Improving the teaching of meiosis and plant physiology in first year biology undergraduate practicals

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Abstract
First-year undergraduate biology and biomedical science students were dissatisfied with a practical on meiosis using pre-prepared slides of locust testes, which they found unengaging and pedagogically unsound in 2007. Similar feedback for a plant physiology experiment based on pre-prepared slides of wood was obtained from biology students. A teaching development grant was used to employ a UROP student to redesign the former practical around student-prepared monocot anther squashes, and the latter around dicot pollen tube germination. In both cases, assessment of the practical was also redesigned.

Feedback from the student employed through UROP was very positive, and both practicals now assess dissection and slide-making skills as well as observation. Student satisfaction with the meiosis practical in 2008 was not significantly improved, and performance in the assessment was unchanged: the improvements were not fully implemented, and work is ongoing. Student satisfaction with the plant physiology practical was improved, and formal assessment was made possible.

Meiosis practical
For the past decade, the teaching of meiosis in first year biology undergraduate classes has relied on the use of pre-prepared locust testis squashes. However, students had found the passive inspection of these slides unengaging (figure 1).

![Figure 1: Student satisfaction with meiosis practical (a) 2007 (b) 2008](image)

Jauhar and Storey (1982) proposed the use of the Ornithogalum tenuifolium (O. virens, Star of Bethlehem) as a suitable organism from which to obtain anthers undergoing meiosis, from which students could produce their own slides (figure 2).

![Figure 2: Alternatives to locust testis squashes (a) prophase I diakinesis in locust testes (b) O. thyridoides (c) O. virens anaphase II.](image)

A UROP (undergraduate research opportunities programme) student was recruited to investigate the feasibility of using this species. Sourcing of O. tenuifolium proved extremely difficult, and the readily available O. thyridoides proved to be less satisfactory: although tetrads and some stages of meiosis were observed in preparations (figure 2), it proved difficult to obtain preparations of prophase I of comparable quality to those in the locust testis squashes.

![Figure 3: O. thyridoides anther squash meioses (a) prophase I (b) telophase II (c) tetrad formed after telophase II](image)

The student’s mean score on meiosis questions in the electronic assessment of the practical increased from 67% to 72%, but this was not significant. Student satisfaction was also not improved significantly (figure 1): this was mostly due to the inflorescences of O. thyridoides undergoing coordinated meiosis, so that usually only one or two buds on a given inflorescence would contain a significant population of meiotic cells.

As a result of this disappointing feedback, we are investigating the use of Allium schoenoprasum (chives) anthers as suggested by Robinson (1982), where the greater number of flowers per inflorescence gives a greater chance of finding meiotic cells.

![UROP student's experience](image)

"... The work was not for someone that already knew how to do it, but to give me a chance to do real, hands-on work. It was a choice that I didn’t regret, and the three hours a week I spent were more productively used than they would be, had I chosen to stay at home! With this experience priming me for further work, I could then go with more confidence in my internship during the summer..."

Pollen germination practical
Given the disappointing results in the meiosis practical, and the lead-time before work on the chives could be started, our UROP student suggested trying to improve other practicals the students found unsatisfactory. One such candidate was a first year plant physiology practical on wood anatomy, which again involved pre-prepared slides. Furthermore, it had become uncoupled from the corresponding lectures, which had become increasingly physiological.

Pollen tubes of Impatiens walleriana (busy lizzie) show tig growth that is affected by the availability of calcium and borate ions (Bilderback, 1982). Their growth is rapid enough to observe and quantitate in a few hours, giving the practical more immediacy, and the ability to generate large data sets suitable for analysis in the statistical package R, which we focus on in our current first year programme. However, many horticultural cultivars are sterile, or nearly so, and a significant part of the work was finding a cultivar with viable pollen, and a substrate on which it would germinate reliably.

![Figure 4: Impatiens pollen tube germinations (a) male flower (b) germinating pollen tube](image)

Germination of pollen from Impatiens "White Wizard" was found to be reliable on agar ‘drops’, with rates of 800 μm hr⁻¹ in medium supplemented with calcium and borate. 45% of the students agreed that the new experiment had been useful and interesting, and from the point of view of the lecturer taking the practical, it had been far more successful than the previous wood anatomy practical. We are now maintaining a crop of this cultivar for future years and have plans to extend the practical to look at further factors influencing pollen tube growth rates.

References

Acknowledgements
We would like express our thanks to Anastasios Stavrou, the UROP student without whom there would be neither work nor poster, and the Centre for Educational Development, for their award of a Teaching Development Grant, without which there would be no UROP student.