



# Gene Expression: Tools of the Trade

Executive Summary  
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# Table of Contents

I. Report Introduction.....	1
II. Market Overview.....	2
III. Survey Introduction.....	3
V. Conclusion/Recommendations.....	4
VI. Appendix I: Questionnaire.....	5
VIII. References.....	9

# Report Introduction

Welcome to the 2005 Gene Expression Analysis Report. In this report, you will find an overview of the gene expression market, an introduction to Biocompare's 2005 Gene Expression Analysis Survey, a thorough discussion of the survey results and final conclusions and recommendations. The *Market Overview* summarizes the revenue generated by the gene expression market as a whole as well as by each of the key segments of the market: DNA microarrays, real-time PCR, bioinformatics and RNA interference. In addition to revenues generated in recent years, the market overview provides projections for growth within each market segment over the next few years. The goals and methodology of the 2005 Gene Expression Analysis Survey are outlined in the *Survey Introduction*. The key findings from each survey question are explained in the *Discussion of Results* section. Cross-tabulation of responses from multiple questions and relevant data from previous Biocompare surveys may also be presented in *Discussion of Results*. Overall conclusions and recommendations regarding the gene expression market are presented in the final section of the report. (Detailed survey data, including the questionnaire and graphed and tabulated responses, can be found in the appendices.)

# Market Overview

The market for gene expression analysis is dominated by three distinct technologies: microarray analysis, quantitative real time PCR (qPCR) and RNA interference (RNAi). Though estimates vary greatly, the market for tools that aid in studying genetic expression figures in the billions every year. In 2003, genomics researchers worldwide (in both academia and industry) spent more than \$4.5 billion on reagents, instruments and other products, according to one estimate. (LeadDiscovery Ltd., 2003)<sup>1</sup>

Making up a healthy part of these expenditures were purchases of DNA microarrays and related reagents and devices. In 2003, pre-made commercial microarrays, supplies for self-printed microarrays, and microarray analysis software brought in revenues worth \$596 million. (Frost & Sullivan, 2004)<sup>2</sup> That figure is estimated to grow to \$937 million by 2010, representing an annual growth rate of 6.7%. (Frost & Sullivan, 2004)<sup>2</sup> While several companies, including Agilent, Applied Biosystems, and GE Healthcare (Amersham Biosciences), have a significant presence in the market, Affymetrix has maintained its dominance. (Frost & Sullivan, 2004)<sup>3</sup>

The popularity of DNA microarrays is helping to drive up sales of quantitative (real-time) thermal cyclers. Front-running companies including Applied Biosystems, Bio-Rad (and its recent acquisition MJ Research), Cepheid, Corbett Research and Roche continue to compete for business from the traditional sectors of life science research in addition to newer areas such as bio-defense, agriculture and environmental industries. Along with liquid-handling instruments, real-time thermal cyclers are expected to make up the majority of revenue growth from sales of nucleic acid and liquid-handling instruments, which is estimated at 7.7% annually.

The approach of genomics research has resulted in an overwhelming amount of data, spawning the bioinformatics market.\* In 2004, the analytical software component of the bioinformatics market brought in \$245 million, which is estimated to increase to \$375 million by 2009. (Navigant Consulting, Inc., 2004)<sup>7</sup>

Efforts to understand the genome have recently received a big boost from the refinement of RNA inhibition, in which exogenous double-stranded DNA introduced into a cell undergoes a natural process to silence expression of the mRNA with a complementary sequence. Worldwide, the RNAi market brought in revenues of \$48 million in 2003. (Frost & Sullivan, 2004)<sup>8</sup> With an annual growth rate of 31.5%, the market expects to bring in \$358 million by 2010. (Frost & Sullivan, 2004)<sup>8</sup> At that point, use of RNAi for target validation is estimated to generate \$146.4 million with its use in basic research bringing in \$97.6 million. (Frost & Sullivan, 2004)<sup>8</sup> Over the long term, the purchase of RNA oligonucleotides is estimated to generate 56% of the market while vector-based siRNA may be responsible for 18%. (Frost & Sullivan, 2004)<sup>8</sup>

\*Various types of software systems and databases are needed to provide the powerful information technology to do the work of collecting and analyzing data. These software may bring in revenues of nearly \$300 million from customers in the U.S. alone, by some estimates.

# Survey Introduction

The goal of the 2005 Gene Expression Analysis Survey is to help suppliers capitalize on the expanding, multi-billion dollar gene expression analysis market by providing insight into the brands, technologies and applications currently used in laboratories as well as researchers' plans and desires for the future. The survey addresses each of the key segments within the gene expression arena: DNA microarray analysis, quantitative real-time PCR and bioinformatics software. Although RNA interference is an important and growing portion of the gene expression market, its current level of revenue generation is less than 20% of the other market segments. For this reason, RNA interference was not a focus of the 2005 Gene Expression Analysis Survey. RNA interference will likely be addressed in future Biocompare surveys.

The 2005 Gene Expression Analysis Survey consisted of 19 questions: 16 closed-ended and 3 open-ended. Of the closed-ended questions, 9 included "other" as an answer choice with space for survey participants to type in the answer most appropriate for their research. Demographic information was obtained from answers to 5 of the survey questions and from addresses submitted by survey participants. The survey was administered on-line between February 14th - 18th, 2005.

# Conclusions and Recommendations

The 2005 Gene Expression Analysis Survey gives us valuable insight into critical aspects of each segment of the gene expression market. Price is always an issue with customers, but it seems an especially hot topic with microarray customers. Suppliers who are able to offer DNA microarray systems at a better price stand the best chance of capitalizing on the expected 6.7% annual growth within the microarray market.

With an estimated annual growth rate of 7.7% for real-time PCR thermocyclers, suppliers may want to look to Bio-Rad's iCycler iQ and Applied Biosystems thermocycler offering. These instruments, owned by the greatest percentage of respondents, provide examples of what customers are looking for. It should be kept in mind, however, that while these are currently the most popular instruments, no one instrument truly dominates the market. When looking to increase market share, suppliers should bare in mind that non-specific detection remains a popular option. And until specific detection can challenge them on ease of use and price, non-specific reagents like SYBR Green will remain a common method of detection. As researchers generate tetrabytes of data per annum with microarray and real-time PCR experiments, bioinformatics software will be increasingly in demand. The results of this survey suggest that suppliers offering user friendly software will collect the greatest percentage of the projected \$300 million in bioinformatics revenue.

Affymetrix and Applied Biosystems still take the largest portion of the gene expression pie. But as evidenced by Invitrogen's association with gene expression products, customer perceptions can change. The 2005 Gene Expression Analysis Report shows us that the gene expression market is big and getting bigger and that suppliers offering customers the most cost effective, easy to use products will take home the biggest slice of the multi-billion dollar pie.

# Appendix I: Questionnaire

Questions marked with an asterisk (\*) are required.

**First Name\*:**

**Last Name\*:**

**Company/Institution Name\*:**

**Department:**

**Street Address\*:**

**P.O. Box/Building/Room Number:**

**City\*:**

**State/Province:**

**Zip/Postal Code\*:**

**Country\*:**

**Which title best applies?\***

- |                                    |   |                                |
|------------------------------------|---|--------------------------------|
| - Principal Investigator           | - Account Manager                           | - Product Manager              |
| - Process Engineer                 | - Postdoctoral Fellow                       | - Lab Director/Chief Scientist |
| - Research Director/VP of Research | - Department Head                           | - Consultant                   |
| - Graduate Student                 | - President/CEO/VP/Owner                    | - Procurement Manager          |
| - Technician/Research Assistant    | - Business Development Director/<br>Manager | - Professor/Instructor         |
| - Staff Scientist                  |   | - Other                        |

**In which type of institution do you work?\***

- |                               |                    |              |
|-------------------------------|--------------------|--------------|
| - Clinical Diagnostic Testing | - Pharmaceutical   | - Government |
| - Biotech                     | - Private Research | - Other      |
| - Academic                    |                    |              |

**Which best describes your purchasing authority?\***

- Authorize
- Recommend
- Evaluate
- No purchase role

**Do you currently perform gene expression analysis in your research?\***

- Yes
- No

**Do you plan to perform gene expression analysis in your research?\***

- Yes, within 0-3 months
- Yes, within 3-6 months
- Yes, within 6-12 months
- Yes, in > 12 months
- No

**Which of the following gene expression analysis technologies/applications do you plan to use?\***

- |                   |                          |                          |
|-------------------|--------------------------|--------------------------|
| - DNA microarrays | - SAGE                   | - N/A                    |
| - Real-Time PCR   | - Northern Blot Analysis | - Other (please specify) |
| - Bioinformatics  | - Differential Display   |                          |

**Which company do you think of when you think of gene expression analysis products?****Which of the following best describes the goal of your research?\***

- |                  |                          |
|------------------|--------------------------|
| - Basic Research | - N/A                    |
| - Diagnostics    | - Other (please specify) |
| - Drug Discovery |                          |

**Do you use specific detection or non-specific detection methods for real-time PCR?\***

- |   |                          |
|---|--------------------------|
| - Specific (e.g. TaqMan, Molecular Beacons) | - N/A                    |
| - Non-specific (e.g. SYBR green)            | - Other (please specify) |
| - Both                                      |                          |

**Why do you use a non-specific detection method?\***

- |                        |                          |
|------------------------|--------------------------|
| - Price                | - N/A                    |
| - Ease of use          | - Other (please specify) |
| - Established Protocol |                          |

**For which of the following applications are you primarily using real-time PCR?\***

- |   |  |
|---|--|
| - Qualitative detection of pathogens                | - Amplified fragment length polymorphisms (AFLPs)              |
| - Restriction fragment length polymorphisms (RFLPs) | - SNP analysis   |
| - Global gene expression                            | - Heteroduplex mobility assay (HMA) for polymorphism detection |
| - Confirmation of microarray data                   | - N/A  |
| - Primary validation or absolute quantification     | - Other (please specify)                                       |
| - Relative gene expression                          |  |
| - SSCP for polymorphism detection                   |  |

**What brand/model of real-time thermal cycler do you use?\***

- Pyrosequencing Rotor-Gene 3000
- ABI PRISM® 7900HT
- Bio-Rad MyiQ
- MJ Research Chromo 4™
- Corbett Research Rotor-Gene™ 2000
- Roche LightCycler®
- Corbett Research Rotor-Gene™ 3000
- Cepheid Smart Cycler® II
- Stratagene Mx3000P™
- Idaho Technology R.A.P.I.D.™
- ABI PRISM® 7500
- ABI PRISM® 7300
- MJ Research DNA Engine Opticon®
- Stratagene Mx4000™
- Roche LightCycler® 2.0
- Bio-Rad iCycler iQ
- Cepheid Smart Cycler® TD
- ABI Prism® 5700
- ABI Prism® 7000
- ABI Prism® 7700
- MJ Research DNA Engine Opticon® 2
- N/A
- Other (please specify)

**What one improvement would you most like to see in bioinformatics software?****What one improvement would you most like to see in your DNA microarray system?****What types of DNA microarrays do you use?\***

- Apoptosis
- Cytokine
- Cell Cycle
- Signal Transduction
- Neuroscience
- Cancer
- Genotyping
- N/A
- Other (please specify)

**Which of the following do you plan to purchase in the next 12 months?\***

- Microarray scanner
- Real-Time PCR Thermal Cycler
- Microarray printer
- Bioinformatics software
- N/A
- Other (please specify)

**How likely is it that you will require antibodies to investigate the proteins encoded by your genes of interest?**

1                      2                      3                      4                      5  
 Not at all likely                      <—————>                      Very likely

**What limitations do you currently face in your microRNA research?\***

- Assays require too much RNA
- Lack of sensitivity
- Lack of bioinformatics research tools (e.g. for microRNA target analysis)
- Low throughput
- Lack of ability to distinguish between mature and precursor microRNA's
- Lack of pre-validated or pre-tested assays
- I do not use microRNA in my research

**What type(s) of microarray applications and/or solutions is your lab considering starting in the next 12 months?\***

- Gene expression
- Labeling methods with minimal RNA input (e.g. double IVT)
- RNA sample prep and labeling with paraffin-embedded tissues
- Comparative genomic hybridization
- RNA sample prep and labeling with laser capture microdissection samples
- SNP analysis
- N/A
- Other (please specify)

# References

- 1) "DNA Sequencing and PCR Markets," LeadDiscovery Ltd, April 2003.
- 2) "Strategic Analysis of World DNA Microarray Markets," Frost & Sullivan, March 1, 2004.
- 3) "Emerging Technologies in Lab-on-a-Chip: Microarrays and Biochips," Technical Insights, Frost & Sullivan, October 29, 2004.
- 4) Frost & Sullivan
- 5) "US Biotechnology Instrumentation Markets," Frost & Sullivan, Feb 28, 2002.
- 6) "US Functional Genomics Market," Frost & Sullivan, Oct 4, 2002.
- 7) "Bioinformatics Analytical Software: A Strategic Market Outlook," Navigant Consulting Inc, Feb 2004.
- 8) "World RNAi Markets—Current and Future Outlook," Frost & Sullivan, Jul 5, 2004.
- 9) DNA Microarrays: An Essential Technology, May 2004. Available from Biocompare, Inc.
- 10) Real-time PCR: Quantifying the qPCR Marketplace, August 2004. Available from Biocompare, Inc.