

Involving students in curriculum development: design of a new genetics laboratory

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INTRODUCTION

In Fall 2017, the Biology Department introduced a new laboratory-based genetics course. To develop the course, we modified a team-based approach successfully used in the past (figure 1). During the summer, I tested and revised protocols, researched background literature, and gave feedback from a student perspective. We also figured out how long it took to do experiments and other activities for the students to make a course schedule. During the first offering of the course, I served as a student academic apprentice. Although we found some drawbacks to our modification of the team-based approach, the involvement of a student in course development helped the course run more smoothly in its initial offering and be more interesting for the enrolled students.

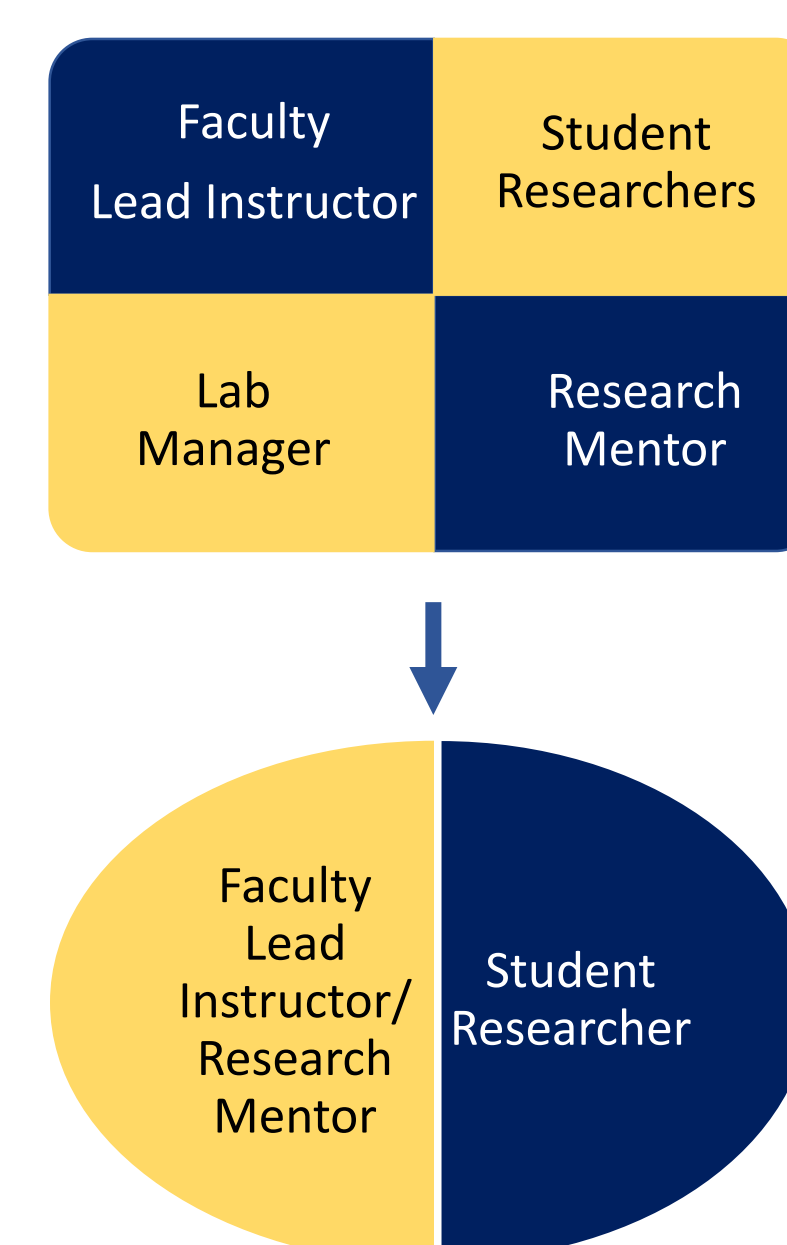
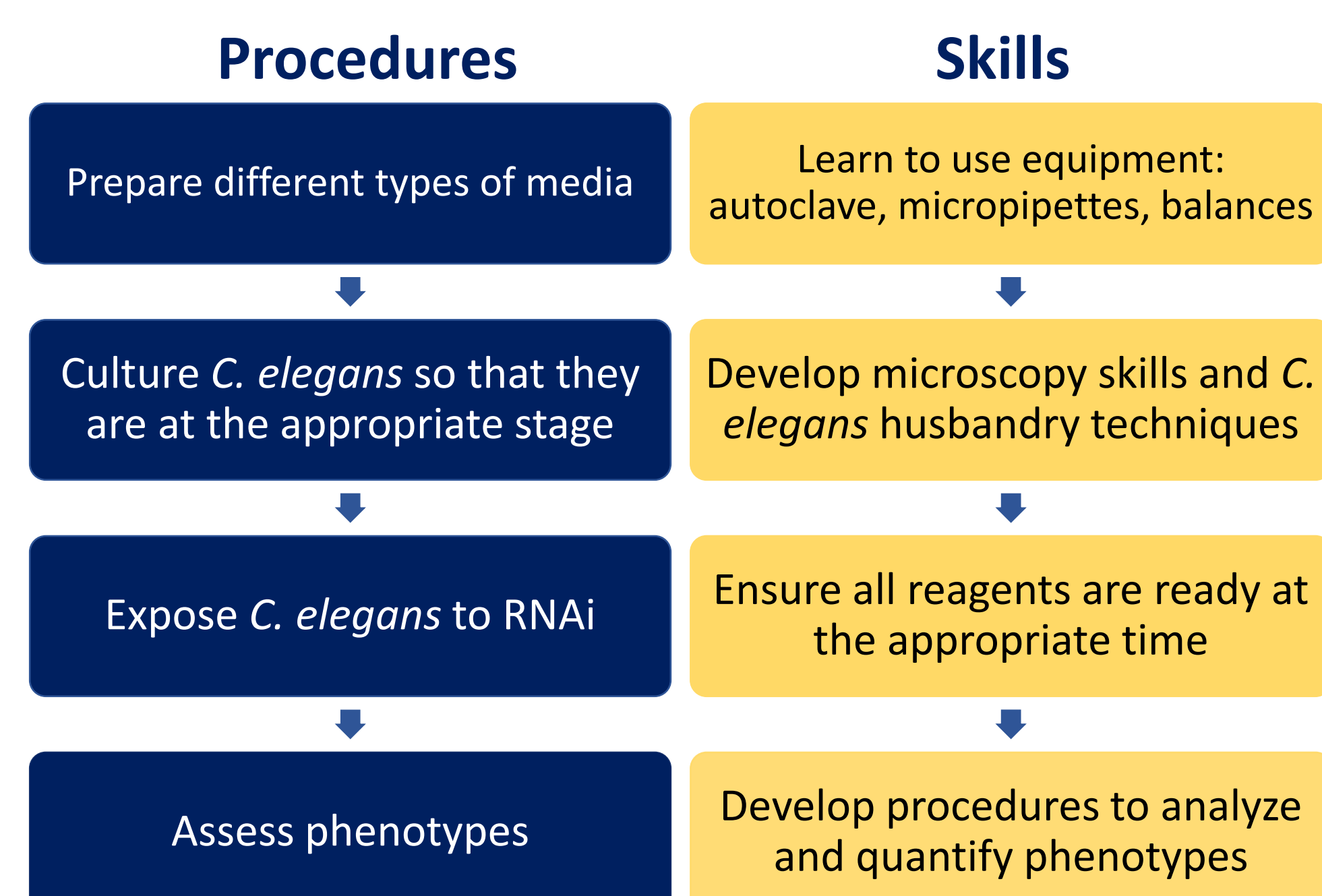


Figure 1. A modified team-based course development model used for development of a Genetics Inquiry course. Due to budget and staffing constraints, team members included 1 student researcher and 1 faculty lead instructor (who was also the research mentor).

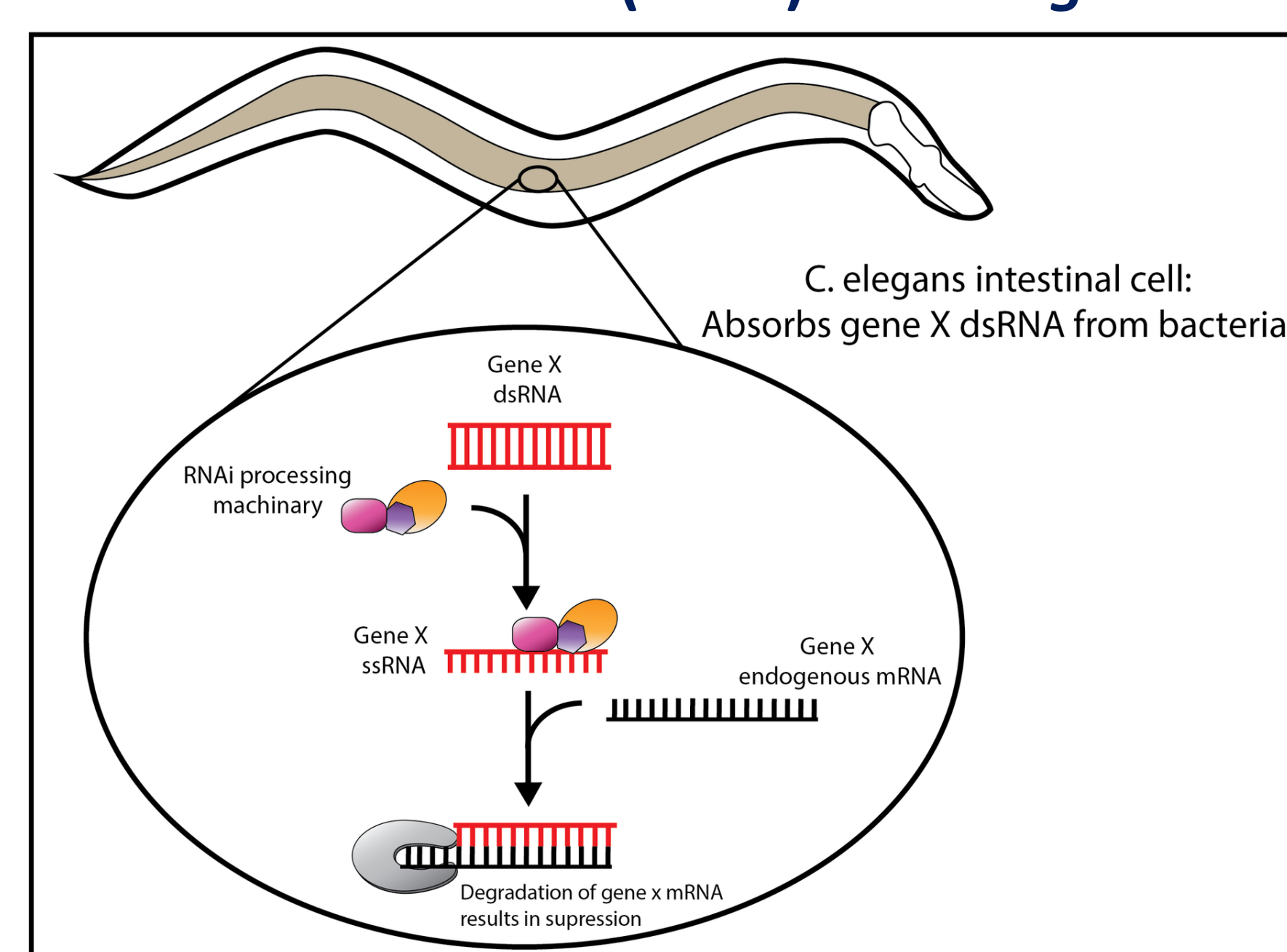
Module	Principle Question	Module Type	Module Development Tasks
Population Genetics	How do we determine what questions to ask about populations?	Mining existing data	Beta-test the modules with a focus on: - Timing - Background knowledge required - Student engagement level
Pharmacogenetics	How does genotype affect response to prescription drugs?	Case study	
Genomic Disease Odyssey	How is whole genome sequence data used in medicine?	Mining existing data/Simulation	NA
Reverse Genetics	What can we learn about the role of genes by interfering with their expression?	Experimental	Perform trial runs of the experiments with a focus on: - Timing - Degree of pre-lab preparation required - Success of protocols
Molecular Genotyping	Can we predict genotype based on your response to caffeine?	Experimental	

REVERSE GENETICS LAB

In order to introduce a lab with live organisms, the timing of the pre-lab preparation had to be finely-tuned in addition to establishing functional protocols that would work in the hands of undergraduates with limited lab experience.



RNAinterference (RNAi) in *C. elegans*



Challenges with original protocol:

- Distinguishing between phenotypes
- Getting phenotypes to show up

Changes to the module:

- Added more background information on how to identify phenotypes

During the semester:

- Students were able to develop strategies to measure phenotypes.

MOLECULAR GENOTYPING LAB

In a previous genetics laboratory course, Dr. Lyman Gingerich had taught a module involving the bitter tasting gene, TAS2R38, and the ability to taste PTC. When we discussed alternatives to this lab, I thought that students would be interested in learning about their bodies' ability to metabolize caffeine.

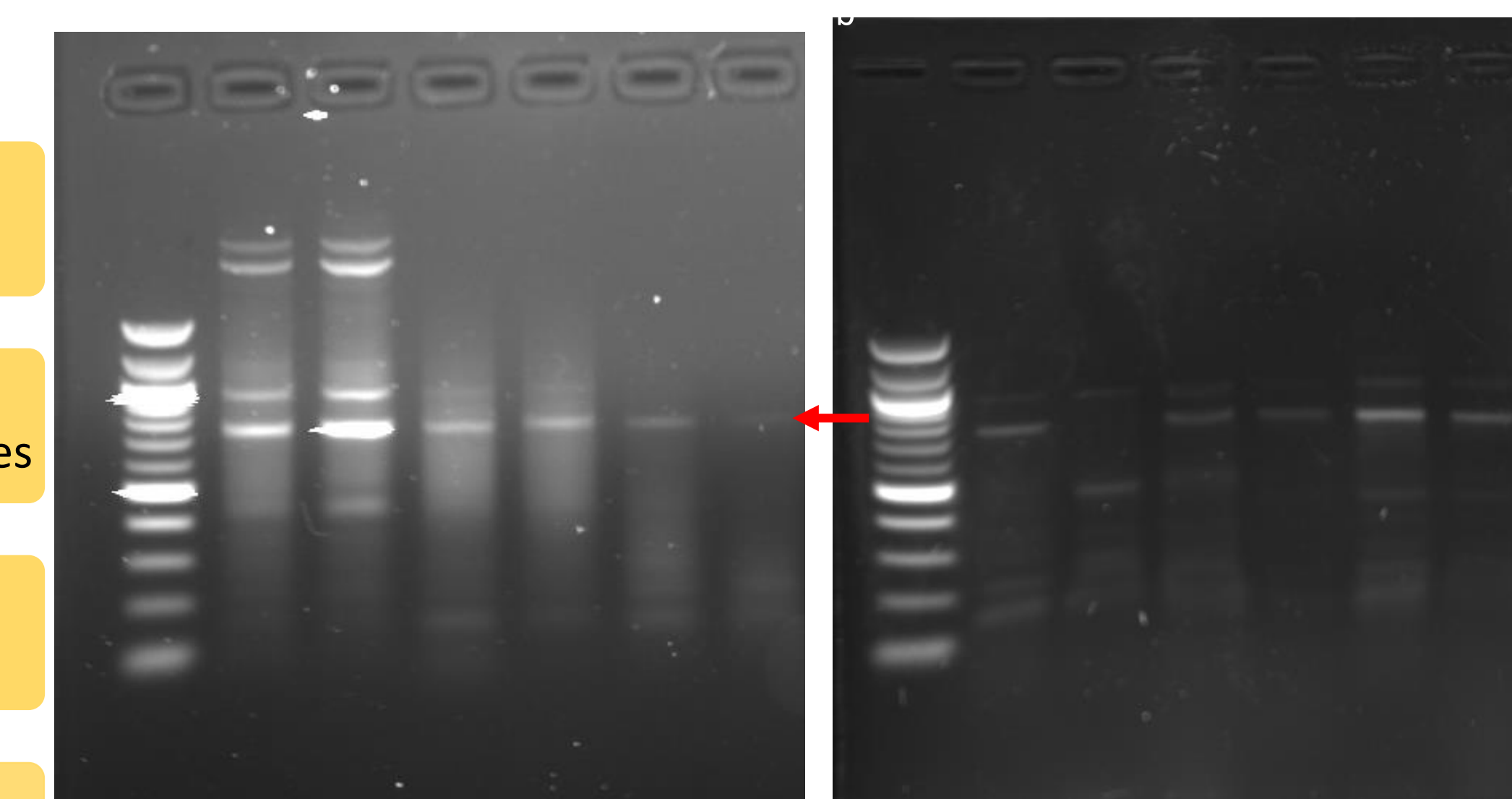
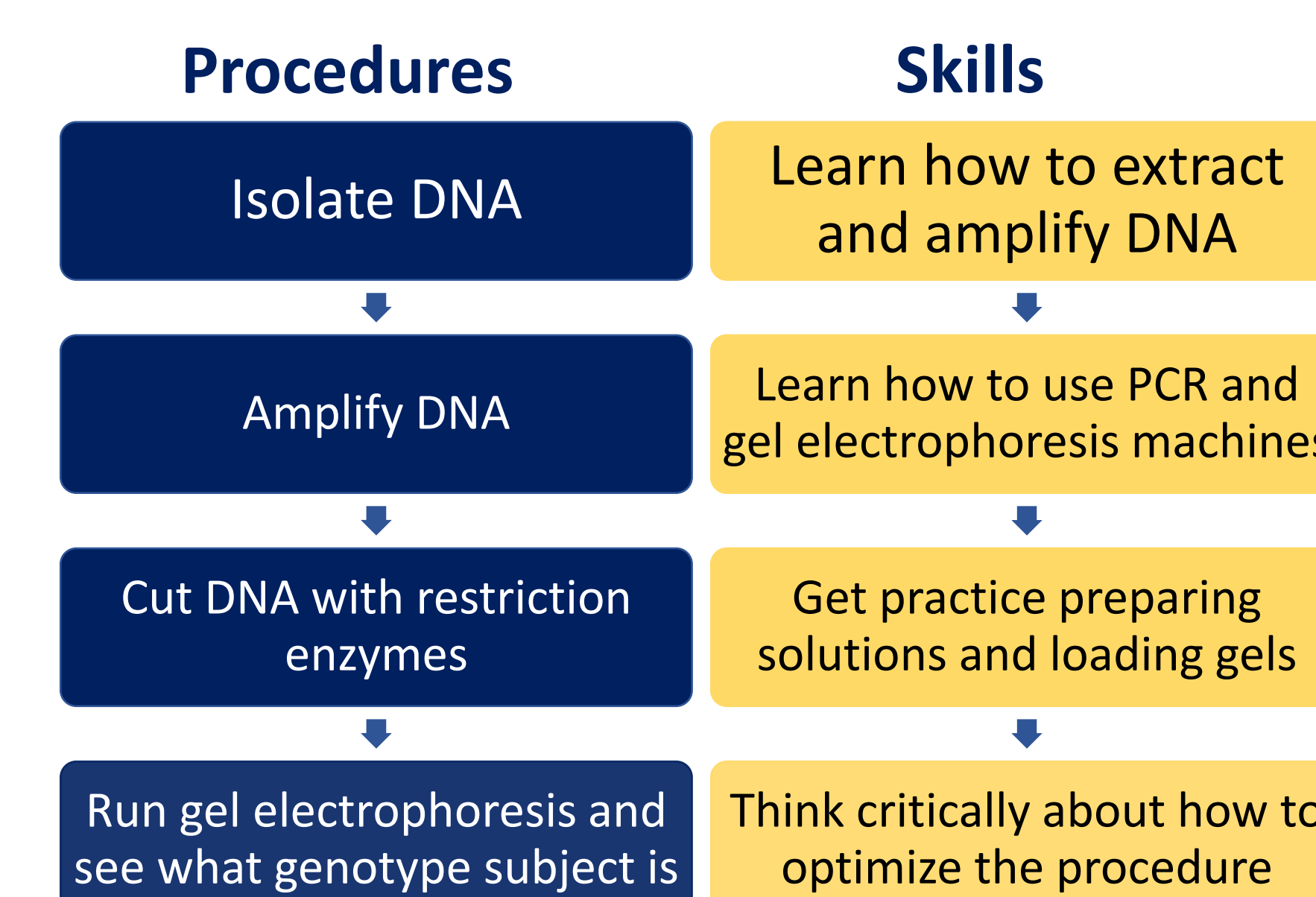


Figure 2. Genotyping of the *cyp1a2* gene, which is involved in caffeine metabolism. DNA samples from 6 individuals were amplified by PCR (a) and then subject to restriction enzyme digestion (b). Genotype is determined by banding pattern (b). Arrows indicate relevant bands.

Challenges with original protocol:

- DNA isolation protocol gave variable yields
- Non-specific PCR products produced

Changes to the module:

- Changed the DNA extraction protocol
- Optimized the annealing temperatures for the primers

During the semester:

- Unsuccessful during the first trial
- Students involved in protocol development (results shown above)

CONCLUSIONS

The involvement of an undergraduate student in course development is very helpful for understanding what skills a student brings to the course and what skills can be further developed during the course. This is particularly useful insight when trying to scaffold a course within a curriculum.

Benefits to the team-based model:

- Protocols are tested and improved before the semester
- Protocol timing established so that additional activities can be planned within the class period

Challenges using the modified model:

- Fewer minds working on how to optimize the protocols
- Workload not shared between students (as it often is in the course)

SKILLS DEVELOPED THROUGH THIS RESEARCH EXPERIENCE

- Maintaining an accurate lab notebook
- Preparing different types of media
- Taking care of *C. elegans*
- Optimizing procedures
- Properly using equipment including thermocyclers, micropipettors, and microcentrifuges
- Effectively analyzing data, communicating results, and making decisions about how to proceed

ACKNOWLEDGEMENTS

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CITATIONS

Hallström, Helena, et al. "Coffee Consumption and CYP1A2 Genotype in Relation to Bone Mineral Density of the Proximal Femur in Elderly Men and Women: a Cohort Study." *Nutrition & Metabolism*, BioMed Central, 22 Feb. 2010, nutritionandmetabolism.biomedcentral.com/articles/10.1186/1743-7075-7-12.
<https://www.sarahtrones.com/portfolio/>