1999/2000 ABRF Microarray Research Group Study

The State of the Art of Microarray Analysis: A Profile of Microarray Laboratories

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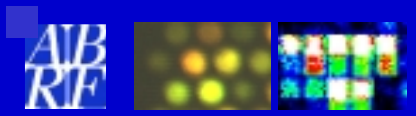

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INTRODUCTION

- This survey of microarray laboratories was opened for submissions in December 1999 by the Association of Biomolecular Resource Facilities (ABRF) Microarray Research Group.
- The survey was geared to gather information from academic, pharmaceutical, and commercial laboratories that offer microarray technologies as a shared facility resource. Individual laboratories using these technologies were also welcome to participate.
- A preliminary analysis of data was presented at the ABRF2000 meeting.
- This is a continuing study. The results presented here covers survey data collected from Dec. 1999 to Feb. 2000. A revised survey will be opened for submissions in September 2000. Results of analysis of data collected in the second half of 2000 will be presented early in 2001 both on the web and at the next ABRF meeting.

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METHODS

Data was requested from laboratories using GeneChip (oligonucleotide arrays from Affymetrix) and cDNA array related technologies by posting instructions for participation on microarray related electronic discussion groups.

A web based survey form was used to collect information such as instrumentation, protocols, staffing, funding, and throughput. Data was collected on an anonymous basis. The survey form was posted at http://brcweb.bio.cornell.edu/surveys/microsurvey.html.

This survey data was analyzed to build a current profile of microarray analysis laboratories.

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Survey Participation

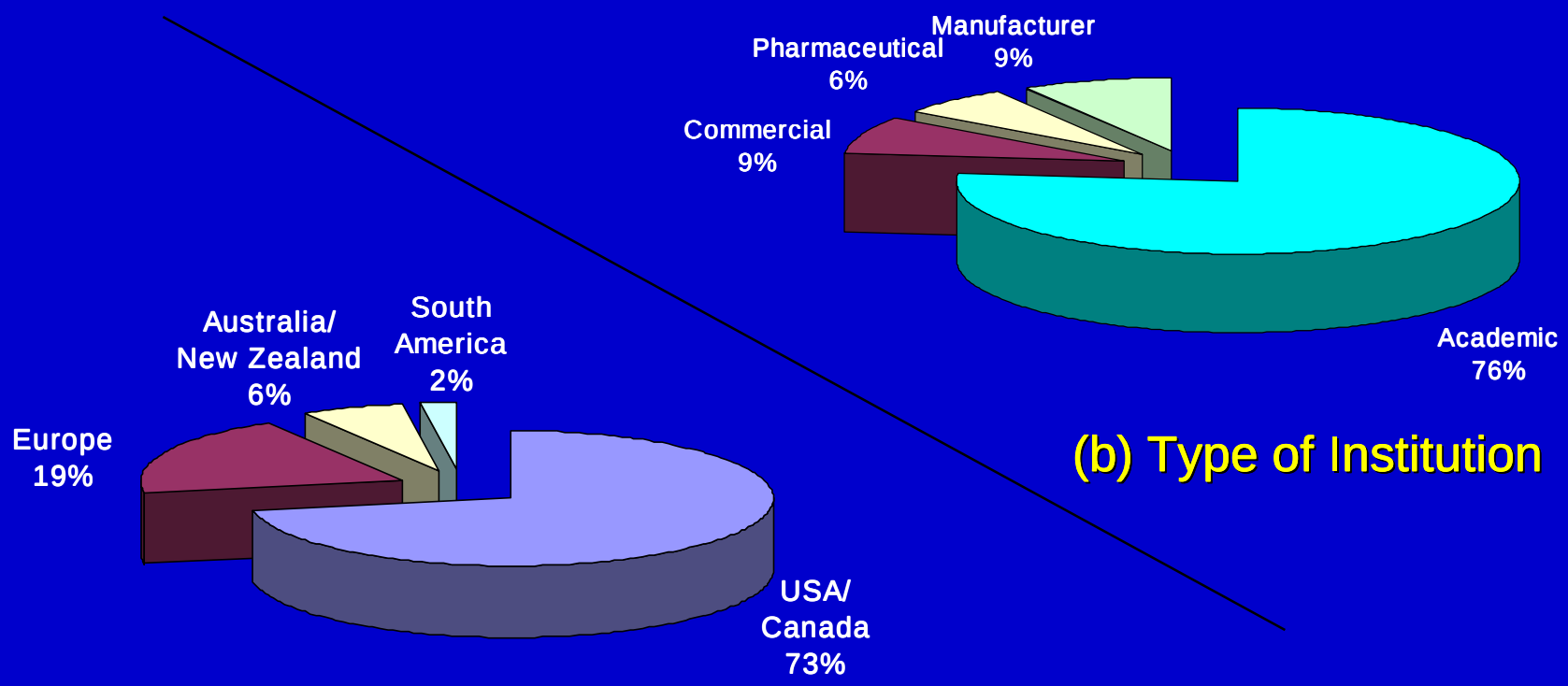
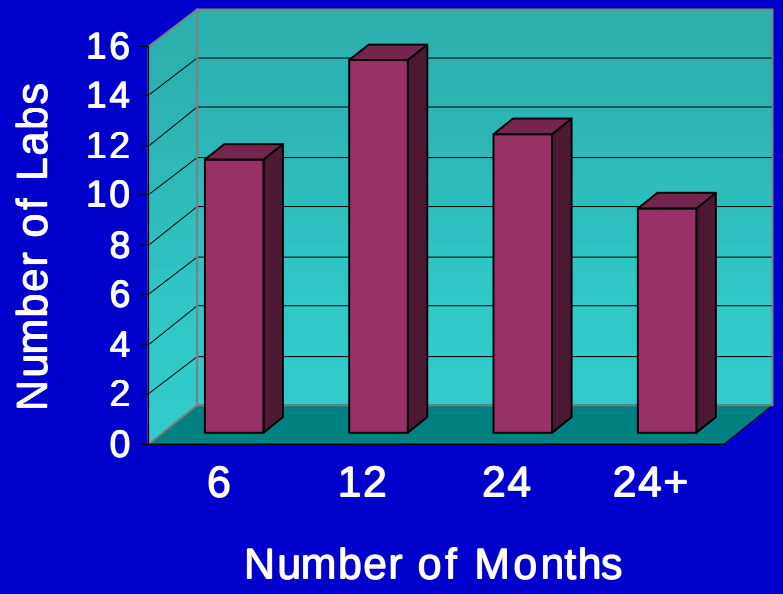
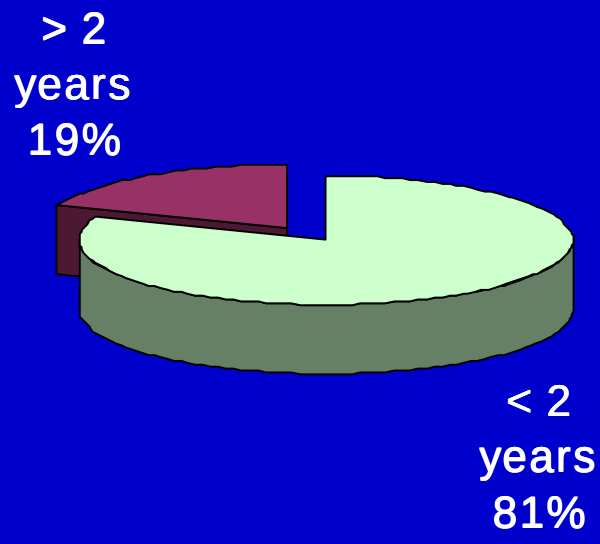


Figure 1. Survey Participation. (a) The geographical location of survey participants and (b) the type of institutions that participated are shown. Data from microarray instrument and related manufacturers was accepted but was not included in the results of this survey.

Length of Time Microarray Facility Operational



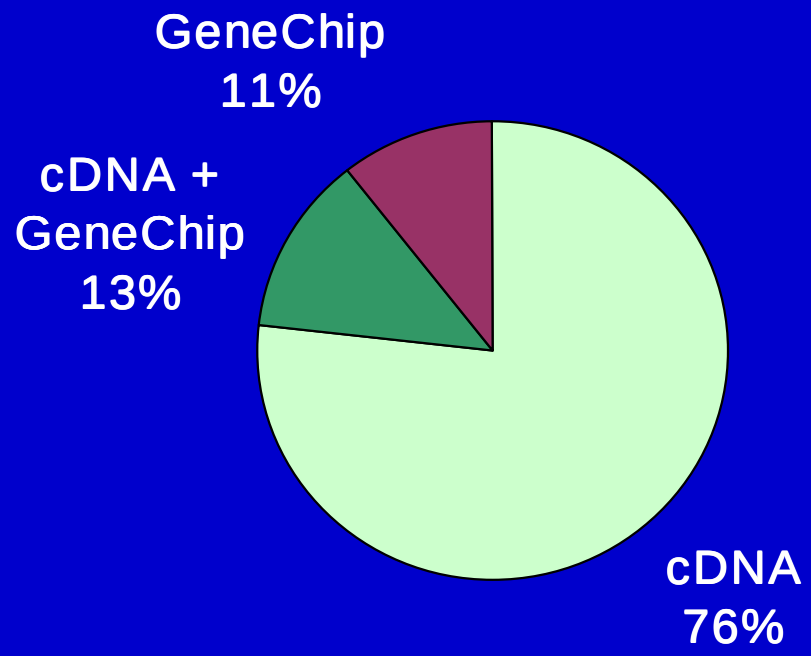
(a)



(b)

Figure 2. Length of Time Microarray Facility Operational. (a) The number of months that participating microarray facility laboratories have been operational. (b) The percent that have been operational more or less than two years.

Types of Microarray Technologies Used



n = 47

Figure 3. Types of Microarray Technologies Used. The percent of microarray laboratories that use GeneChip and/or cDNA microarray technologies is shown.

Factors Used in Selecting Microarray Technology

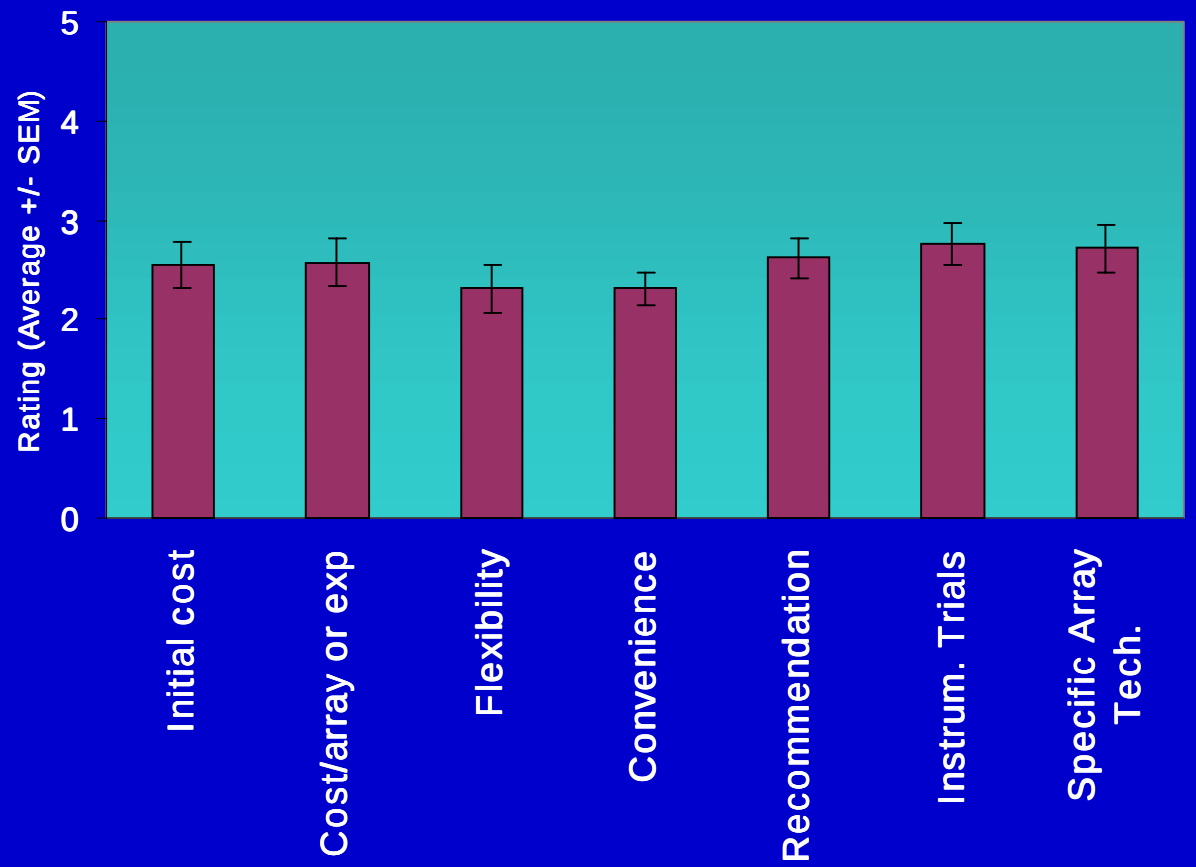
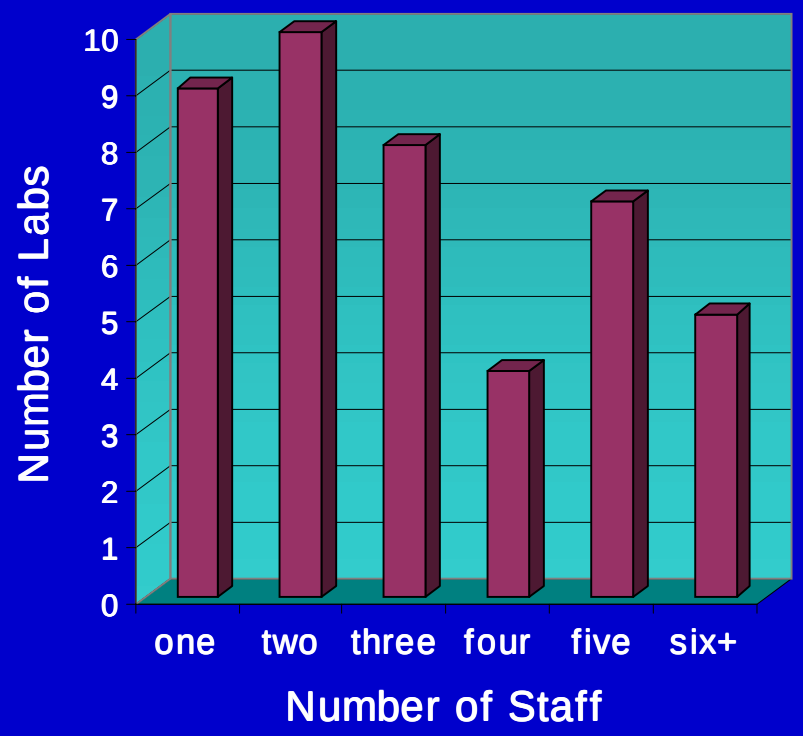


Figure 4. Factors Used in Selecting Microarray Technology. Participants rated the relative importance of factors that influenced their selection of microarray technology (1= high importance, 5 = low importance in decision to adopt current system).

Number of Staff in Microarray Facilities



Mean ± SEM = 3.5 ± 0.5
Min = 1, Max = 15, n = 44
Expecting Staff to Increase = 34/44

Figure 5. Number of Staff in Microarray Facilities. The number of microarray laboratories with specific numbers of staff are shown in the bar graph. Statistics related to the number of staff per laboratory are listed below the graph.

Experience of Staff in Microarray Facilities

Average number of years of experience in microarray field

Staff

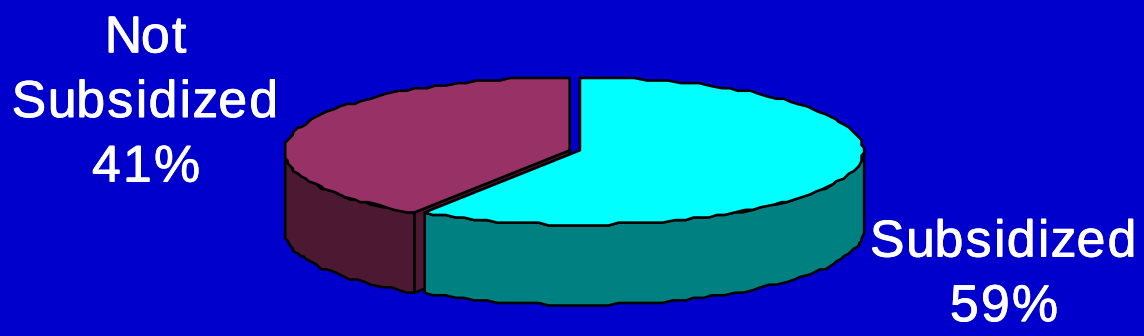
Mean ± SEM = 0.29 ± 0.12 years
Min = 0
Max = 4
n = 38

Facility Director

Mean ± SEM = 1.28 ± 0.16 years
Min = 0
Max = 6
n = 44

Figure 6. Experience of Staff in Microarray Facilities.

Sources of Funding



n = 44

Percent of total budget subsidized (if subsidized):

Mean ± SEM = 82% ± 6%

Min = 25%, Max = 100%, n = 23

Figure 7. Sources of Funding. The percent of microarray facility laboratories that are subsidized is shown in the pie chart. The average percent of the total budget that is subsidized is listed below the chart.

Future Expansion Plans: Types of Technology

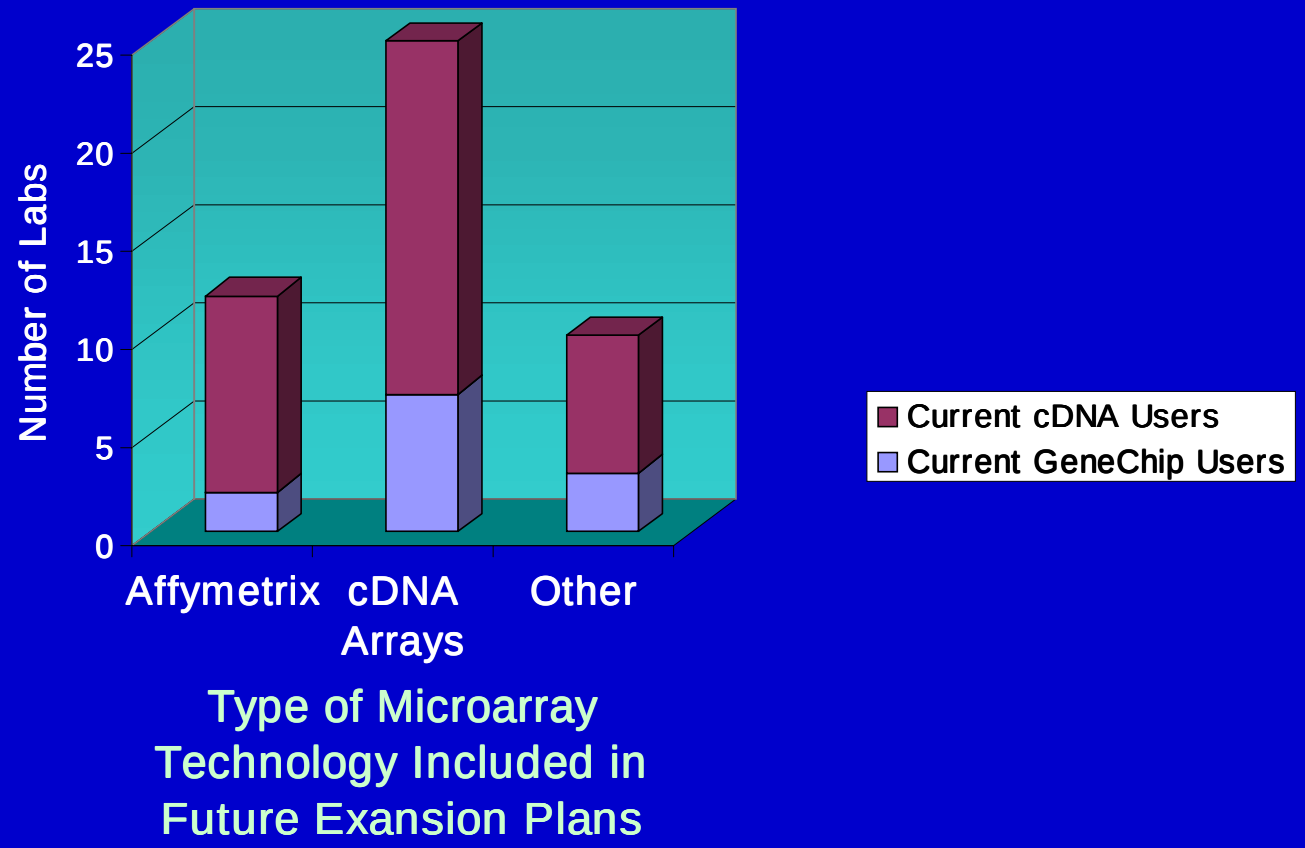


Figure 8: Future Expansion Plans: Types of Technology. The types of microarray technologies that current microarray laboratories reported are in their future expansion plans are noted below each bar. The number of labs planning on expanding their use of each type of technology and the type of technology that they are currently using are shown (red bars show the number that are currently cDNA array users; blue bars show the number that are currently GeneChip users).

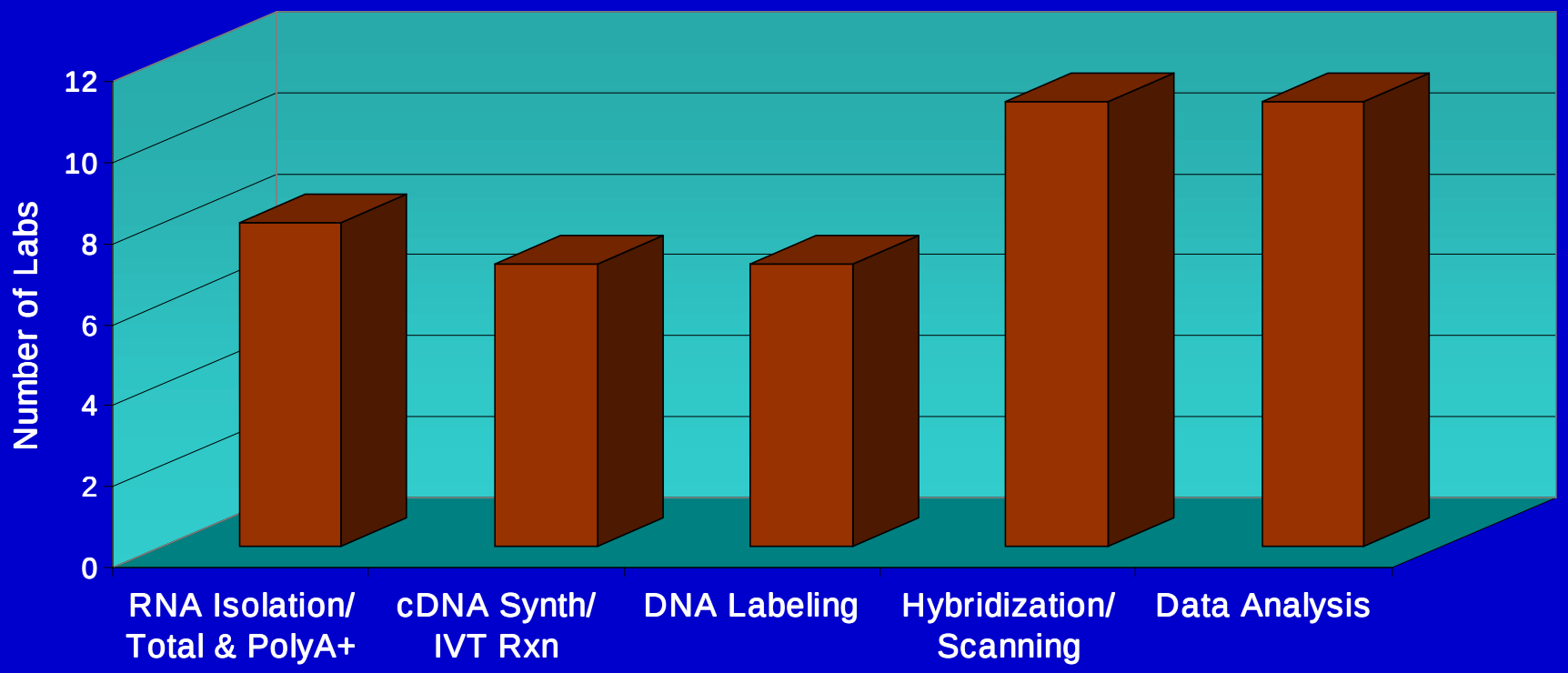
Typical GeneChip Facility

- 1 Fluidics Station
- 1 Scanner
- Use Non-Affymetrix Software (4/11 labs).
- Satisfactory Data in <6 Months (10/11 labs).
- 1 Year from System Installation to Full Steam
    - <1 Year for 4 labs
    - <2 Years for 6 labs
    - >2 Years for 1 lab

n = 11 respondents

Figure 9. Typical GeneChip Facility. Listed are the average type and number of instruments in the typical GeneChip facility laboratory that participated in the survey. Also listed is the typical length of time from installation to achieving satisfactory data and the time required to ramp up to full use.

GeneChip Core Services



n = 11

Figure 10. GeneChip Core Services. Types of core services offered by GeneChip microarray facility laboratories.

GeneChip Throughput

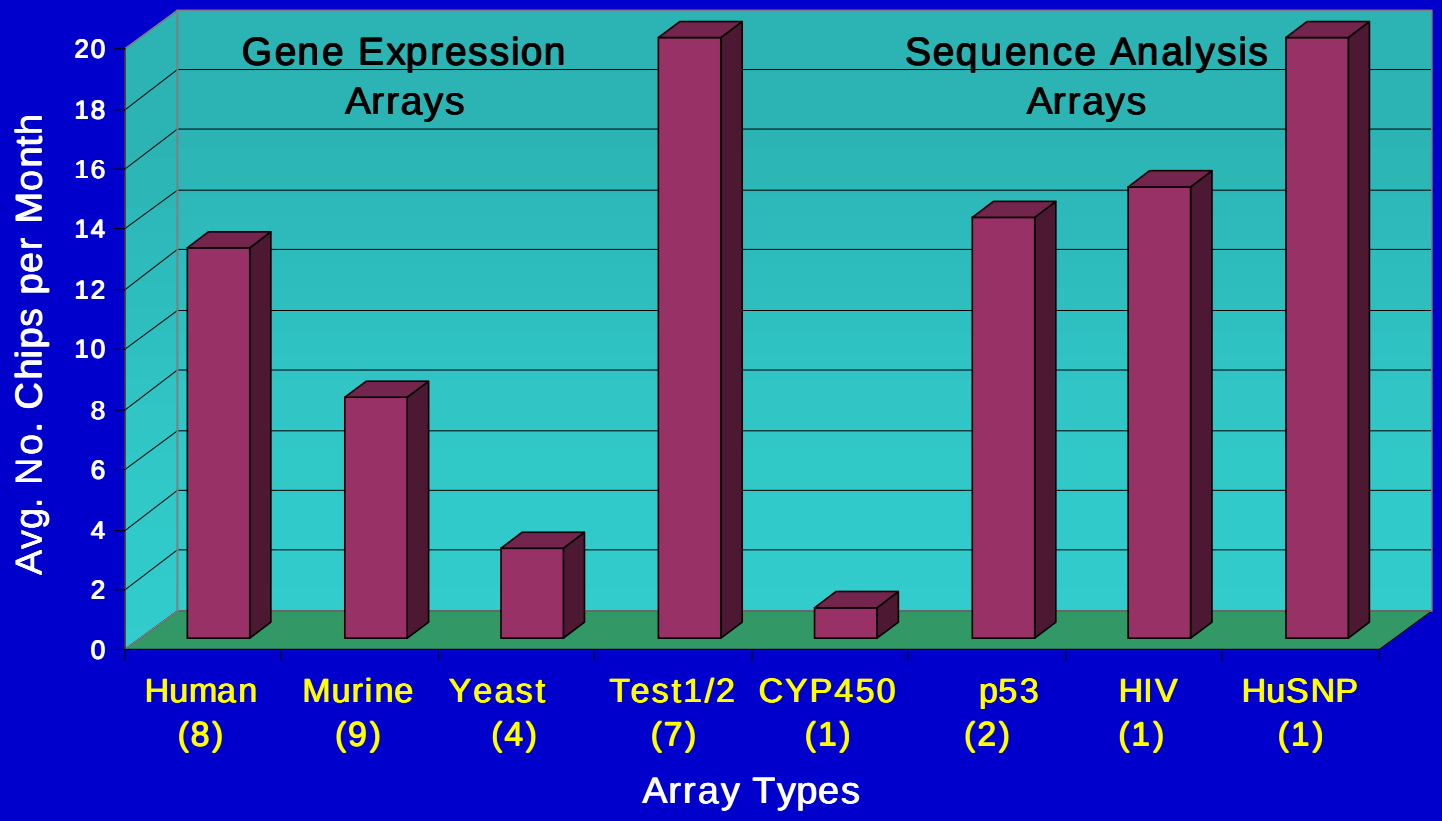


Figure 11. GeneChip Throughput. The average monthly use of various GeneChip arrays is shown. Array types are noted below each bar. The number of microarray laboratories that reported using each type of array is indicated in parenthesis.

General Types of GeneChip Arrays Used

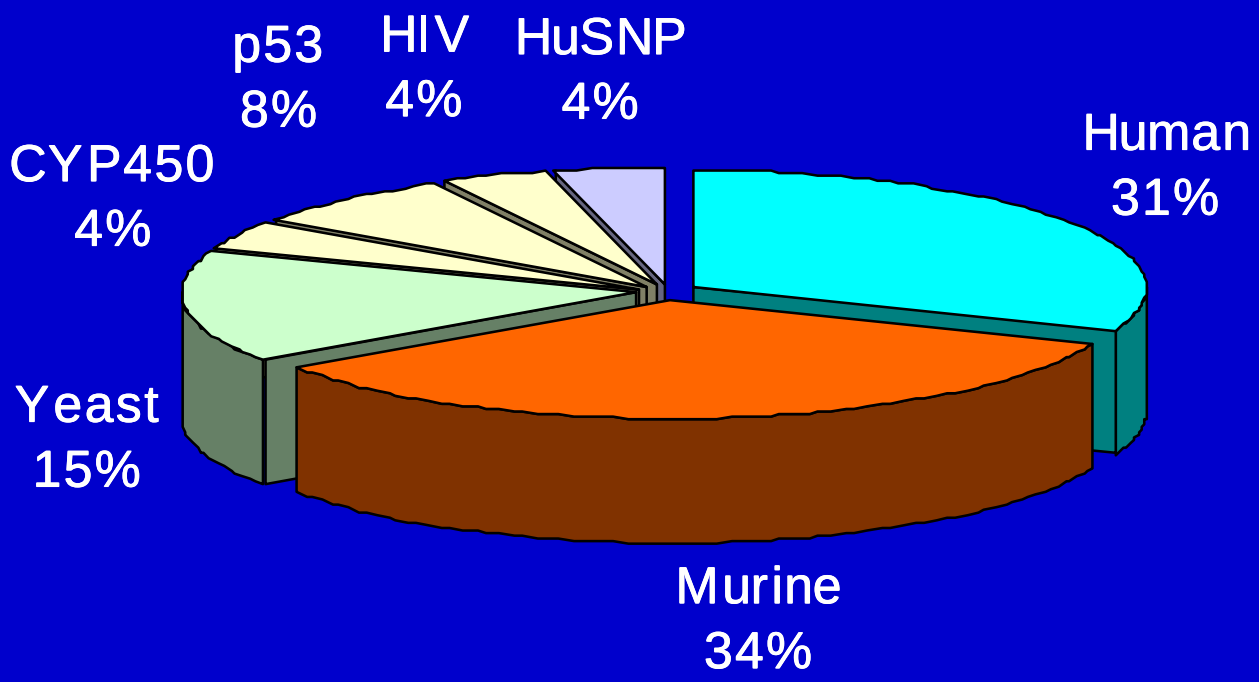


Figure 12. General Types of GeneChip Arrays Used. Shown is the percent of use of different types of GeneChips classed according to general type.

Current and Future Use of Specific Types of GeneChip Expression Arrays

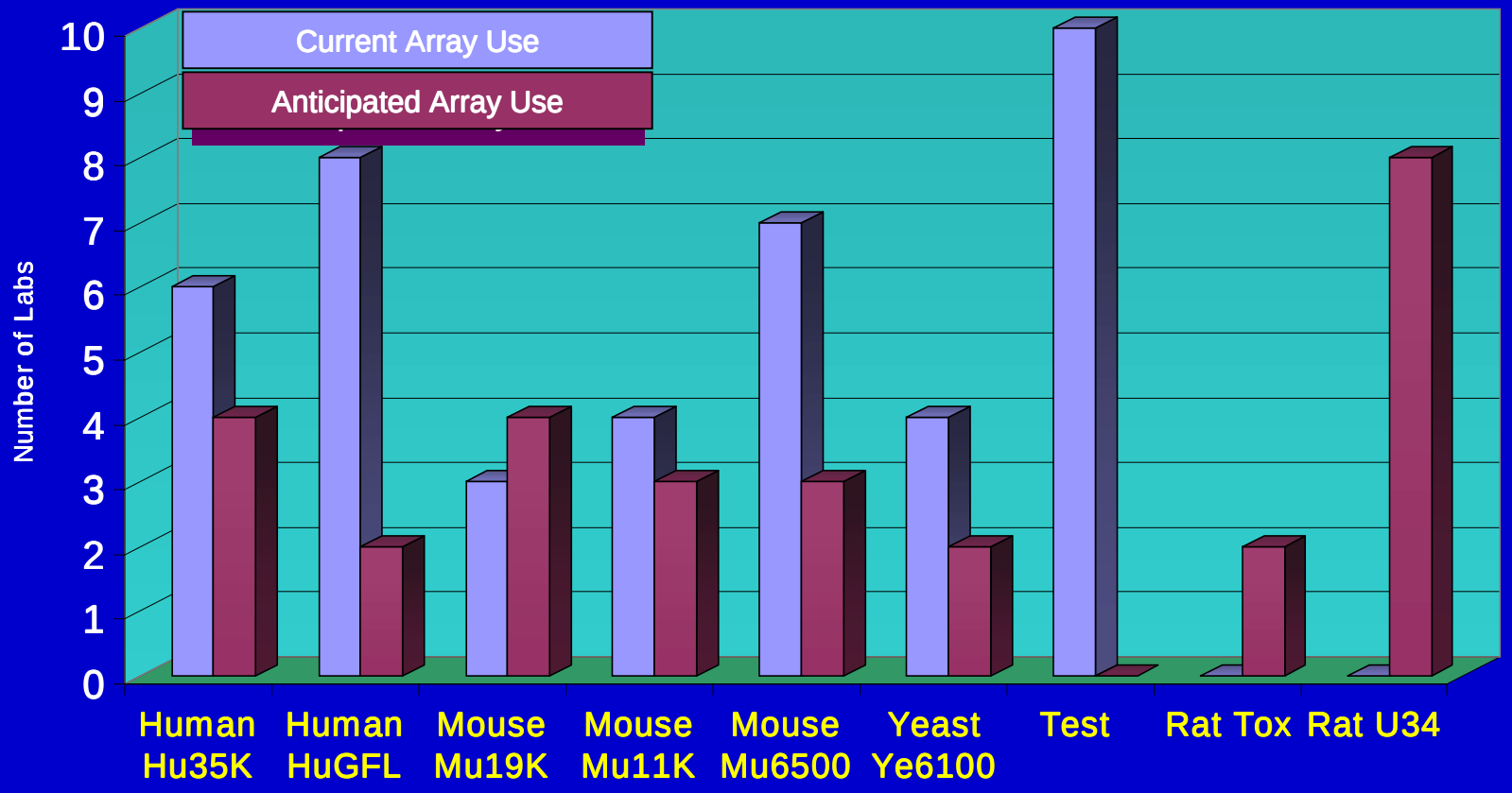


Figure 13. Current and Future Use of Specific Types of GeneChip Expression Arrays. The number of laboratories currently using specific types of GeneChip expression arrays are shown (blue bars). The number of laboratories that plan to use GeneChip expression arrays that they are not currently using is also shown (red bars). Rat U34 and Rat Toxicology U34 arrays were just released at the time of the survey.

Evaluations of GeneChip Technology

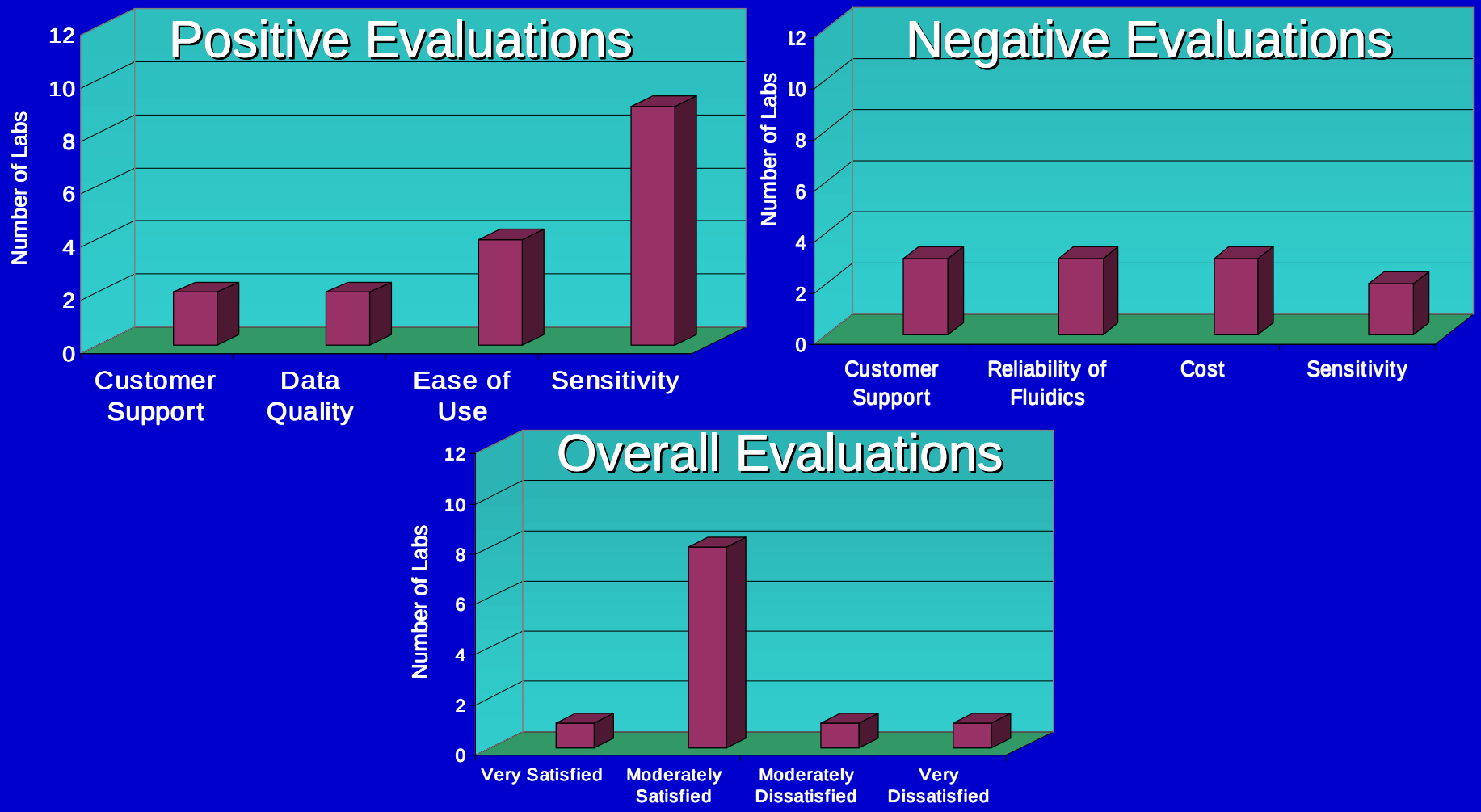


Figure 14. Evaluations of GeneChip Technology. Summaries of the positive and negative ratings of the GeneChip technology given by microarray facility laboratories using the technology .

GeneChip Microarray Conclusions

Implementation of GeneChip technology into facility laboratories began less than two years ago on average.

Some laboratories report lengthy startups, but the majority are moderately satisfied with the overall performance of their GeneChip systems.

The GeneChip system configuration currently used in most laboratories consists of one fluidics workstation and one confocal laser scanner.

Most Affymetrix gene expression studies are currently performed with murine and human GeneChip arrays.

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Typical cDNA Microarray Facility

- Utilizes an arrayer, scanner and dedicated computing equipment.
- Charges per array.
- Cost an average of $300,000 to set up facility.
- Costs an average of $7,500 to produce a unique array.
- Produces an average of 194 arrays per month:

  (median = 100, range = 4 - 2,000)
- Provides arrays for an average of 8 research groups:

  (median = 5.5, range = 1 - 54)
- Use cy3 and cy5 labeled target DNA.
- Use poly L-lysine coated slides.
- Use protocols other than manufacturers recommendations.

Figure 16. The Typical cDNA Microarray Facility. Listed is a profile of the typical cDNA facility based on responses to survey questions on equipment utilized, physical properties of the arrays produced and start-up costs of the facility.

cDNA Microarray Core Services

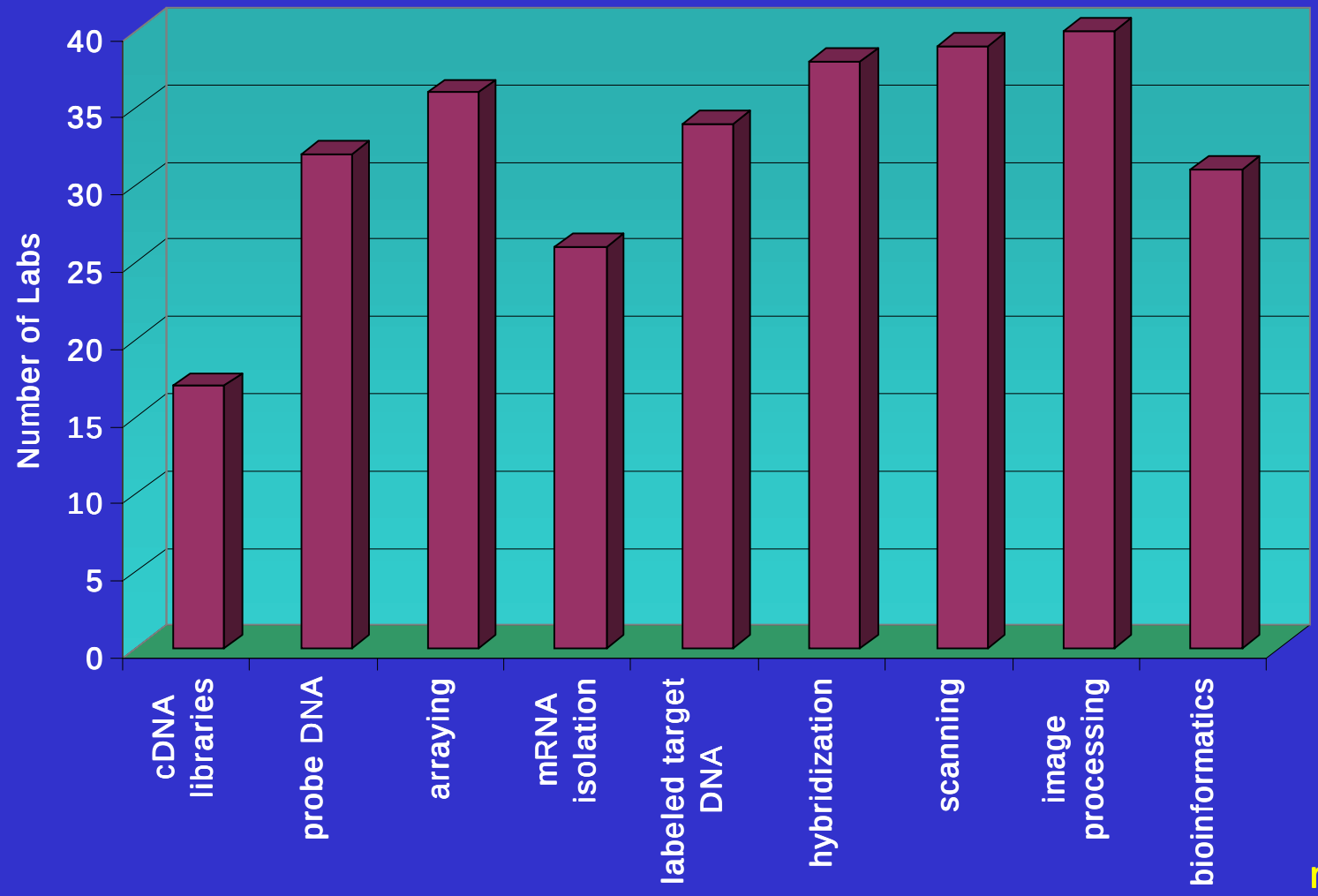
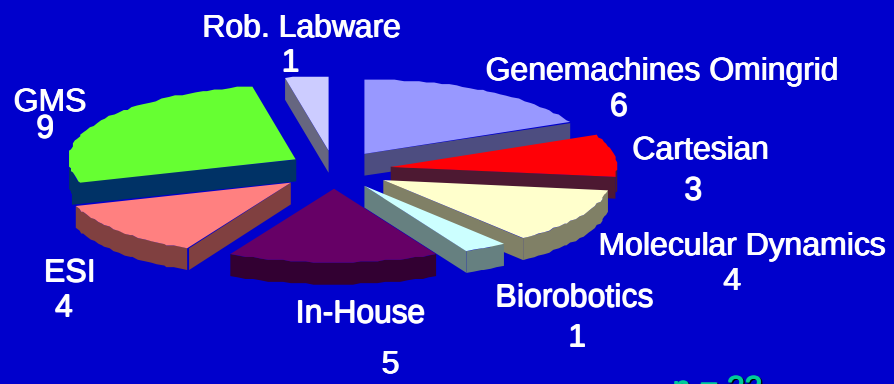


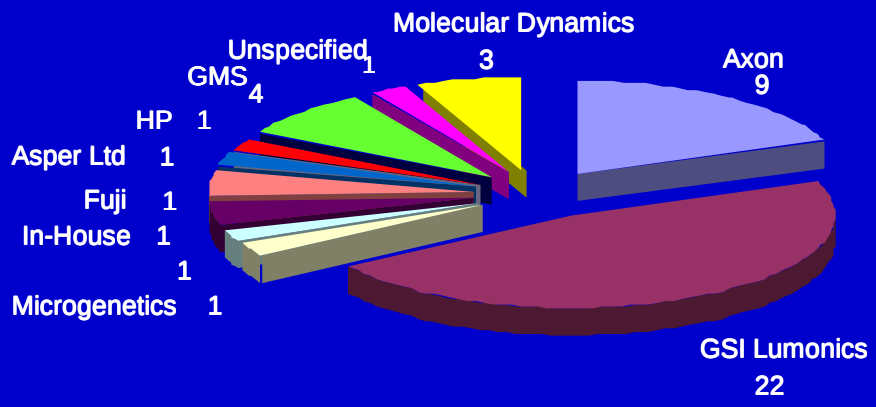
Figure 17. cDNA Microarray Core Services. Types of core services offered by cDNA microarray facilities.

Instruments in Use in cDNA Arraying Labs



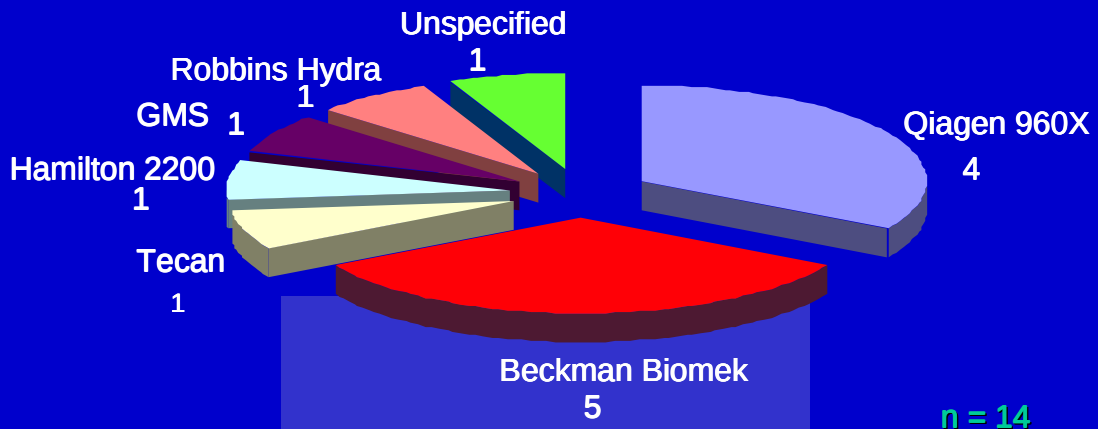
n = 33

(a) cDNA Arrayers



n = 45

(b) Scanners



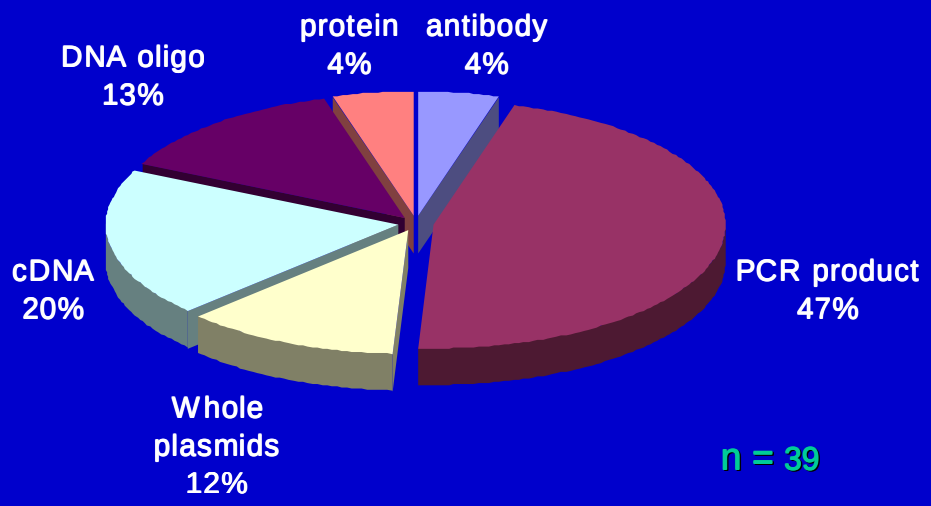
n = 14

(c) DNA Handling Robots

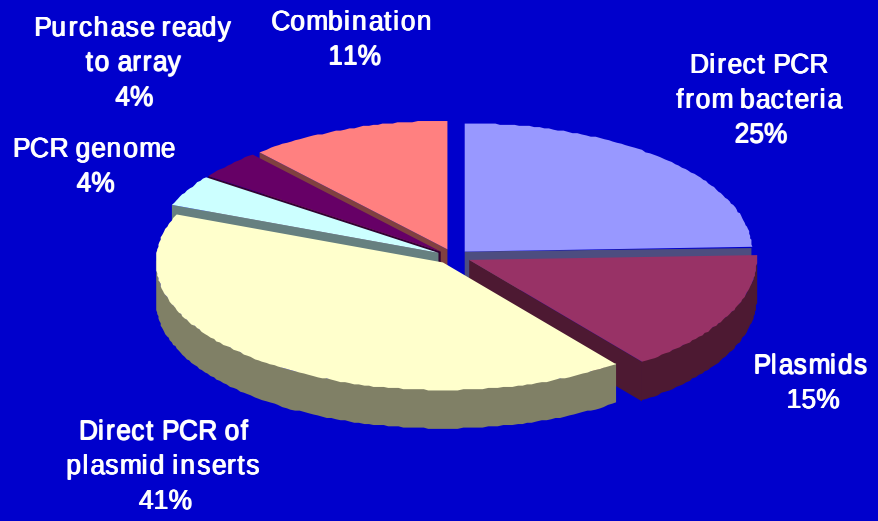
n = number of respondents with each make of instrument

Figure 18. Instruments in Use in cDNA Arraying Labs.

Probes



(a) Probe Material Arrayed



(b) Method of Probe Production

Figure 19. Probes. (a) Types of biological material arrayed in cDNA facilities. (b) Methods commonly used to produce DNA probe material.

Source of cDNA Target

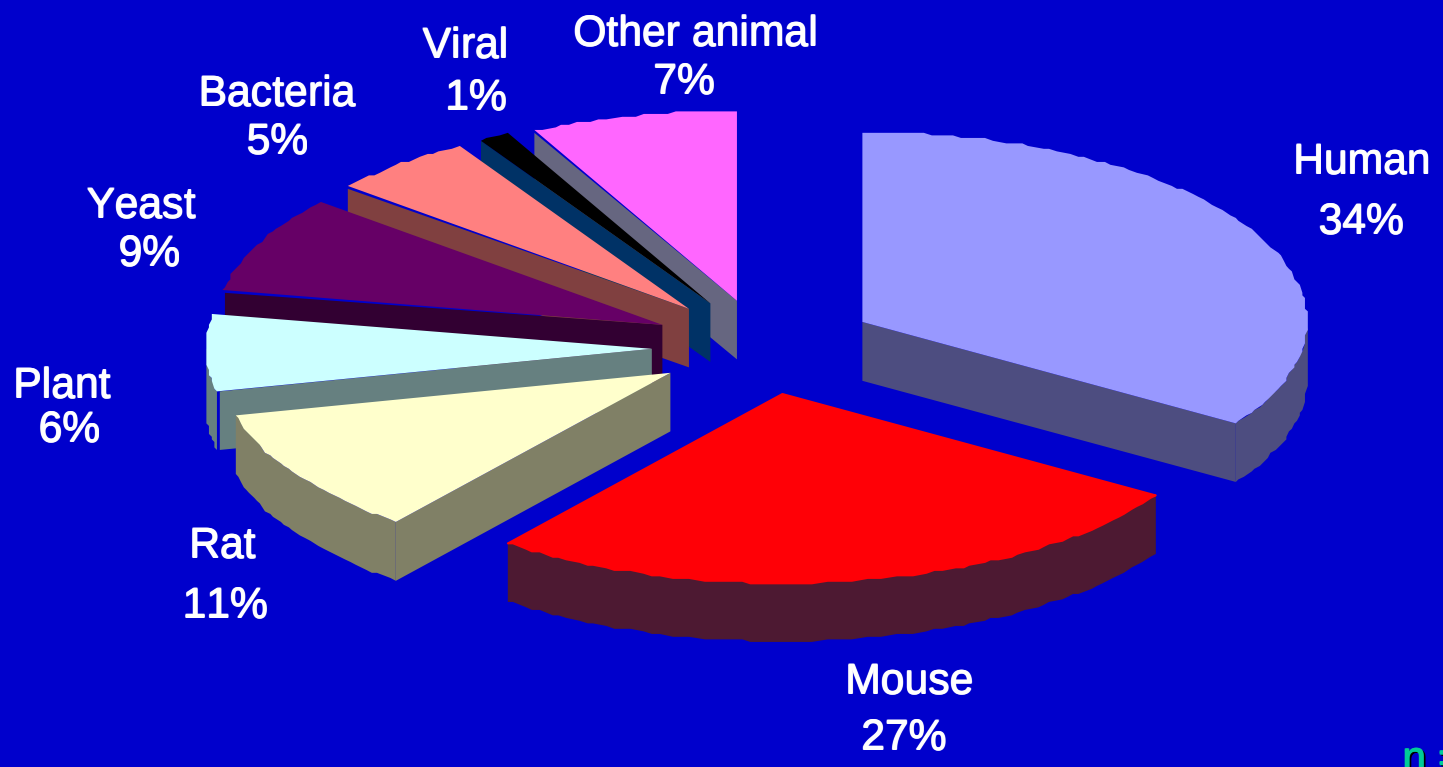


Figure 20. Source of cDNA Target. Sources of cDNA target used in cDNA microarray facility laboratories.

Typical cDNA Array

- No. of features = 6263

  (median = 6000, range 300-16000)

- Size of features = 155 µm

  (median = 150 µm, range 100-300 µm)

- Distance between features = 248 µm

  (median = 248 µm, range 25-500 µm)

Figure 21. The Typical cDNA Array. Listed are the number, size, and spacing of the features of the typical cDNA array used in the cDNA microarray facility laboratories that participated in the survey.

Typical cDNA Array Costs

Average facility set up = $323,500

(range = $70,000 - $1,000,000)

Average cost per feature = $1.26

(range = $0.005 - $10.00)

Average cost per labeled target cDNA = $123

(range = $20 - $500)

Figure 22. Typical cDNA Array Costs. Listed are the average cost of setting up a cDNA microarray facility and the average cost of the array features and labeled target cDNA as reported by the cDNA microarray facility laboratories that participated in the survey.

cDNA Microarray Conclusions

The cDNA arrayers use a wide range of instrumentation from different manufacturers, but all have a similar slide format derived from Pat Brown's concept.

The predominance of some cDNA microarray related companies may be correlated to the length of time they have been in the market. Examples of this are Qiagen and Beckman in robotics, and GSI Luminomics in the scanner arena.

General Conclusions

Most microarray facility laboratories were established less than two years ago.

Most microarray laboratories plan to expand both staff and instrumentation.

Expansion plans by both cDNA arrayers and GeneChip users indicate a trend to create shared resource laboratories in which these technologies coexist and complement each other.

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Future Directions

Continue survey:

- To have a larger representation of users.
- To allow representation of labs currently starting up.
- To allow updates that reflect changes in the field.

Implement studies that will help determine:

- Sensitivity (minimal detection levels).
- Specificity (quantitative changes in gene expression).
- Reproducibility of microarray experimental data.
- Protocols and reagents that give optimal results.

References

Background References on Microarrays

ABRF Microarray Research Group

http://www.abrf.org/ABRF/ResearchCommittees/MARG/marg.html

Association of Biomolecular Resource Facilities (ABRF)

http://www.abrf.org/

DNA Microarrays

http://barinth.tripod.com/chips.html

EPA Microarray Consortium

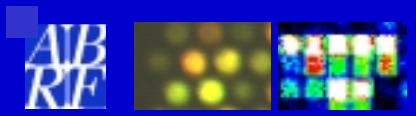
http://www.epa.gov/nheerl/epamac/

Gene Chips

http://www.gene-chips.com/

Grid It

http://www.bsi.vt.edu/ralscher/gridit/



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