TriMark Publications

March 2009
Volume: TMRBIF09-0301

BIOINFORMATICS MARKETS

(SAMPLE COPY, NOT FOR RESALE)

Trends, Industry Participants, Product Overviews and Market Drivers

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

1. Overview

1.1 Statement of Report

The merger of computational analysis and the life sciences, known as bioinformatics, has produced a burgeoning marketplace in which key informatics solutions are integral to the business strategies of high-tech and biopharmaceutical companies. The discipline of bioinformatics entails computer-driven methods of analysis to manage data emerging from gene and protein technologies. In this report, TriMark Publications offers an overview of bioinformatics markets, presenting evidence that segments of the field are poised for significant future growth.

1.2 About this Report

This study is arranged to provide analysis and forecasts by product type and application, surveying the bioinformatics market and the latest information regarding emerging new products and industry trends. The study quantifies and qualifies bioinformatics market segments as areas of research, product development and investment. Forecasts of the bioinformatics market and an analysis of products in the worldwide information-processing market will provide a basis for understanding the significance of past developments and future possibilities within this market category. The main objectives of this analysis are as follows:

- Identify current and potential technology drivers through a comprehensive look at various platform technologies for segments of the bioinformatics market.
- Impart a complete understanding of the chief bioinformatics tools and their predictive, screening, prognostic, monitoring, pharmacogenomic and product value, from basic principles to application.
- Distinguish feasible market opportunities by identifying viable applications in the bioinformatics arena, with a focus on the biggest and fastest-expanding markets for systems biology approaches and high-throughput drug screening.
- Focus on global industry development through an in-depth analysis of the major world markets for bioinformatics, including forecasts for growth.
- Present current market figures regarding the value of the bioinformatics market, projections and growth rates drawn from the global diagnostic industry.

By purchasing this report, you will have:

- An understanding of the most exciting bioinformatics market segments, current and future.
- The latest information on leading products and R&D initiatives.
- Familiarity with recent developments and their effects on selected markets.
- Knowledge of the bioinformatics market as an area of growth, research and investment.

Key questions answered in this review are:

- How can bioinformatics tools and artificial intelligence technologies facilitate drug discovery, design and development?
- What are the main types of computational biology technologies that are currently available?
- Who are the current key players in this marketplace?
- Which life science informatics market areas have the greatest potential for growth?
- What is the current state of the bioinformatics market?
- Which biotechnology and pharmaceutical companies are investing in bioinformatics solutions?
- What main computational research techniques are incorporated into the business strategies of leading companies?
- What are the benefits of bioinformatics?

This study contains:

- A comprehensive overview of the several categories of bioinformatics technology platforms that are or will be revolutionizing the treatment of diseases.
- A detailed analysis of recent trends in the life science informatics marketplace.
- In-depth profiles of leading companies with bioinformatics tools and technologies.
- A forecast for the informatics market in the biotechnology and pharmaceutical industries.
- Views and principles on the bioinformatics industry from leading industry experts.
- An analysis of potential bioinformatics applications in the life science sector.
- Market predictions and trends analysis concerning U.S. expenditure on IT solutions.
- Market forecasts for each category of product, including profiles of selected competitors.
- Projections for future applications of bioinformatics in drug discovery.
- An analysis of commercial bioinformatics business strategies.
- The latest news and developments in the bioinformatics marketplace.
- An analysis of the technological approaches undertaken by various competitors, as well as industry and end-user responses to these emerging and existing products.

Analysis includes charts and graphs measuring product growth and trends within the marketplace. Company-specific information, including sales figures, product pipeline status and R&D trends, is provided. Also, this report will:

- Assess bioinformatics market drivers and bottlenecks, from medical and scientific community perspectives.
- Discuss the potential benefits of bioinformatics for various sectors of the medical and scientific community.
- Establish the current total market size and future growth of the bioinformatics market and analyze the current size and growth of individual segments.
- Provide current and forecasted market shares by company.
- Discuss profit and business opportunities by segment.
- Provide strategic recommendations for near-term business opportunities.
- Assess current commercial uses of the bioinformatics market.

The following questions will also be addressed in this study:

- What are the near-term business opportunities in the bioinformatics market?
- What are the current and forecasted bioinformatics market sizes in the U.S., European Union (E.U.) and Japan, as well as in other key country markets?
- What are the business models currently used by companies in the bioinformatics market?
- How will manufacturers, researchers, physicians and patients influence this market?
- What are the drivers and bottlenecks influencing the bioinformatics market?
- What are the technologies used in bioinformatics?
- Who holds the proprietary rights to the bioinformatics market technology platforms?
- How is this technology currently being applied and utilized?
- In the U.S., Japan and the E.U., what regulatory processes apply to bioinformatics technologies?
- How will new bioinformatics technologies change drug development paradigms?
- How will applications of computational biology and information science affect clinical programs and patient care?
- How will bioinformatics technologies reduce healthcare expenditures?
- How will bioinformatics technologies decrease R&D costs?

1.3 Scope of this Report

The emphasis in this analysis is on those companies that actively are developing and marketing bioinformatics technologies. The reader should consult other TriMark Publications reports at http://www.trimarkpublications.com for a detailed discussion of the important individual market segments that are related to the bioinformatics technologies market, such as genomics, gene expression reagents and other pharmaceutical development methods. This study reviews the market for bioinformatics technologies in the drug development market. It defines the dollar volume of sales, both worldwide and in the U.S., and analyzes the factors that influence the size and growth of market segments. It details market sizes and growth rates, with projections for both the U.S. and world markets.

The report discusses activity and trends in the pharmaceutical and biomedical markets as well as examining detailed trends that have developed to stimulate these markets. Moreover, it surveys companies known to be marketing, manufacturing or developing bioinformatics technologies in the U.S. and worldwide. Special effort was made to include mention of smaller companies and companies located around the world. Leading companies are discussed in depth, with a section on the history of the company, the product lines, business and marketing analysis, and a subjective commentary of the company's position in its market.

1.4 Methodology

The author of this report is a Ph.D. in biochemistry from the University of Minnesota, with many decades of experience in scientific writing and as a medical industry analyst. He has been a senior director of several large regional and national healthcare laboratories. The senior editor is a Ph.D. in physiology with a focus on computational physiology from the University of Toronto in Canada, with postdoctoral training and experience in cell and systems biology from the University of Toronto. The editor is a Ph.D. in biomedical sciences with a focus in microbiology from Meharry Medical College in Nashville, TN, with postdoctoral training and experience in molecular and cell biology as well as computational analysis obtained at the University of Pittsburgh, the National Institutes of Health and, most recently, at the Walter Reed Army Institute of Research.

Company-specific information is obtained mainly from industry trade publications, academic journals, news and research articles, press releases and corporate websites, as well as annual reports for publicly-held firms. Additionally, sources of information include the non-governmental organizations (NGOs) such as the World Health Organization (WHO) and governmental entities like the U.S. Department of Health and Human Services (HHS) and U.S. federal agencies such as National Institutes of Health (NIH), Food and Drug Adminstration (FDA) and the Centers of Disease Control and Prevention (CDC). Where possible and practicable, the most recent data available have been used.

Some of the statistical information was taken from Biotechnology Associates' databases and from TriMark's private data stores. The information in this study was obtained from sources that we believe to be reliable, but we do not guarantee the accuracy, adequacy or completeness of any information or omission or for the results obtained by the use of such information. Key information from the business literature was used as a basis to conduct dialogue with and obtain expert opinion from market professionals regarding commercial potential and market sizes. Senior managers from major company players were interviewed for part of the information in this report.

Primary Sources

TriMark collects information from hundreds of Database Tables and many comprehensive multi-client research projects, as well as Sector Snapshots that we publish annually. We extract relevant data and analytics from TriMark's research as part of this data collection.

Secondary Sources

TriMark uses research publications, journals, magazines, newspapers, newsletters, industry reports, investment research reports, trade and industry association reports, government-affiliated trade releases and other published information as part of its secondary research materials. The information is then analyzed and translated by the Industry Research Group into a TriMark study. The Editorial Group reviews the complete package with product and

market forecasts, critical industry trends, threats and opportunities, competitive strategies and market share determinations.

TriMark Publications Report, Research and Data Acquisition Structure

The general sequence of research and analysis activity prior to the publication of every report in TriMark Publications includes the following items:

- Completing an extensive secondary research effort on an important market sector, including gathering all relevant information from corporate reporting, publicly-available data and proprietary databases.

- Formulating a study outline with the assigned writer, including important items, as follows:

    - Market and product segment grouping, and evaluating their relative significance.
    - Key competitors' evaluations, including their relative positions in the business and other relevant facts to prioritize diligence levels and assist in designing a primary research strategy.
    - End-user research to evaluate analytical significance in market estimation.
    - Supply chain research and analysis to identify any factors affecting the market.
    - New technology platforms and cutting-edge applications.

- Identifying the key technology and market trends that drive or affect these markets.

- Assessing the regional significance for each product and market segment for proper emphasis of further regional/national primary and secondary research.

- Completing a confirmatory primary research assessment of the report's findings with the assistance of expert panel partners from the industry being analyzed.

1.5 Executive Summary

Bioinformatics may be defined as "the collection, classification, storage and analysis of biochemical and biological information using computers, especially as applied to molecular genetics and genomics." Bioinformatics finds use in many applications of the life sciences such as molecular medicine, microbial genome applications, agriculture and comparative studies, among others. Bioinformatics contributes to these areas through research fields such as the omics—genomics, proteomics, transcriptomics, metabolomics and pharmacogenomics.

Bioinformatics can be broadly divided into three product categories, namely, 1) content, 2) analysis software and services, and 3) information technology (IT) infrastructure. With the current abundance of genome sequence data, more researchers are utilizing bioinformatic databases and software to organize their data, increase research efficiency and pose questions, which would be impossible to approach via a traditional laboratory setting. The global bioinformatics industry has enjoyed a double-digit growth rate in the past and is expected to follow the same pattern at an average annual growth rate (AAGR) of [redacted]% through [redacted]. The U.S. remains the largest market in the world, but Asia-Pacific countries—particularly India and China—are witnessing the fastest growth and are anticipated to emerge as the dominating forces in the future. Genomics occupies the largest share out of the various bioinformatics application areas; however, proteomics is poised to take the lead. The content database market represents the largest segment in the market; but, it is the analytical software segment that is posting the fastest growth rate.

Bioinformatics will open new avenues for the other related sectors, with the biggest opportunity area in the drug discovery sector. Bioinformatics tools and software help reduce both the cost and the time taken to discover a new drug, making drug discovery an attractive field in which to venture. From a systems biology approach, bioinformatics allows data to be combined into interactive models that highlight disease pathways and aid the discovery of on/off-target effects of compounds. The greatest challenge for the bioinformatics industry is to keep pace with patent protection and the lack of standardization.

The process of designing a new drug using bioinformatics tools has opened a new area of research. Computational techniques assist researchers in searching for drug targets and in designing drugs *in silico*. These techniques are built into software packages, providing the ability to choose likely drug candidates through the automated modeling of a very large number of compounds. Several different algorithms have been used for this type of testing, many of which were adapted from artificial intelligence applications. With today's computational resources, several million compounds can be screened in a few days on the appropriate clustered computers.

Bioinformatics-enabled data management has assisted companies to improve productivity within their R&D programs by identifying new drug targets, diagnostic biomarkers and biomarkers of drug efficacy and toxicity. R&D laboratories are coordinating the analysis of increasing volumes of disparate biological data, largely comprised of gene and protein sequences. As informatics technology becomes increasingly important in drug R&D, the application of bioinformatics/informatics, at least [redacted]% based on genomics and proteomics, has the potential to drive growth in the worldwide pharmaceuticals drug market from the $[redacted] of [redacted] to $[redacted] by [redacted]. It is projected that the annual market growth rate for bioinformatics will be around [redacted]% or $[redacted] by [redacted].

The following are some key concepts to consider:

- Phenomenal development in IT and the Internet have fueled the growth of the bioinformatics industry.
- More than $[redacted] is spent on R&D for each new drug or biologic.
- Big pharma is being reinvented due to sweeping patent expirations and higher costs. Additionally, globalization is altering the traditional competitive advantages derived by pharma and biotech companies.
- As researchers learn more about the human genetic code, they are increasingly working to develop personalized treatments, which can be tailored to specific groups of patients based on their genetic constitution.
- Recent advances in genomics, proteomics and computational power present new ways to understand, diagnose and treat illness.
- Bioinformatics as a science is still evolving. The underlying mathematical and algorithmic methods are still being developed.
- The primary goal of the biotechnology industry is to invent new biologically-active substances for the treatment of disease and the management of agriculture, along with those for the pharmaceutical industry, the principal user of genomic science in the markets covered in this report.
- Expectations are that the biotechnology market will increase to more than $[redacted] by [redacted].
- TriMark projects that the global bioinformatics market will rise to roughly $[redacted] by [redacted].

2. Introduction

Over the last few years, as genomes have been sequenced and proteins have been studied with renewed enthusiasm, researchers in the fields of the life sciences and pharmaceutical development have been inundated with massive quantities of data. With the amount of data rapidly approaching a petabyte (a quadrillion bytes), the question becomes, what do you do with it all once you have it stored in various computers? The answer is to use those same computers to manage, retrieve, organize, compare and integrate the data. In a word, this is known as bioinformatics.

What are some of the typical problems addressed by bioinformatics?

- Evolutionary biology or phylogenetics: Phylogenetics is the study of relatedness among the different kinds of life on earth. Using bioinformatics tools, scientists can begin to reconstruct the evolutionary relationship between two species and estimate the time of divergence from a common ancestor. For instance, closely-related organisms have similar nucleotide and protein sequences, and conversely, more distantly-related organisms show more dissimilarity.

- Identification of gene families and prediction of protein function: To gather the maximum information from the accumulating genome sequences, conserved genes are classified in terms of homology. For example, orthologs are genes in different species that evolved from a common ancestral gene. Proteins that share significant amino acid sequence conservation are categorized into the same protein family. Such information is important because families that are conserved in bacteria, for instance, but are absent from eukaryotes, may be potential new targets for broad-spectrum antibiotics.

- Genome mapping: With annotation tools, scientists now can map disease genes in large pedigrees by navigating a vast number of web sites and databases. Computational strategies can be used in positional cloning projects and to narrow the number of gene candidates.

- Computer-aided drug design (CADD): This is a specialized discipline using computational tools to simulate drug receptor interactions. CADD methods, *e.g.*, virtual high-throughput screening (vHTS), are highly dependent on bioinformatics tools, applications and databases, and as such, there is considerable overlap between CADD and bioinformatics.

- Other problems include prediction of protein folds from DNA sequence data; comparison of gene expression patterns between normal and diseased tissue; and protein modeling, or predicting the three-dimensional structure based on similarity to an experimentally-determined protein structure.

The analysis of these and other challenges inherent in understanding biological data is made possible by bioinformatics. Laboratory-based science has converged with information science, transformed through the rapidly-changing field of bioinformatics.

There are several interesting breakthroughs on a consumer level that have been successful due to the advances in bioinformatics, including:

- The first biotechnology drug, Epogen, from Amgen, Inc.
- Diagnostics for hereditary breast cancer.
- Variations in leukemia.
- The first complex human disease gene: diabetes.
- Metabolically-enriched “yellow rice”.
- “Smart bomb” against cancerous white blood cells.

Other uses include industrial enzymes that do everything from making our detergents better to digesting oil spills. Typically, bioinformatics is associated with massive databases of gene and protein sequences, as well as structure and function information, into which are deposited new sequences that can be searched by remote computer access whenever any sequence needs to be compared with what is already known. The field is thus relatively young, as it arose after automated protein and DNA sequencing became possible in the mid-[redacted], and after computers began to

