Inexpensively incorporating a DNA microarray experiment into part of an undergraduate laboratory course

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YGMB Education Workshop
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Why introduce undergrads to DNA microarrays?

-- Global analysis of gene expression; common research approach
-- Vehicle to introduce undergraduates to genomics
  -- Greater appreciation for biological complexity
  -- Introduction to handling large datasets

How can this be accomplished? Issues of…

-- whether undergrads have relevant background
-- time
-- ease of data analysis/volume of data
-- expense
Do undergrads have relevant background?

-- Bio 326 (Microbio) only requires Intro-level Biology/AP credit
  --> Class usually equally composed of Sophs, Juniors, Seniors
  --> Students majoring in Bio, Biochem & Mol Biol, Chem,
      Env Sci, French, Neuroscience, Physics, Psych
  --> 5-6 groups of 3-4 students each in the lab (18-24 students overall)
  --> Lab scheduled once a week for 3 hrs

-- Dickinson also offers a course in Genomics, Proteomics, & Bioinformatics
  --> Students often take GP&B after taking Microbiology; a few GP&B
      students subsequently take Micro to gain the “wet lab” experience

*In short, most all my students have NO genomics background before
performing the DNA microarray studies*
How can my lab students have time to complete array work as part of a lab course?

-- do need to consider your goals you have for your students

<table>
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<th>Weekly activities</th>
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<tr>
<td><strong>2 wks in advance</strong></td>
<td>Yeast transformations</td>
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<td><strong>1 wk in advance</strong></td>
<td>Grow/harvest yeast</td>
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<td><strong>Week 1</strong></td>
<td>RNA extractions</td>
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<td><strong>Week 2</strong></td>
<td>cDNA synthesis</td>
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<td><strong>Week 3</strong></td>
<td>cDNA/Cy dye hybridizations (Genisphere)</td>
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<td><strong>Week 4</strong></td>
<td>MAGIC Tool (red/green ratios)</td>
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<td><strong>Week 5</strong></td>
<td>Data analysis/database exploration</td>
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<td><strong>Week 6</strong></td>
<td>Data analysis/database exploration/lab group comparisons</td>
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Red text = professor completes
Weeks 1-3 = “wet”; weeks 4-6 = “dry”
Pros and cons to the multi-week lab

Not a cookbook lab, but rather an open-ended project (BIO2010)

Students become invested in the long-term project

Some students struggle connecting the weeks together

Some students struggle with ‘big picture’ vs. protocol details

Do see students transition to thinking about the ‘big picture’ over the course of the project

Students overcome fears of analyzing thousands of data points (students also are prompted to explore databases)

Students write a lab report exploring relationships of some yeast genes with altered gene expression…

--> Discuss genes that are functionally related (consider GO, localization, protein-protein interactions, etc.)
Analysis of data via Yeast Community Databases
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http://yeastgfp.ucsf.edu/
Analysis of data via Yeast Community Databases

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<th>Promoter</th>
<th>Gene Name</th>
<th>GFP Allele</th>
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<tr>
<td>TEF1</td>
<td>OLE1</td>
<td>cGFP</td>
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<tr>
<td>Backbone</td>
<td>p416TEF</td>
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**Gene: OLE1**
- **Construct:** Episomal c-terminal
- **Strain:** FY1679
- **Genotype:** ura3/ura3, his3, leu2, trp1
- **Localization:** Endoplasmic reticulum
- **Medium:** MM - ura plates
- **Growth Phase:** not defined
- **Growth Time:** 5 h
- **Growth Temp:** 30 °C
- **Construct verification:** none
- **Comment:**
  - OLE1 DM2 G3472 YGL655W
  - SGD NIPS YPD

[Image of yeast cells with green fluorescence]
How can I afford to obtain microarrays?
How can I learn all the protocols?
How can I analyze the data?

GCAT -- a resource for those who teach undergraduate students
http://www.bio.davidson.edu/projects/gcat/gcat.html
How can I afford to obtain microarrays?
How can I learn all the protocols?
How can I analyze the data?

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**GCAT Microarray 2008 Summer Workshops - Nov. 26 Deadline**
What do I do to become a GCAT member?

The arrays MUST be performed by undergraduates.

You, and your students, MUST complete yearly assessment.

Array requests occur yearly, in late Spring.

Dry-lab analysis via MAGIC Tool is free!

--> Don’t even need to be a GCAT member.

GCAT offers hands-on training workshops (next one in July 2009).

While HHMI helps support GCAT, there is a limit to numbers of slides obtained for the GCAT community per year.
*Costs for 6 groups of students

DNA microarrays -- one per group x 6 = $160 (via GCAT)
2 Genisphere kits (3DNA 900) = $720 (GCAT member pricing)
Shipping arrays for scanning = $26

Total = $906

*Equates to $151 per group, for a period of at least 6 weeks
(therefore $25 per group per week over the 6 weeks)

*Assumes you have standard yeast supplies (tubes, incubator, hot phenol, etc), in hand
Conclusions/Summary

-- Streamlining of hands-on microarray work and prep allows for increased time for data analysis by students

-- Reduced hands-on “wet-lab” time does not detract from quality of investigative experience

-- Students note enhanced appreciation/understanding of biological complexity via data analysis/lab report preparation

-- Newly available genomics/proteomics tools allow for new approaches to data analysis each time course is taught

-- via GCAT, this is quite inexpensive for a six-week lab