



Protein Expression Analysis: Tools of the Trade

Biocompare Surveys and Reports

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Report Introduction

The 2005 Protein Expression Analysis Report contains an overview of the protein expression market, an introduction to the 2005 Protein Expression Analysis Survey, a thorough discussion of the survey results and final conclusions and recommendations. The Market Overview focuses on key technologies used in protein expression studies. It discusses the relatively new protein microarray market and details the markets of established technologies: 2D gel electrophoresis, liquid chromatography, mass spectrometry and flow cytometry. The market for each of these technologies is growing and the Market Overview provides projections for just how much each segment of the protein expression market is expected to grow over the next few years. The goals and methodology of the 2005 Protein Expression Analysis Survey are outlined in the Survey Introduction. The key findings from each survey question are discussed in the Discussion of Results section which makes up the bulk of the report. Overall conclusions and recommendations regarding the protein expression market are presented in the final section of the report. (Detailed survey data, including the questionnaire and tabulated responses, can be found in the appendices.)

Market Overview

Current estimates are that there are somewhere between 300,000 to 1 million proteins in the human proteome. Sifting through such a myriad of proteins in search of drug targets or diagnostic biomarkers is a formidable task. It can be as straightforward as investigating a mutant protein or as complex as teasing apart signaling pathways or physiological processes to determine which proteins are interacting. To address the wide range of analysis types requires the use of many different tools. This includes technologies such as protein microarrays, 2D gel electrophoresis, chromatography, and mass spectrometry. The collective term for such efforts is proteomics, the study of protein function, structure, subcellular localization, interaction, and tissue distribution. It is an area that, according to a 2003 study, generates more than \$2 billion annually worldwide and is increasing at a rate of 14%.

One of the relatively newer technologies in this market is protein microarray. According to Frost & Sullivan, the worldwide market for protein microarrays is now \$149.3 million and will grow at a rate of 31% through 2009 to \$575 million.² One of the leaders in the protein array market is CIPHERgen, which owns 29% of the market, said S. Ravi Shankar, an analyst at Frost & Sullivan. Biacore and Luminex own 25% and 12% of the market, respectively.² With protein microarrays still in an early phase of existence, the "market is experiencing a high number of both new entrants and companies exiting the market," Shankar said.²

Similar to DNA microarrays, protein microarrays offer the possibility of high-throughput screening. Instead of performing assays on one protein at a time, protein microarrays allow researchers to simultaneously screen thousands of proteins in a single experiment.

"The intention of this approach is to rapidly identify a protein biomarker," said Daniel Chan, PhD, director of the Biomarker Discovery Center at Johns Hopkins School of Medicine. "Right now, protein microarrays are not ready for a routine clinical laboratory, but I think it's a good research tool."

The market for established technologies is also on the rise. Right now, 2D gel electrophoresis generates \$405.7 million a year worldwide with annual increases of 12.8%, according to Frost & Sullivan.² By 2010, revenues should hit \$717.2 million. GE Healthcare (formerly Amersham Biosciences) and Bio-Rad currently hold 65% of the market, says Shankar. Other companies with a significant market share include Invitrogen, Genomic Solutions, Cambrex, Owl Separations and PerkinElmer.

Researchers also heavily rely on liquid chromatography to separate proteins. Worldwide, the liquid chromatography market generated \$2.516 billion in 2003, according to Frost & Sullivan. Protein liquid chromatography accounts for \$154 million of this total.² While the entire liquid chromatography market is expected to reach \$3.83 billion in 2010, protein liquid chromatography will increase to \$237 million.² Major players include Agilent, Dionex and Waters, Shankar said.

Elucidation of protein structure and amino acid sequence keeps the market for mass spectrometry running. This year, mass spectrometers will generate \$995.8 million worldwide, Shankar said. The growth rate of 6.4% will increase revenues to an estimated \$1.4 billion by 2010, when the growth rate will decline to 3.2%. "This market has strong established players like Amersham Biosciences, ThermoElectron, Waters, Bruker Daltonics and Agilent," he said.

Another technology central to proteomics is flow cytometry, which helps in sorting and quantitating beads and cells that display certain proteins. In 2003, flow cytometry generated revenues of \$650 million worldwide, according to Kalorama Information. With a growth rate of 15%, revenues are expected to reach \$1.3 billion by 2008.³ BD Biosciences and Beckman Coulter currently own 81% of the market.³

¹ "Proteomics 2003," Select Biosciences, July 2003.

² "World Protein Liquid Chromatography Markets," Frost & Sullivan, Jun 9, 2004.

³ "Cell-based Diagnostics: Technologies, Applications, and Markets," Kalorama Information, Jan 2005.

Survey Introduction

The 2005 Protein Expression Analysis Survey is intended to help suppliers gain a better understanding of which techniques their customers are using for protein expression studies, what types of samples they are using and how they are preparing them, which systems they plan to purchase, which companies they most frequently purchase from and the importance of analysis software packages in their research. Through the understanding of customer practices offered by the 2005 Protein Expression Analysis Survey, suppliers will be in a position to capitalize on the expanding, multi-billion dollar, protein expression analysis market.

The 2005 Protein Expression Analysis Survey consisted of 24 questions: 18 closed-ended and 6 open-ended. 9 of the closed-ended questions 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 6 of the survey questions and from addresses submitted by survey participants. The survey was administered on-line between April 11th and 13th, 2005.

Conclusions and Recommendations

The 2005 Protein Expression Analysis Survey shows us a customer base that is making use of a wide variety of tools in their proteomics research. Given the diverse nature of proteins, it is not surprising that researchers utilize multiple techniques in order to elucidate their structure, function, localization, and interactions. What works well for one protein will not necessarily be suitable for studying the next.

Protein microarrays are a relatively new tool available to scientists. Within the 2005 Protein Expression and Analysis Survey, we find an equal percentage of respondents using protein microarrays as are using mass spectrometry in their protein biomarker research. And given the relative youth of protein microarrays, a noteworthy percentage (43%) of researchers surveyed plan to use them this year. It will be interesting to see how these numbers change and grow in future surveys.

The researchers surveyed for this report have plans to purchase equipment for use with protein microarrays as well as for established technologies, including 2D electrophoresis, mass spectrometry, chromatography, and FACS. In order to capitalize on these sales as well as the longer-term projected growth of the proteomics market, suppliers need to understand the diverse needs of the researcher involved in protein expression analysis. Researchers are certain to need an assortment of techniques and tools to elucidate the role of the 300,000 to 1,000,000 proteins encoded by the genome. It is unlikely that any one supplier will be able to fulfill all the needs of the proteomics researcher. The message then, is to choose your market segment(s) and serve them well. BD Biosciences was the clear favorite of the respondents when it came to FACS products and together with Beckman Coulter they hold 81% of the flow cytometry market. BioRad, on the other hand, is not as dramatic of a stand-out favorite in any one market, but is one of the top 3 companies preferred by survey participants for 2D electrophoresis, chromatography and protein microarrays. Together with GE Healthcare, BioRad possesses 65% of the 2D electrophoresis market. Whether the focus is on a big slice of a single market segment or smaller slices of multiple market segments, there is plenty of room for success in the diverse field of proteomics.

Appendix I: Questionnaire

Principle area of research or work? (Check all that apply.)

- Bioinformatics
- Microbiology/Virology
- Immunology
- Genomics/Genetics
- Cell Biology
- Diagnostics/Pathology
- Drug Discovery
- Administration
- Biochemistry
- Marketing/Sales
- Pharmacology/Toxicology
- Molecular Biology
- Bioengineering
- Neuroscience
- Proteomics
- Purchasing
- None of the Above
- Other (please specify)

Which of the following best describes the goal of your research?

- Diagnostics
- Drug Discovery
- Basic Research

Do you currently perform or plan to perform protein expression analysis in your research?

- Currently Perform
- Plan to Perform
- Neither Perform or Plan to Perform (exited from survey)

Which of the following do you currently use or plan to use?

- Protein Microarrays
- 2D Gel Electrophoresis
- Chromatography
- Mass Spectrometry
- FACS
- Western Blotting
- Immunoprecipitation
- Immunohistochemistry
- ELISA
- ELISPOT
- None of the Above
- Other (please specify)

What type of samples do you use?

- Cells
- Tissue
- Other (please specify)

What cell types do you use?

- Bacterial Cells
- Mammalian Cells
- Insect Cells
- Plant Cells
- Other (please specify)

From which company do you purchase the most reagents for protein arrays?

(Open-ended)

From which company do you purchase the most kits and reagents for FACS analysis?

(Open-ended)

From which company do you purchase the most kits and reagents for 2D electrophoresis?

(Open-ended)

From which company do you purchase the most chromatography products?

(Open-ended)

From which company do you purchase the most mass spectrometry products?

(Open-ended)

What types of chromatography do you use?

- Ion Exchange Chromatography
- Affinity Chromatography
- Gel Filtration/Permeation Chromatography
- 2D Chromatography
- N/A
- Other (please specify)

How many samples will you test by protein microarray in 2005?

- 0
- 1-50
- 51-499
- 500-999
- >999

How do you prepare your samples for mass spectrometry?

- HPLC
- 1D Electrophoresis
- 2D Electrophoresis
- Liquid Chromatography
- LC/LC
- 1D Electrophoresis/LC
- Gas Chromatography
- SPE
- CE
- 2D Electrophoresis/LC
- N/A
- Other (please specify)

What is the biggest challenge you face when performing 2D electrophoresis?

(Open-ended)

Which of the following types of cell analyzers/sorters do you use?

- Bench top analyzing system
- Flow cytometry system
- Magnetic bead sorting system
- None
- Other (please specify)

How do you prepare your samples for 2D electrophoresis?

- Ammonium sulfate precipitation
- IgG & Albumin Removal
- Protein Pre-fractionation
- Acetone Precipitation
- Methanol Precipitation
- TCA/Acetone Precipitation
- 2D Clean-up Kit (commercially available)
- N/A
- Other (please specify)

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

- Mass Spectrometry System
- Protein Array Printer
- Scanner for use with Protein Arrays
- FACS System
- 2D Electrophoresis System
- Scanner for use with 2D Electrophoresis Gels
- High Pressure Chromatography System
- Medium Pressure Chromatography System
- Low Pressure Chromatography System
- None of the Above

Please rank the following image analysis software packages from 1 to 5 in order of their importance to your research.

(1 = Not At All Important, 5 = Extremely Important)

- High-end statistically driven software with database capability (>\$75,000 USD)
- Mid-range standard 2D image analysis software (\$30,000 - \$75,000)
- 1D gel image analysis software
- Mass spec LIMS
- Mass spec LIMS linked to 2D gel image analysis

Which of the following are you using or expecting to use to conduct research on protein biomarkers?

- Maldi Mass Spectrometry
- Protein Arrays
- Neither of the Above

Please rank the following image analysis software packages from 1 to 5 in order of their importance to your research.

(1 = Not At All Important, 5 = Extremely Important)

- 2D Electrophoresis Data Analysis Software
- Mass Spectrometry Data Analysis Software
- Chromatography Data Analysis Software
- FACS Data Analysis Software
- Protein Array Data Analysis Software
- Complete Proteomics Data Analysis Solution for all of the Above Applications

References

- 1) "Proteomics 2003," Select Biosciences, July 2003.
- 2) "World Protein Liquid Chromatography Markets," Frost & Sullivan, Jun 9, 2004.
- 3) "Cell-based Diagnostics: Technologies, Applications, and Markets," Kalorama Information, Jan 2005.