



2001/2002 FAR EAST MSPPSA SERIES

# DNA SEQUENCING

AN ANALYSIS OF  
MARKET SIZE & GROWTH  
MARKET SHARE  
PURCHASE PLANS &  
SUPPLIER ASSESSMENT FOR THE  
FAR EAST LIFE SCIENCE RESEARCH MARKET

*A Multi-Client Report*

by  
PhorTech International  
San Carlos, California

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# I. BACKGROUND

## A. SURVEY OBJECTIVES

The purpose of this survey was to provide the management of our client companies with an analysis of the current market for DNA sequencing, (including the installed base of both manual and automated sequencers, and thermal cyclers,) in the Far East market and of the attitudes and expectations of a cross-section of researchers who utilize DNA sequencing in their work.

The survey was Web-based, at a location on our Web site made known to respondents through an email invitation. The surveying was blind, with no reference made to any of our clients for the survey. To encourage respondents to express themselves freely and without bias, the survey was anonymous, and made frequent use of open-ended questions.

We used several demographic screens to characterize respondents, their organization and type of laboratory facility, core facility, sequencing service laboratory or neither. In addition, the utilization of various sources of sequencing data was examined here.

We also characterized the nature of sequencing respondents currently perform, including their throughput for each of five sequencing strategies and volume of templates for a selection of sequencing methodologies performed either in the lab or by a sequencing service. Additional questions requested information regarding the enzymes and labels employed, relative utilization of kits vs. individual reagents (and primary suppliers for each), the types of templates and finally, the primary methods for purifying and sequencing templates.

Early on the in survey, respondents were asked whether or not they currently use DNA sequencing techniques in their work. Those respondents who answered positively were asked to specify the volume of sequence data generated on an annual basis, and the number of reactions run to generate this data from all sources. They were then asked to provide the percentage of data obtained from in-lab manual sequencing, in-lab automated sequencing, on-site facilities and off-site sequencing services. Respondents using sequencing services were questioned regarding the most important criteria for selecting a service and to itemize the cost per template, indicating whether this included template preparation or the sequencing reaction only.

All respondents were asked to identify the instruments they had access to from a list of the following six options: automated sequencers, robotic workstations, manual film readers, sequence analysis software, fluorimager/phosphorimager, or automated film reader.

Questions pertaining to in-lab manual or automated sequencing include an itemization of each type of sequencer owned by the group, followed by

detailed audit questions. In particular, respondents were asked to provide the brand, model, quantity, date acquired, and approximate cost for each unit. Respondents were questioned why they chose their most recently acquired brand of sequencer, whether they would choose this unit again and to explain their reasoning.

Users were asked to provide an estimate of their weekly throughput by itemizing the number of templates, followed by the bases called and reagent cost per template. The number of manual sequencing gels run in a week was also measured and all sequencing users were asked to estimate the percent change in usage over the next 12 months. Users were also asked to select the highest-rated manufacturer in key areas. The suppliers and key areas varied depending on the category of instrument but all included questions regarding ease of use, service/support and quality. Respondents using automated sequencers were also asked to rank manufacturers based on innovation, instrument throughput, running costs and commitment to the field.

Automated sequencing users provided details regarding instrument features and desired improvements, in addition to their primary sequencing application. They were also asked to identify the proportion of their sequencer or sequencing service throughput dedicated to non-sequencing applications, describing each application and the proportion of total throughput.

In response to the increase in cycle sequencing, an audit of thermal cyclers was included. Respondents were asked to specify the brand, model, sample capacity, year acquired and cost for the most recently purchased thermal cyclers used at least one third of the time for cycle sequencing.

All respondents were asked a question regarding the likelihood of future auto sequencer, robotic workstation, analysis software or thermal cycler purchases over the coming 12 months, and were asked to specify which instruments and suppliers they were considering.

Major objectives of the survey were to estimate the present size of the Far East market and to determine the present market share for major instrument categories and for leading manufacturers, to measure the market's historic growth rate, based upon the identified installed base, to identify the leading manufacturers in terms of units placed and estimated dollar sales volume, and to profile DNA sequencing users by instrumentation category. Profiles of respondents most likely to purchase new instrumentation in the near term will also be carefully examined. Finally, wherever possible, these results will be compared with the data reported in the companion report covering the U.S. sequencing market performed in 1999.

The audit should permit the evaluation of our clients' present market positions, identify marketing strengths and weaknesses, and suggest strategies to develop or improve sustainable competitive advantage.

This report is the third 2001/2002 study in a growing series of market research analyses that began in 1993. We plan to continue the series, adding titles and alternating between U.S. and international markets, depending upon our clients' suggestions and support.

Topics in the U.S. series to be published in 2001/2002 include:

Electrophoretic Instrumentation & Reagents  
Molecular Biology Reagent Systems, Vol. 2

This series also includes the following reports covering international markets:

Densitometers & Image Analysis in Europe  
DNA Sequencing in the Far East.

The 2000/2001 series covered the following three reports:

U.S. DNA Amplification  
U.S. Molecular Biology Reagent Systems, Vol. 1  
Molecular Biology Reagent Systems, Vol. 1 in the Far East.

In the 1999/2000 series, we have released three reports examining the following markets. These are:

Microplate Equipment in Europe  
DNA Sequencing in the U.S.  
Monoclonal Antibodies in the U.S.

The following nine titles have been released in the series for 1998/1999:

Cell & Tissue Culture in the U.S.  
Cytokines & Growth Factors in the U.S.  
DNA Amplification in the Far East  
DNA Sequencing in Europe  
Electrophoretic Gel Media in Europe  
HPLC in the Life Sciences in the U.S.  
Molecular Biology Reagent Systems, Vol. 1  
Molecular Biology Reagent Systems, Vol. 2 in the Far East  
Protein Expression Systems in the U.S.

The following titles have been released in the U.S. series for 1997/8:

DNA Sequencing

Molecular Biology Reagent Systems, Vol. 1  
Molecular Biology Reagent Systems, Vol. 2  
Molecular Diagnostics.

Clients are reminded that additional copies of any of these reports that have been purchased in the past are available at a modest cost. Please contact us for further details. Those wishing to know publication dates for any of these reports, or wanting to read summaries of the 72+ reports in this series are invited to visit our Web site at: [www.phortech.com](http://www.phortech.com).

## B. SURVEY METHODOLOGY

Three sources of names were used for this survey. First, e-mail invitations to take part in the survey were sent to a selected cross-section of life science researchers from our panel of 7,000 life science researchers worldwide. After selection for appropriate areas of interest and screening out of competitors, invitations were sent to 871 Far East members of the panel who have been in contact with us in the last year and previously indicated their involvement in work with nucleic acids, or sequencing techniques. These constituted source A. The second source, source B, consists of 1,434 Far East subscribers obtained from the publishers of Nature magazine. Since the number of survey returns was below expectations, an additional 3,000 Far East life scientists obtained from Marketwise was obtained as source C. Letter invitations were mailed to the researchers on this list. Customized email invitations were sent to the researchers in source A on August 31<sup>st</sup>, followed, on September 4<sup>th</sup> by emails to the list of Nature subscribers, source B. The letter invitations to the researchers in source C were sent by Air Mail on October 6<sup>th</sup>.

Each participant in source A and B received an email invitation including the web address of the survey and a unique validation code. Researchers from the third source received an invitation on letterhead with the web address and a single validation code, C-87.

To improve response rates, respondents were able to select from a choice of four prizes for completing the survey. These were a laser pointer, a mini-Mag lite flashlight, a selection of Jelly Belly gourmet jelly beans, a \$5 gift card good towards any purchase at Barnes & Noble or a custom designed tee-shirt.

Apart from the prize, no inducements were employed. The questionnaires were anonymous, a combination of tabular entry, check-offs, and open-ended probes.

The undeliverable to sources A and B were on the order of 350 of the 2,305 emails sent. Taking into account the 154 envelopes returned to us from the source C mailing, we calculate that 5,151 invitations were sent to Far East researchers.

By the close of the survey on January 9<sup>th</sup>, 226 responses had been received. After removing duplicate responses and non-users, there were a total of 216 valid responses which translates to a 4.2% response rate. This was well below our expectations. Examining the responses for individual sources, we find that 93 researchers in source A responded to the survey for a response rate of 13.9%. Only 1.4%, or 18 researchers in source B responded to the survey,

while source C fared only slightly better providing 101 responses, with translates to a rate of 3.5%.

The questionnaires were anonymous, using a combination of tabular entry, check-offs, and open-ended probes. However, almost all respondents did identify themselves by filling in the prize entry form. This makes it possible for us to double-check the responses to any questions by telephoning respondents, improving the overall confidence in the data. We did observe some survey fatigue in the form of a reduced number of responses and shorter length than we would expect, particularly for the open-ended questions.

Based upon 216 responses, the overall statistical results presented in this report are accurate to within  $\pm 6.7$  percentage points at the 95% confidence level. In our experience, 95% confidence levels are appropriate primarily for scientific experiments. Most business people making decisions are content to be right more often than they are wrong. In this case, a 65% confidence level, (in which you would be right twice as often as you would be wrong) is more appropriate. Conveniently, 65% confidence levels are nearly exactly one half the size of the 95% level, thus our 65% levels would be  $\pm 3.3\%$  for all respondents.

According to the binomial distribution theory, these values are valid when the measured event has about a 50% probability. When the measured event is considerably more rare than this, the corresponding confidence intervals get smaller. On the other hand, these confidence intervals are valid for answers based upon the complete pool of respondents. When analyzing data for a group that includes only a small segment of respondents, the answers are less certain and confidence intervals are correspondingly larger.

In this report, we will calculate more exact individual confidence intervals when appropriate. In our comments, we will note whether given differences are significant at either the 65% or 95% level. To aid our clients in determining the appropriate confidence interval for various combinations of sample size and measurements, we have created the table found at the top of the next page. Just read the closest percentage on the left and find the closest sample size column. The intersection will show the confidence interval for that combination. For example, a measured 35% value with a sample size of 200 has a 95% confidence interval of  $\pm 6.6\%$ .

95% Confidence Intervals for Various Percentages & Sample Sizes

Percent	n=10	n=20	n=50	n=100	n=200	n=500	n=1000
5%	±13.5%	±9.6%	±6.0%	±4.3%	±3.0%	±1.9%	±1.4%
10%	±18.6%	±13.1%	±8.3%	±5.9%	±4.2%	±2.6%	±1.9%
20%	±24.8%	±17.5%	±11.1%	±7.8%	±5.5%	±3.5%	±2.5%
35%	±29.6%	±20.9%	±13.2%	±9.3%	±6.6%	±4.2%	±3.0%
50%	±31.0%	±21.9%	±13.9%	±9.8%	±6.9%	±4.4%	±3.1%
65%	±29.6%	±20.9%	±13.2%	±9.3%	±6.6%	±4.2%	±3.0%
80%	±24.8%	±17.5%	±11.1%	±7.8%	±5.5%	±3.5%	±2.5%
90%	±18.6%	±13.1%	±8.3%	±5.9%	±4.2%	±2.6%	±1.9%
95%	±13.5%	±9.6%	±6.0%	±4.3%	±3.0%	±1.9%	±1.4%

# II. DEMOGRAPHIC SEGMENTATION

## QUESTION 3.

### Question:

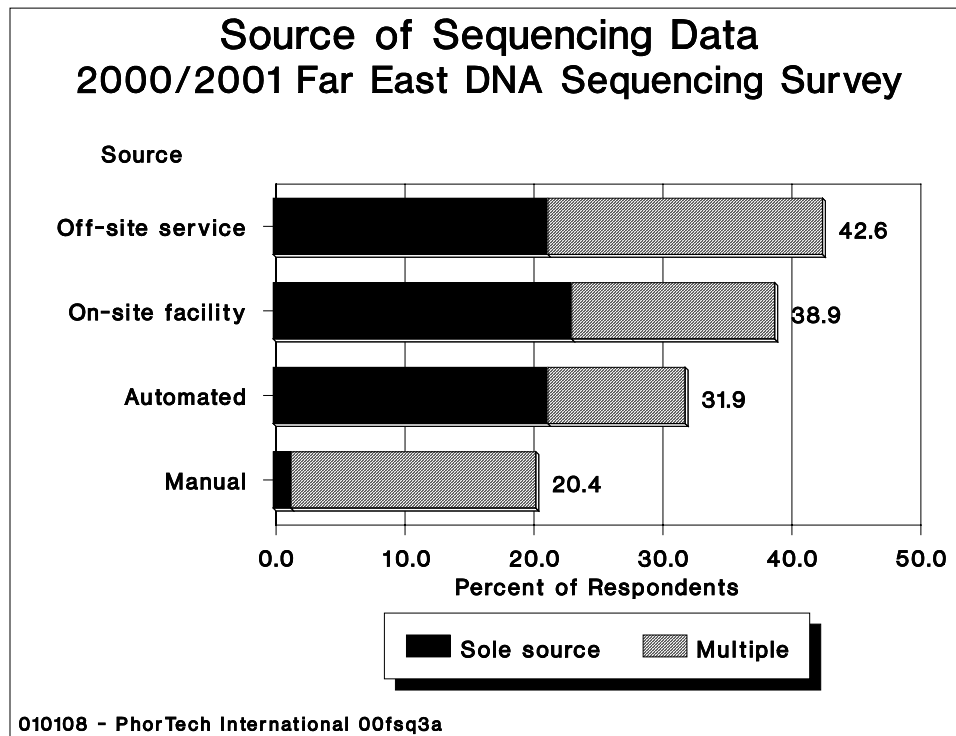
What percentage of your sequencing data is obtained by the following methods (*Please note, these should add up to 100%*): in-lab manual sequencer, in-lab automated sequencer, sent out to on-site facility, sent out to off-site sequencing service?

### Rationale:

This question has been added in order to measure respondent's ever increasing usage of centralized laboratories for DNA sequencing, as compared to in-lab usage. Unless otherwise specified, we will use the responses to this question in our Current Methodology section to define populations using manual and automated sequencing.

### Results:

In the horizontal bar chart below, we present the distribution of responses for 216 respondents, of which 72.7% indicate using a specialized sequencing facility for some or all of their sequencing needs and 48.1% perform at least some sequencing in the lab. Interestingly, the percentage of people using a specialized sequencing facility and performing in-lab sequencing is not significantly different than the values given in our 1999 sequencing survey covering the U.S. market.



Here we see a strong similarity between the number of users obtaining a part or all of their sequencing data from an on-site facility, and the number using an off-site service. Out of the 104 respondents performing sequencing in the lab, 57.7% are performing automated sequencing, 33.7% are performing manual sequencing, and 8.6% are performing both.

In the Current Methodology section of this report, we present further analysis of this question.

## QUESTION 38.

### Question:

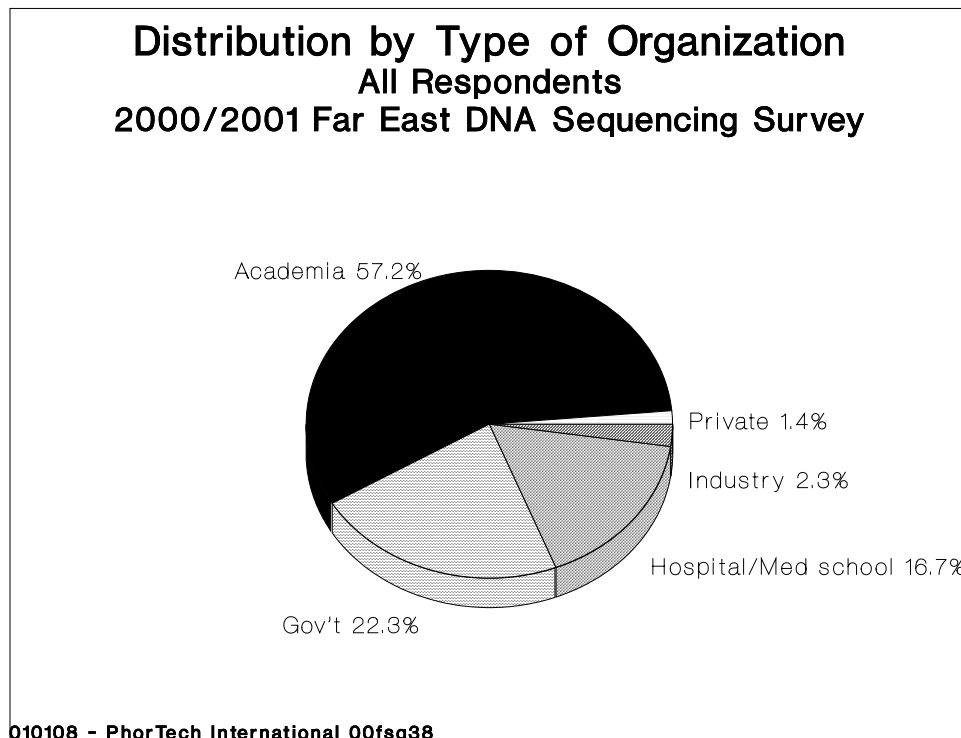
How would you best describe your organization: Academia, Hospital/med school, Industry, Government agency, or Private? (*Best SINGLE answer, please*).

### Rationale:

This screening question identifies the location of respondents performing DNA sequencing, allowing us to examine the relative utilization over the five types of organizations.

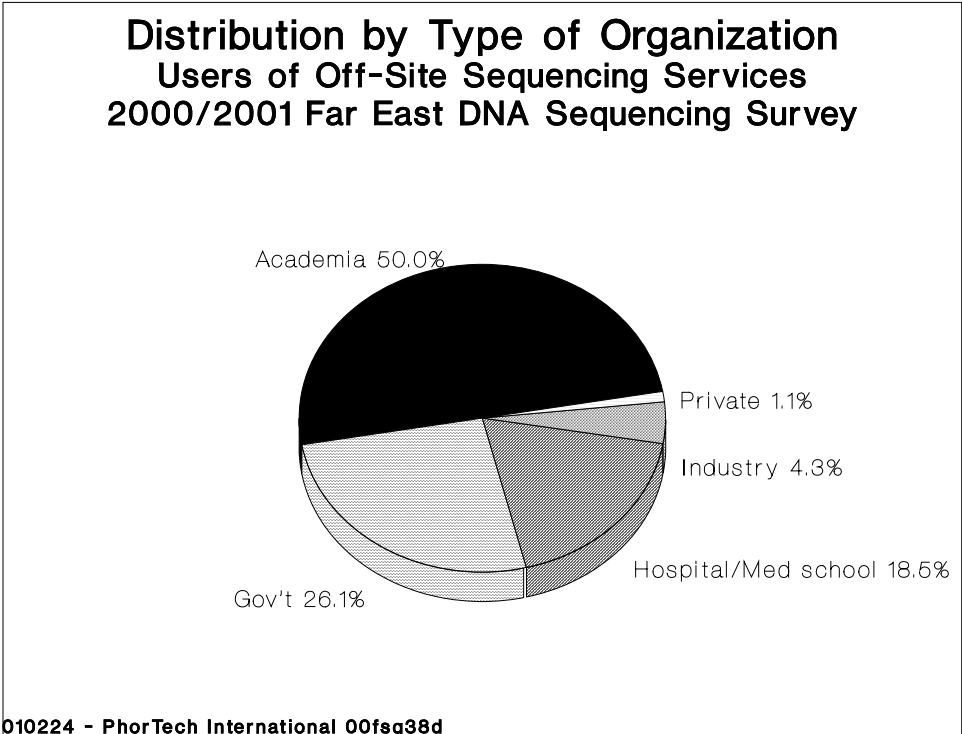
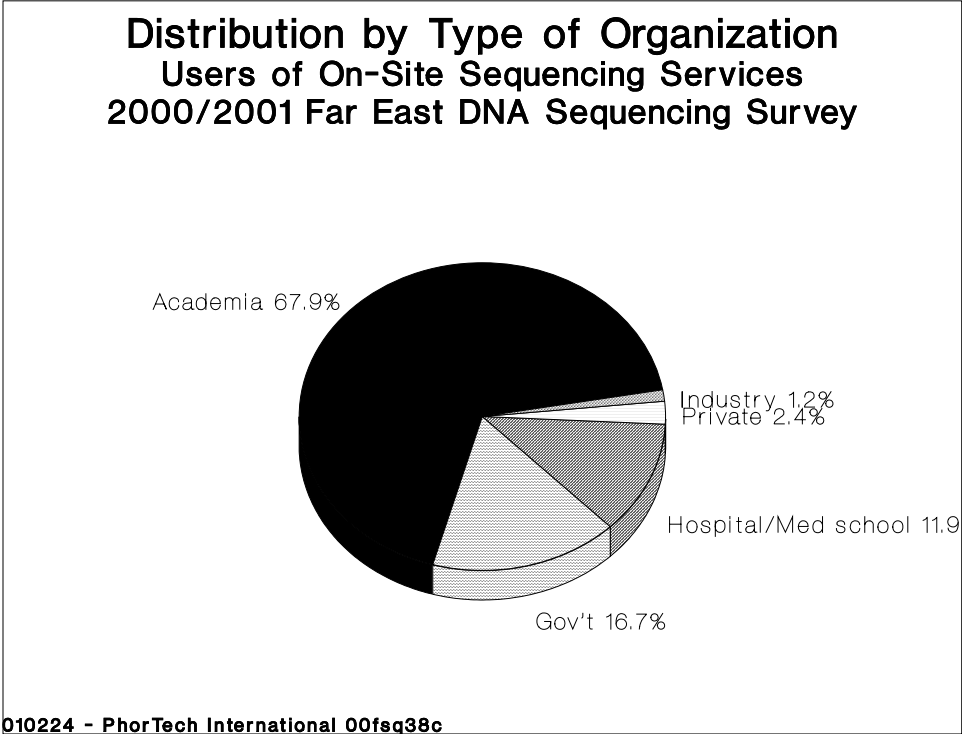
### Results:

In the pie chart below, we profile the results for all 216 respondents. There is a significantly larger group of government researchers than we would normally expect; there is a very small representation of privately funded organizations and industrial researchers.



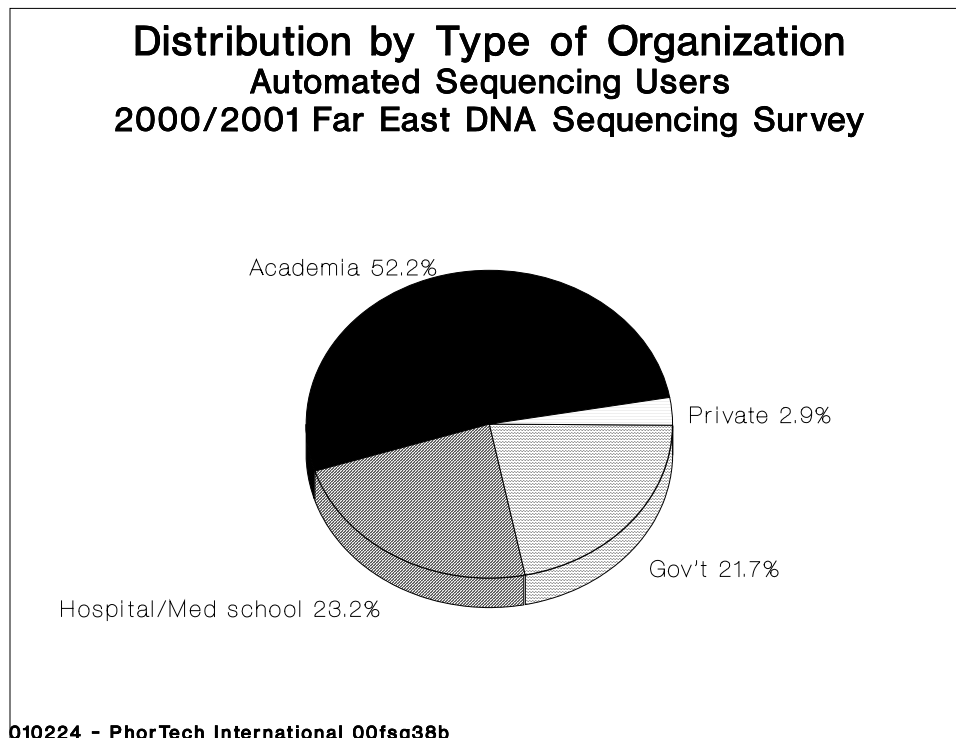
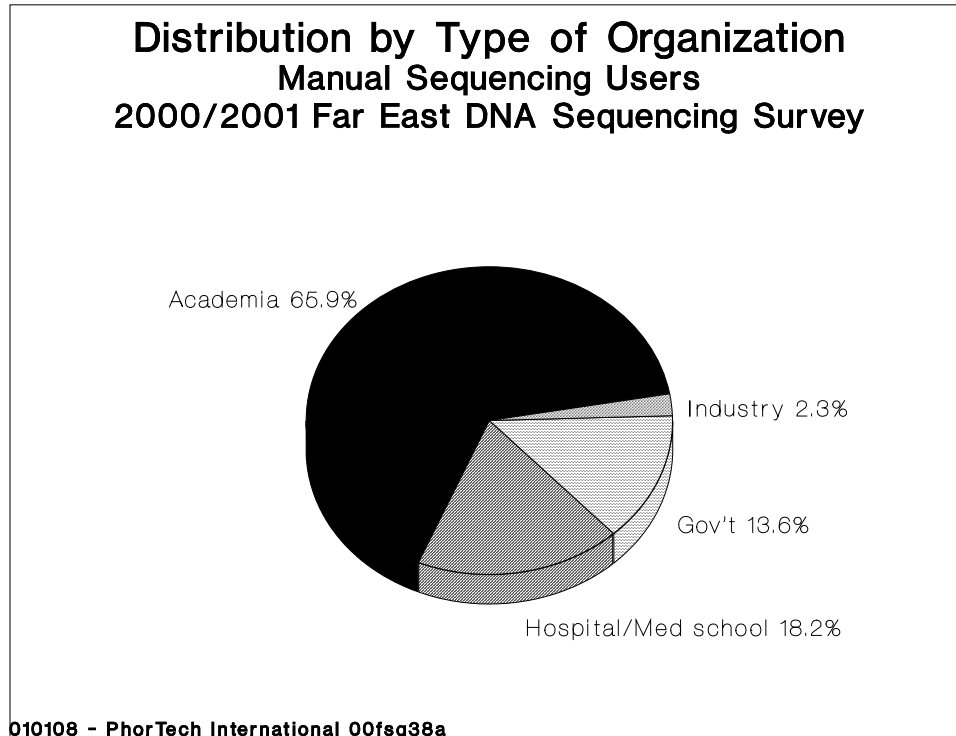
To determine the relative utilization of in-lab sources vs. outside services for each type of organization, we will examine the distribution for each of the four sources of sequencing data. As seen at the top of the next page, academics alone represent nearly three quarters of the group of 84 respondents using an on-site specialized sequencing facility for some or all of their sequencing needs; they represent exactly half of the 92 respondents

using an off-site sequencing service while government researchers make up an additional 25%.



Next is the distribution of the 44 respondents performing manual sequencing in the lab. Although academics appear to be slightly more likely to use this

technique and conversely, government workers less likely to perform it, statistically, there is no significant difference.



In comparison, we find that, of the 69 respondents using an automated sequencer in the lab, government and hospital/medical school researchers appear to be more likely to use this more expensive method of sequencing

than those in academia. However, we remind the reader that there is actually no statistical difference between the two results.

### Analysis:

According to the responses to Question #3, outsourcing, either to on-site facilities or off-site sequencing services, was reported by a relatively similar percentage of researchers in the academic sector (74.0%), in government agencies (70.8%), and in hospitals or medical schools (66.7%).

For those wishing to do further analysis, we provide the number of respondents using each source by their organizational type. Clients are reminded that many respondents use several sources and are therefore included several times.

**Respondent's Source of Sequencing Data for Various Types of Organizations**

Source	Academia	Hosp/Med Schl	Industry	Gov't	Private
On-site	57	10	1	14	2
Off-site	46	17	4	24	1
Manual	29	8	1	6	-
Automated	36	16	-	15	2
Total # Resp	123	36	6	48	3

Finally, in the following table we present the name of the institutions and country locations which are represented by respondents to this survey, grouped by organizational type.

**Organizations and Countries Represented in this Survey**

Academia	
Academia Sinica	Taiwan, ROC
Adelaide University	Australia
Australian National University	Australia
Australian Neuromuscular Research Institute	Australia
Bose Institute	India
Center for Cellular Molecular Biology	India
Central Police University	Taiwan, ROC
Australian National University, Research School of Biol. Sciences	Australia
Charles Sturt University	Australia
Children's Cancer Institute	Australia
Chinese University of Hong Kong	Hong Kong
Deakin University	Australia
Flinders University, School of Biological Science	Australia
Kyushu University, Graduate School of Medical Science	Japan
Taipei Medical College, Graduate Institute of Cell and Mol. Biol.	Taiwan, ROC
Griffith University	Australia
Hiroshima University	Japan

Hokkaido University, Graduate School of Pharm. Science	Japan
Hong Kong University of Science and Technology	Hong Kong
IMTECH	India
Indian Institute of Chemical Biology	India
Indian Institute of Science	India
Indian Institute of Technology	India
Industrial Toxicology Research Center	India
James Cook University	Australia
Jawaharlal Nehru University, School of Environmental Sciences	India
Juntendo University	Japan
Keio University	Japan
KRL	Pakistan
Kyoto University Faculty of Pharmaceutical Sciences	Japan
Lincoln University	New Zealand
Madras Veterinary College	India
Madurai Kamaraj University	India
Mahidol University	Thailand
Massey University	New Zealand
Monash University	Australia
National Research Centre for Environmental Toxicology	Australia
National Tsing Hua University	China
National University of Singapore	Singapore
Okayama University Dental School	Japan
PUE	India
RMIT University	Australia
Seoul National University	Korea
Seoul Women's University	Korea
Shizuoka Institute of Science and Technology	Japan
Singapore Polytechnic	Singapore
Sungkyunkwan University	South Korea
Toho University, School of Pharmaceutical Science	Japan
Tohoku University	Japan
Tokyo Institute of Technology	Japan
Tokyo University	Japan
University of Agricultural Science, College of Fisheries	India
University of Adelaide	Australia
University of Erlangen-Nuernberg	Germany
University of Hong Kong	China
University of Malaya	Malaysia
University of Melbourne	Australia
University of New South Wales	Australia
University of Newcastle	Australia

University of Otago	New Zealand
University of Queensland	Australia
University of Suwon	Korea
University of Sydney	Australia
University of Tasmania	Australia
University of Technology, Sydney	Australia
University of Tokyo	Japan
University of Western Australia	Australia
Yunnan Agricultural University	China
Government Agencies	
AgResearch	New Zealand
Dr. A. Q. Khan Research Lab	Pakistan
CDFD	India
Central Institute of Medicinal and Aromatic Plants	India
Centre for Biochemical Technology	India
Centre for Cellular and Molecular Biology	India
Crop and Food Research	New Zealand
CSIRO	Australia
CSIRO Animal Health	Australia
CSIRO Entomology	Australia
CSIRO Health Science and Nutrition	Australia
CSIRO Livestock Industries	Australia
ICRISAT	India
Institute of Physical and Chemical Research	Japan
Japan International Research Center for Agricultural Science	Japan
Korea Research Institute of Bioscience and Biotechnology	South Korea
National Centre for Disease Investigation	New Zealand
National AIDS Research Institute	India
National Institute for Longevity Science	Japan
NEERI	India
Queensland Institute of Medical Research	Australia
Queensland Health Scientific Services	Australia
RIKEN	Japan
Royal Botanic Gardens	Australia
Tokyo Metropolitan Institute of Medical Science	Japan
VIAS	Australia
WHO Influenza Centre	Australia
Hospital/Medical Schools	
Canterbury Health Laboratories	New Zealand
Centre for Molecular Biology and Medicine	Australia

Children's Cancer Institute	Australia
CIDMLS, ICPMR	Australia
Prince of Songkla University, Pediatrics	Thailand
Epworth Medical Centre	Australia
Fukui Medical University	Japan
Garvan Institute of Medical Research	Australia
Institute of Bone and Joint Research	Australia
Institute of Medical and Veterinary Science	Australia
Institute of Medical Science, University of Tokyo	Japan
Kurume University School of Medicine	Japan
Murdoch Children's Research Institute	Australia
National Children's Medical Research Center	Japan
National Defense Medical College	Japan
National Taiwan University	Taiwan, ROC
National Taiwan University Hospital	Taiwan, ROC
Okinaka Memorial Institute for Medical Research	Japan
Osaka University Medical School	Japan
Phramongkutkloa College of Medicine	Thailand
Princess Margaret Hospital	Australia
Prince Henry's Institute of Medical Research	Australia
Royal Children's Hospital	Australia
Royal North Shore Hospital	Australia
Royal Perth Hospital	Australia
RPA Hospital	Australia
Singapore General Hospital	Singapore
Teikyo University, School of Medicine	Japan
Tohoku University Graduate School of Dentistry	Japan
University of Queensland	Australia
West China Medical University	China
Women's and Children's Hospital	Australia
Industry	
AMRAD	Australia
Fletcher Challenge Forests	New Zealand
Global Technologies	New Zealand
Groupe Limagrain Pacific	Australia
Johnson and Johnson Research	Australia
Landcare Research Ltd	New Zealand
Private	
GeneType Pty Ltd	Australia
M. S. Swaminathan Research Foundation	India



## QUESTION 37.

### Question:

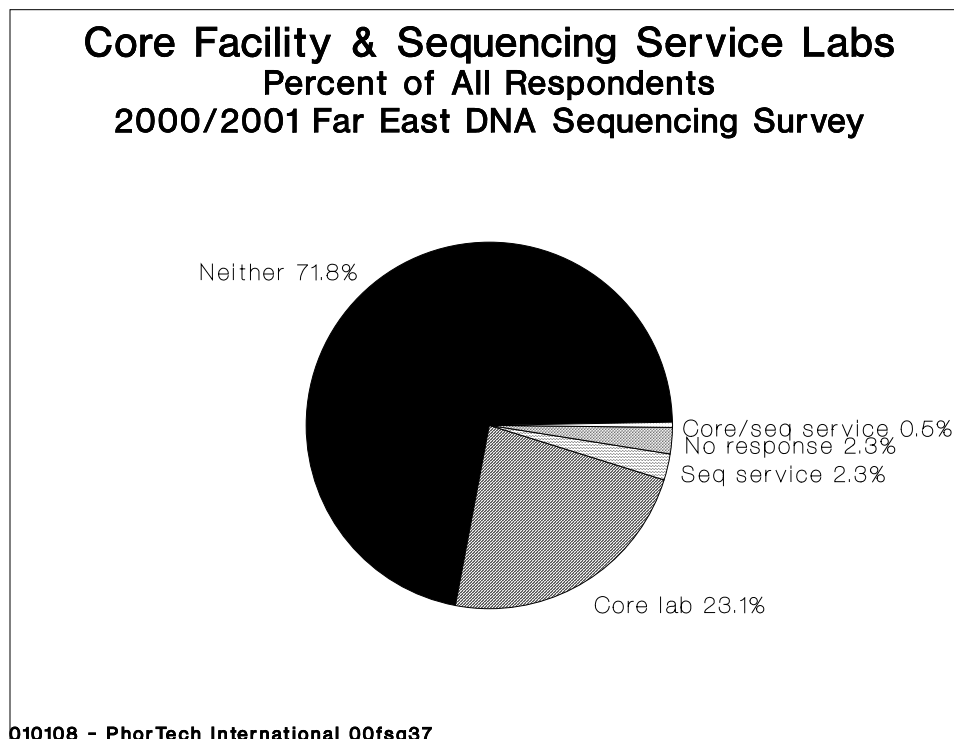
Is your laboratory a core facility or a sequencing service?: Core lab, Sequencing service, Neither

### Rationale:

These types of facilities have a different set of requirements and opinions regarding sequencing and instrumentation. This question was designed to identify those respondents within our sample. We may examine responses for these 'service facilities' later in the report and can also compare these results with previous studies of this market.

### Results:

In the following pie chart depicting the profile for all 216 respondents, 25.9% indicate that they are located in a core or sequencing service lab.



This is about 10% higher than found in our 1999/2000 U.S. report, and 20% higher than found in our 1997/8 U.S. survey results.

### Analysis:

As shown in Question #3, the percentage of researchers using an outside lab such as a core facility or sequencing service is considerable. The number of core facility or sequencing service labs represented in this survey exceeds

25%, a considerable increase when compared with U.S. surveys. Therefore, we can assume that three quarters of our results in this survey represent the usage of the individual life science researcher, and one quarter represents the higher throughput of a core lab or sequencing service.

