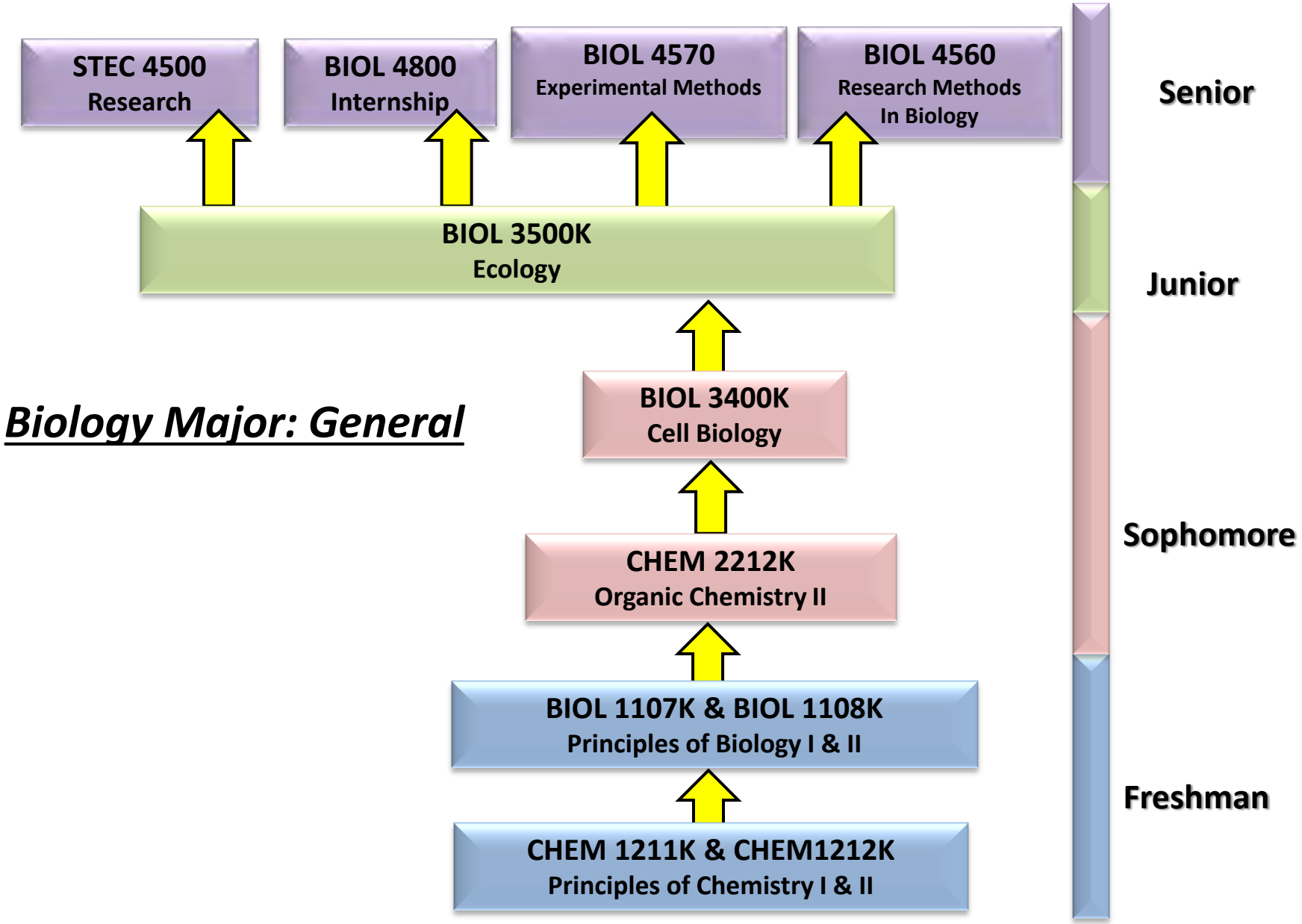
Biodiversity results:

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

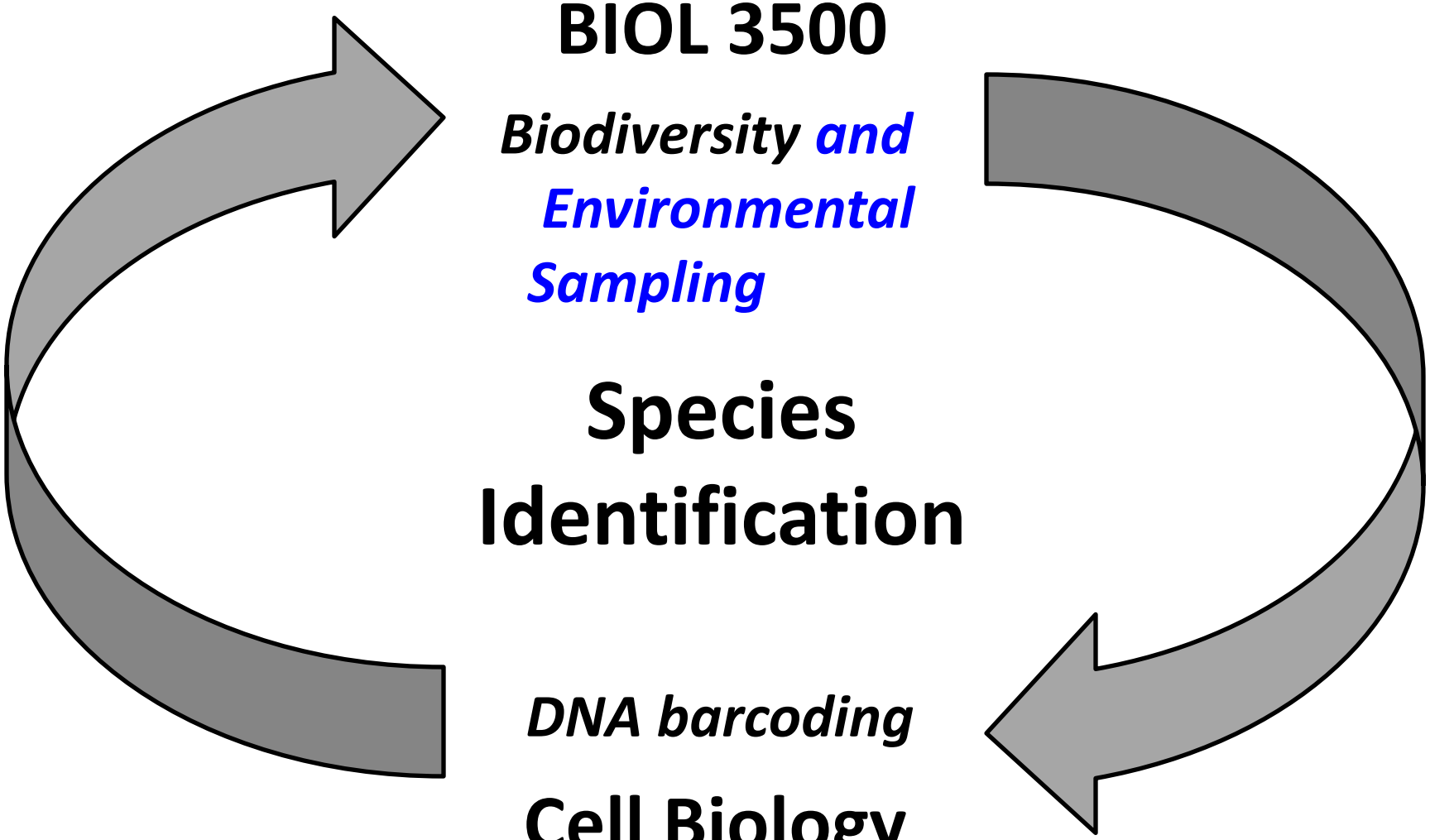
Issues (we had plenty)

- 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



Biology Major: General


Ecology
BIOL 3500
Biodiversity and Environmental Sampling
Species 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

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

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

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

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

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

Ecology (BIOL 3500)

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

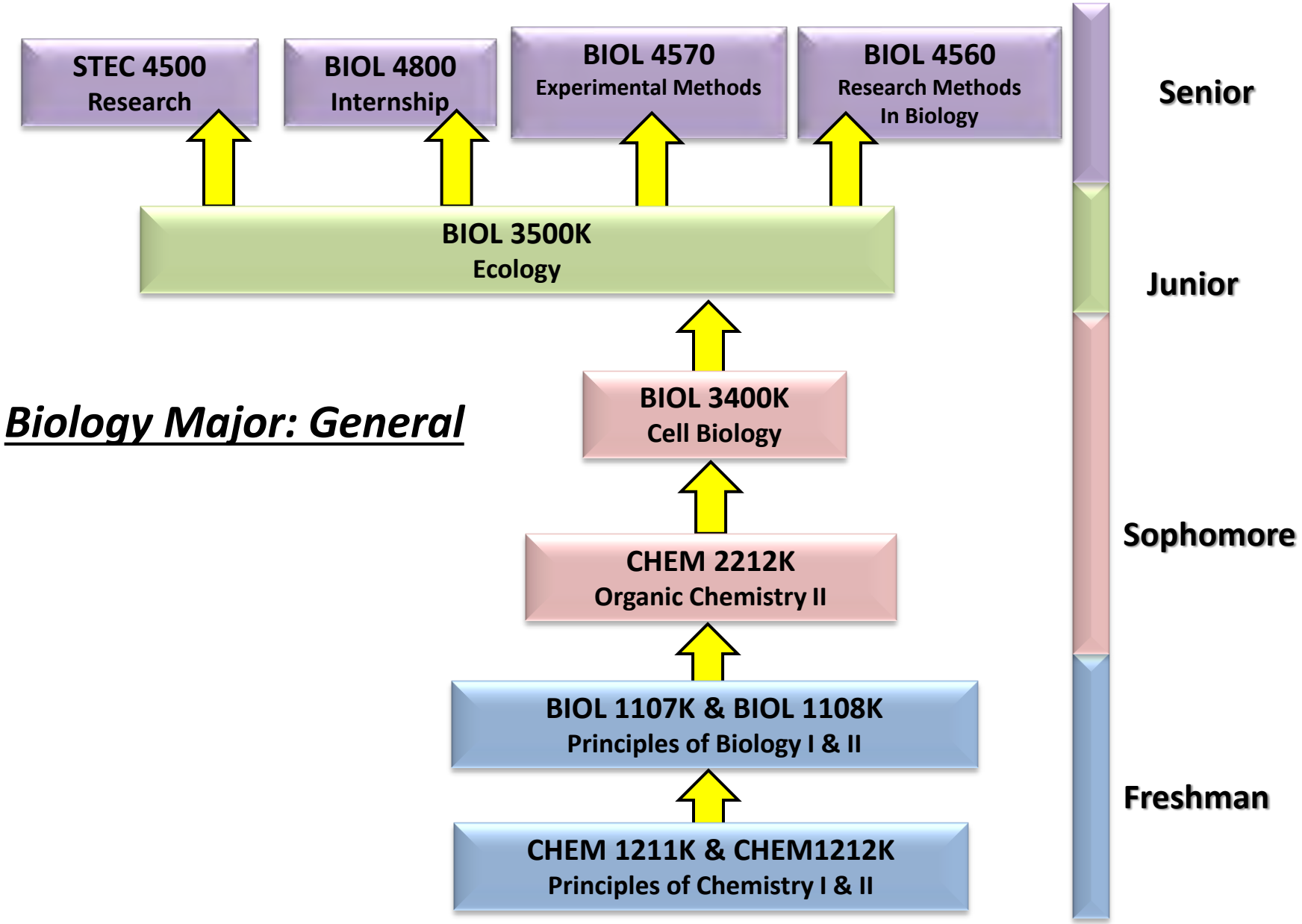
Area	Species Count	Total Abundance	H'	H'_{max}	J'	var H'
GGC1	59	257	3.370489	4.07753744	0.826599095	0.00555266
GGC2	47	153	3.400	3.8501476	0.883004731	0.00748123
GGC3	29	69	3.034	3.36729583	0.901021912	0.01268275
GGC4	106	712	3.698995	4.66343909	0.793190392	0.00266935

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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A multi-section, multi-course collaboration!

Allison D'Costa

James Russell

Clay Runck

Mark Schlueter

Robert Haining

Alessandra Barrera

Erin Quinlan

David Barnes