

Phylogeny of *Aspergillus* and *Penicillium* species: — engaging undergraduate students in science

M. Gita Bangera¹, Martha Christensen², Caroline Peppe¹, Chad Jessup¹, and Andrea Gargas³
¹Bellevue College, Bellevue WA; ²Madison, WI; ³Symbiology LLC, Middleton WI



Teaching

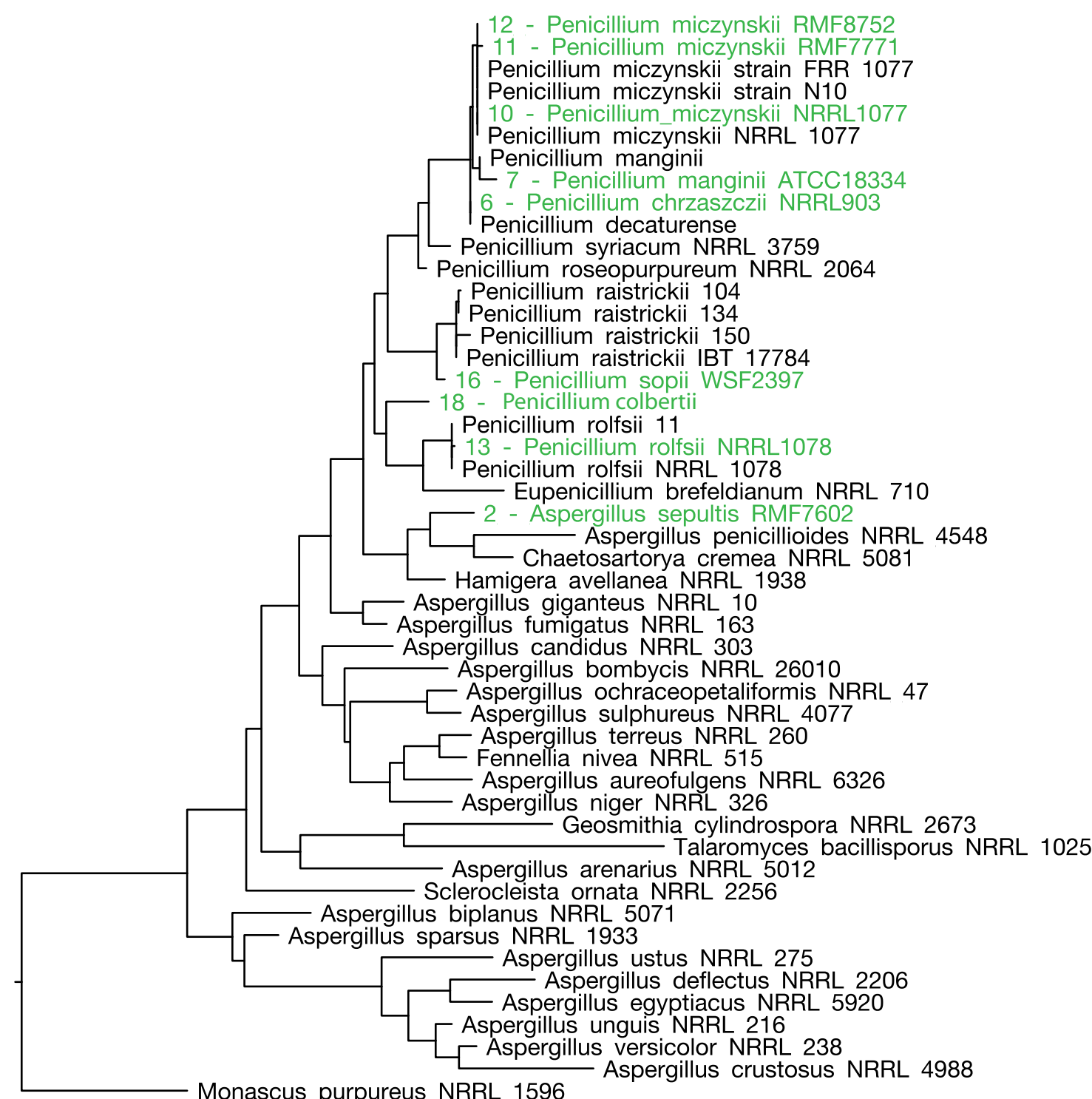
While students in many fields experience the life of the profession for which they are headed, biology students are expected to take a leap of faith into their careers without any real-life exposure. **Comgen** is an NSF-funded project that provides biology students a mini-graduate school experience, including the frustrations and delights of scientific discovery.

Research

Over her career, Martha Christensen has collected new and diverse soil fungi from around the world with a special focus on their ecology and ecosystem roles. Her fungal collection <moldsforyou.org> is an international treasure including over 2,200 specimens.

This project is aimed at classifying fungi from this collection with the latest molecular techniques and introducing the next generation of students to microbial diversity. Our preliminary study focuses on the phylogeny of *Aspergillus* and *Penicillium* species, whose impact ranges from life-saving to lethal. We initially seek to compare phylogenies suggested by ITS rDNA sequences to those based on morphological or biochemical characters.

Results



Phylogram based on Maximum Likelihood analysis of 49 taxa and 737 characters. New sequences are shown in green.

Our initial comparison of a maximum likelihood analysis of ITS rDNA with Christensen et al.'s we found that our DNA data confirms the general groupings of taxa in these trees. We will next expand our dataset to include sequences from other genes (Beta-tubulin introns and the LSU D1 and D2 loop regions), and extend our statistical analysis.

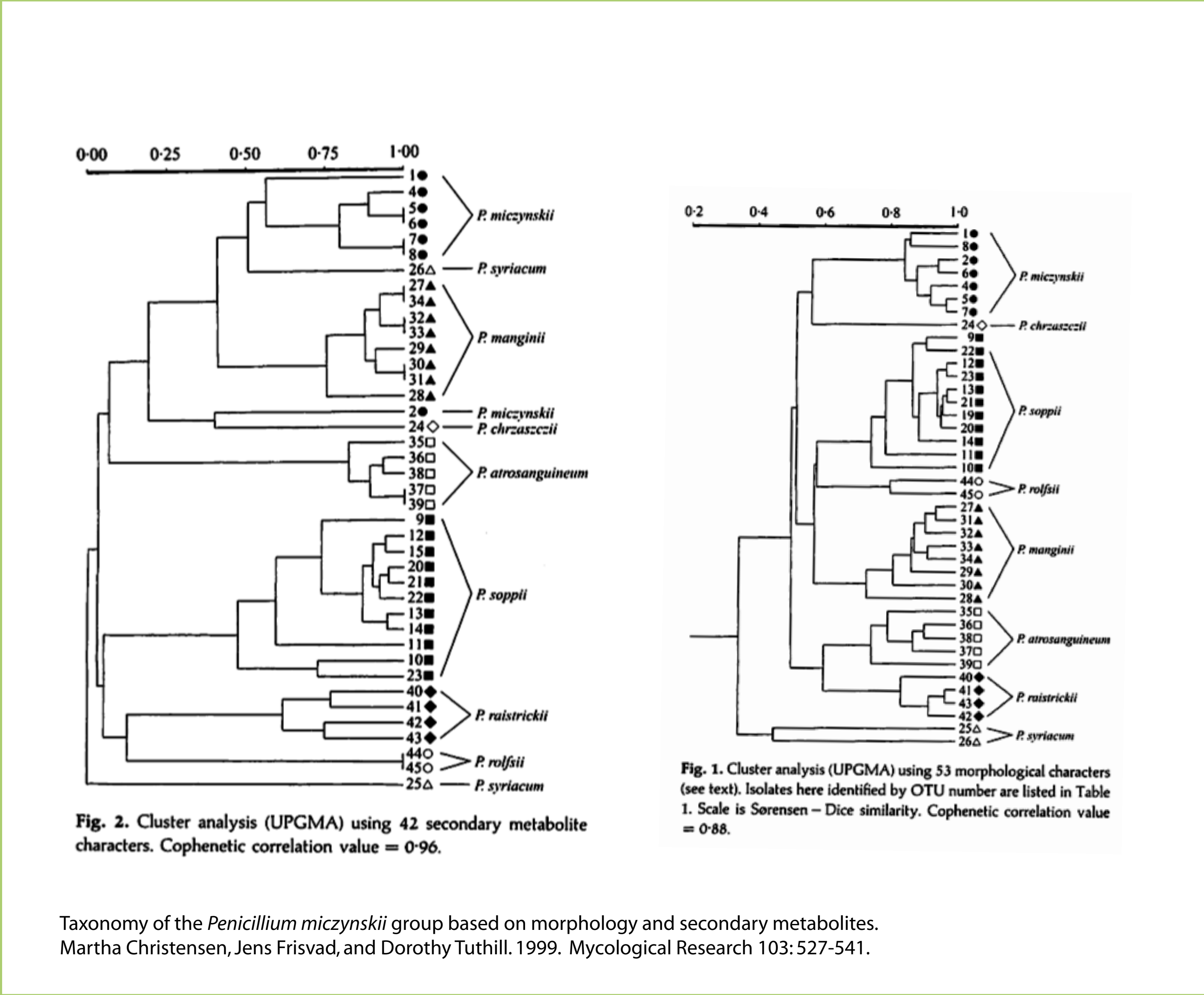


Fig. 2. Cluster analysis (UPGMA) using 42 secondary metabolite characters. Cophenetic correlation value = 0.96.

Fig. 1. Cluster analysis (UPGMA) using 53 morphological characters (see text). Isolates here identified by OTU number are listed in Table 1. Scale is Sørensen – Dice similarity. Cophenetic correlation value = 0.88.

Taxonomy of the *Penicillium miczynskii* group based on morphology and secondary metabolites. Martha Christensen, Jens Frisvad, and Dorothy Tuthill. 1999. Mycological Research 103:527-541.

Teaching

Self-directed learning

- Prerequisite only a basic biology course
- Socratic method with almost no lectures
- Students collaborate on learning concepts and techniques
- Connect new protocols to underlying theories
- Real-world lab product assessment

Original Research

- Authentic problems
- Unknown answers
- Lab notebook as documentation

Research

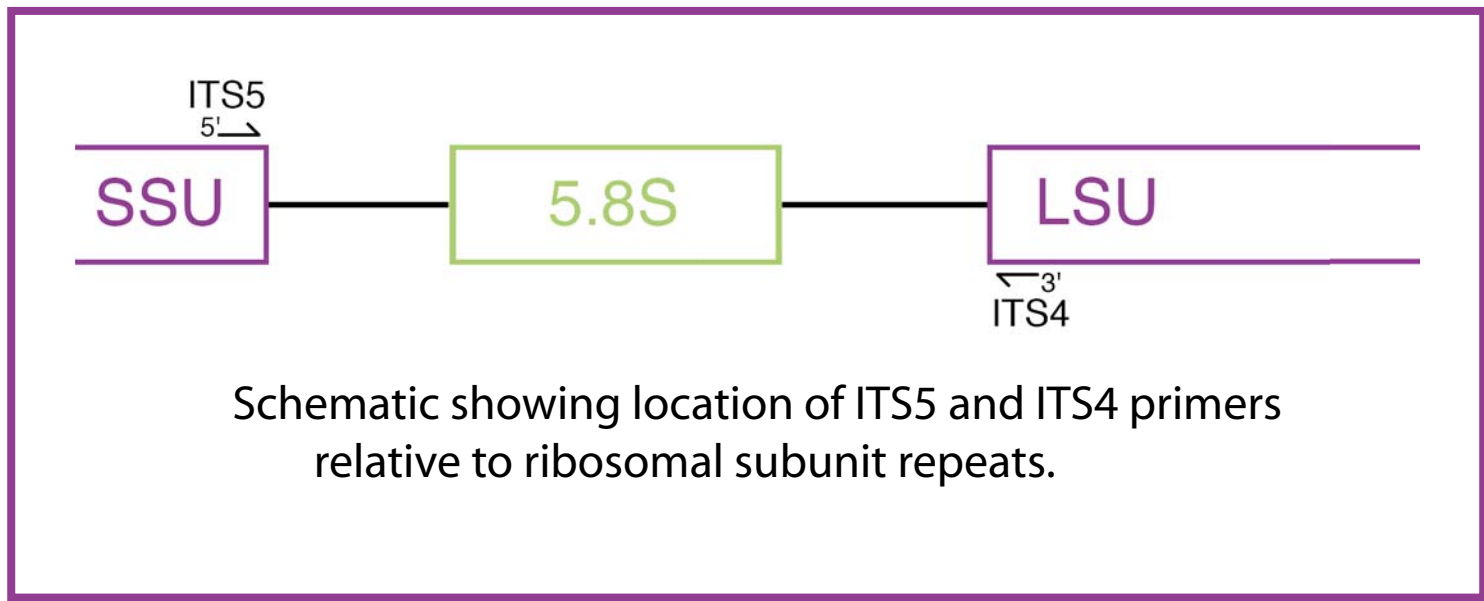
Fungal Cultures

Isolate	Species	Geographical Location	Isolation Date
RMF7602	<i>Aspergillus sepultis</i>	Ida County, Iowa USA	1984
NRRL903	<i>Penicillium chraszcii</i>	Picea forest soil, Poland	1927
ATCC18334	<i>Penicillium manginii</i>	Fagus mycorrhizae, Italy	1963
NRR1077	<i>Penicillium miczynskii</i>	Conifer forest soil, Poland	1927
RMF7771	<i>Penicillium miczynskii</i>	<i>Pinus contorta</i> forest soil, Wyoming USA	1977
RMF8752	<i>Penicillium miczynskii</i>	Conifer forest soil, Oregon USA	1988
NRR1078	<i>Penicillium rolfsii</i>	Pineapple fruit, Florida USA	1905
VSF2397	<i>Penicillium sopii</i>	Temperate forest, Wisconsin USA	1960

PCR

Bio-Rad Mycycler

Program:
95°C 2 minutes
36 cycles:
95°C 30 seconds
50°C 30 seconds
72°C 1 minute
Final extension, 72°C 10 minutes
Hold at 4°C



PCR clean-up

Qiagen® QIAquick PCR Purification Kit™

PCR (sequencing)

Applied Biosystems XTerminator® Kit
Program:
96°C 4 minutes
25 cycles:
96°C 10 seconds
50°C 5 seconds
60°C 4 minutes
Hold at 4°C

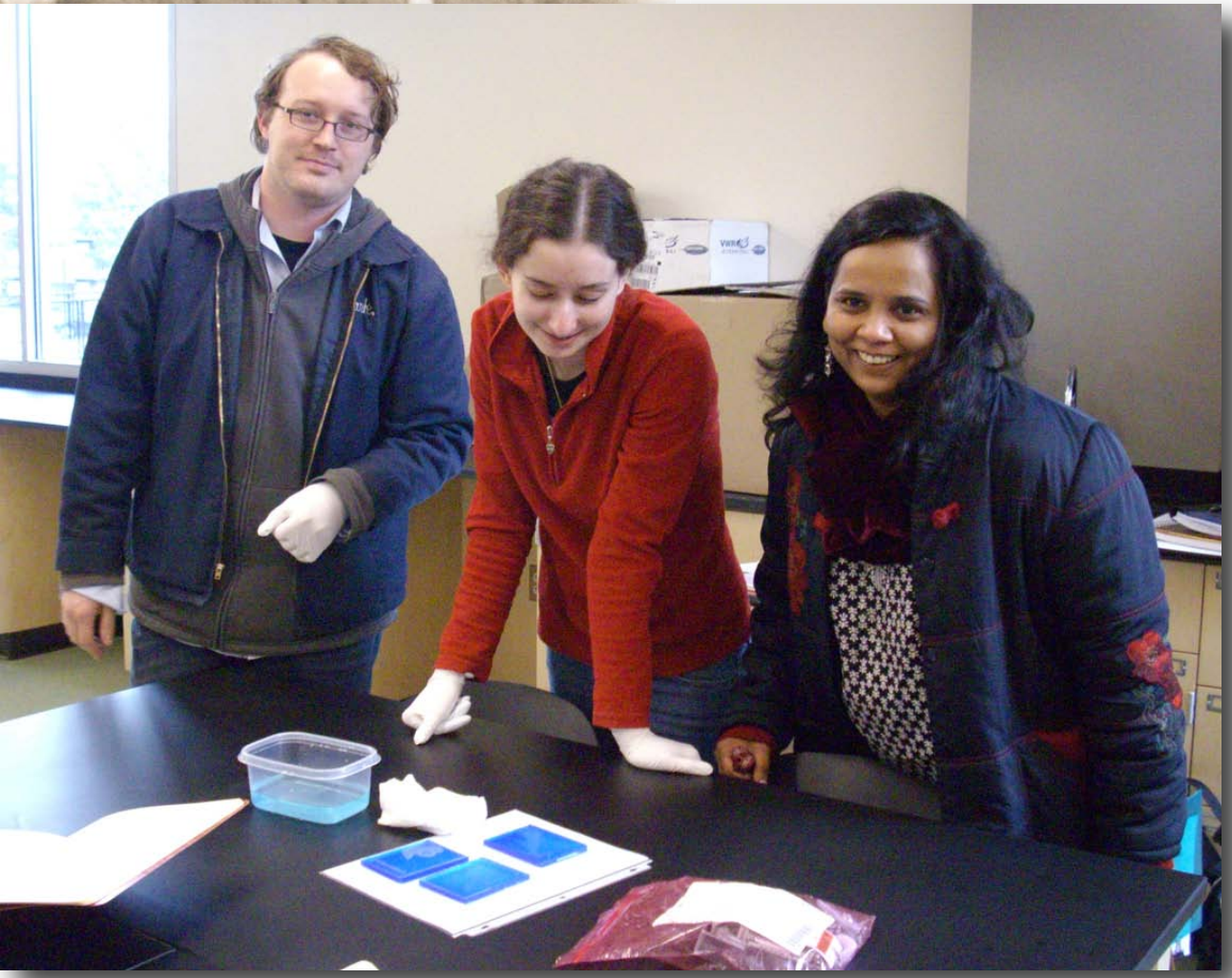
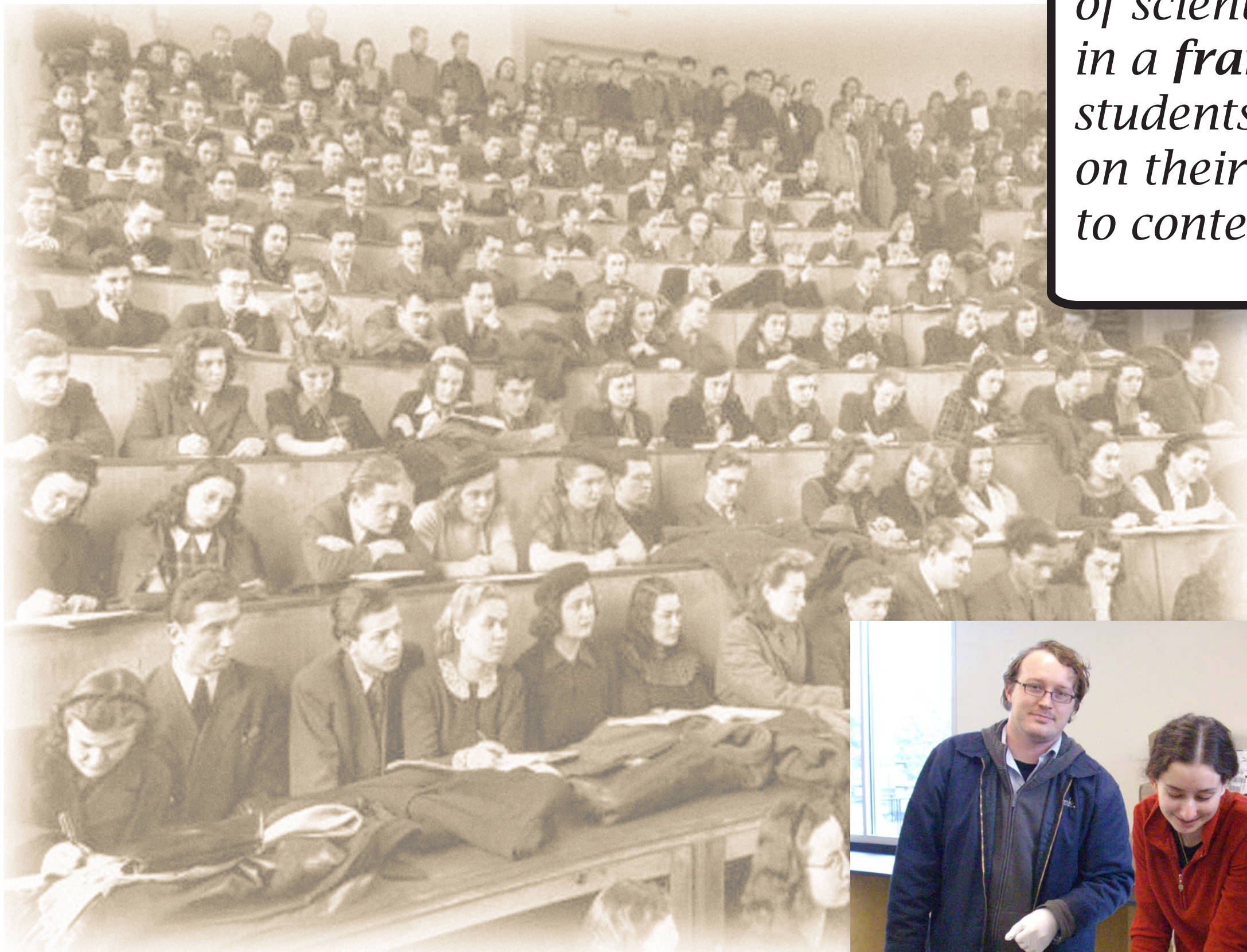
DNA Sequencing

Applied Biosystems 3130 Genetic Analyzer

Sequence Analysis

BLASTn
Sequences from GenBank, Alignment in Se-Al,
Maximum Likelihood analysis Garli 0.96b8

Discussion



“Science education should focus less on what instructors ‘cover,’ and more on what students learn and how well they can **use their knowledge**; less on vocabulary and facts that students memorize, and more on students’ understanding of scientific concepts and how these concepts fit together in a **framework of knowledge** about a subject; less on what students can repeat back immediately in class, and more on their long-term retention and ability to **transfer knowledge** to contexts outside the classroom” (DeHaan, 2005)

Through this project, students with minimal experience in molecular biology, and no experience in mycology or phylogenetics, gained confidence in their abilities as independent researchers, and are emerging as self-directed learners comfortable with ambiguity and able to handle the ever-increasing amount of knowledge.

Our teaching methods have wide applicability for fostering student interest in science. We are currently developing our teaching methods for dissemination to other educators.

Our goal is transformation of not just the classroom, but also the teaching experience.

Support

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<http://scidiv.bellevuecollege.edu/comgen/>
gita.bangera@bellevuecollege.edu

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“I never thought frustration could be fun.”