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Getting Closer to Single-Cell Multi-omics: Standardized Solutions for High-Throughput Simultaneous Multiplexed mRNA and Protein Analysis

In the pursuit of understanding human cellular processes, and ultimately to decipher complex disease mechanisms and develop more effective disease treatments, the need for multi-omic techniques is at the forefront. Single-cell analysis has become key to the study of cellular heterogeneity and function, with single-cell RNA-seq (scRNA-seq) revolutionizing single-cell transcriptome analysis. However, true multi-omics analysis in single cells, specifically meaning the simultaneous analysis of whole genome, transcriptome, proteomic and epigenomic information from the same individual cell, has not yet been possible. Previous attempts have relied on techniques that offered limited multiplexing and processed a limited number of cells. Other techniques have used sequential and separate analysis of transcriptomic and proteomic content in single cells that are then correlated later during analyses.

New products now coming to the market enable high-throughput, high-multiplex, and simultaneous measurement of transcriptome wide mRNA and cell-surface proteins in single cells, offering new insight into the relationship between the genotype and phenotype. These new products also mark the next stage in commercialization of oligo-conjugated antibody products, which are now becoming available as standardized, ready-to-use solutions tailored for single-cell specific applications. Two companies at the forefront of bringing integrated solutions for simultaneous measurement of mRNA and cell-surface protein in single cells to the market are BD (Becton, Dickinson and Company) and 10x Genomics, which is working in partnership with antibody supplier BioLegend.

A new set of solutions aims for a closer integration of pre-conjugated oligo antibodies with instrumentation in order to simplify and standardize the use of new methods for simultaneous proteomic and transcriptomic analyses in single cells.

Oligo-conjugated antibodies associate an oligonucleotide barcode to the epitope the antibody recognizes, thus translating the specificity of that antibody for its target protein into a signal that can be amplified by PCR, and detected via NGS. Oligo-conjugated antibodies have been available for several years for cell analysis applications, including the simultaneous analysis of proteins and mRNA in single cells; however, these tools were offered as unrelated standalone products in the form of kits or reagents for do-it-yourself approaches. A new set of solutions aims for a closer integration of pre-conjugated oligo antibodies with instrumentation in order to simplify and standardize the use of new methods for simultaneous proteomic and transcriptomic analyses in single cells.

Describing BioLegend's oligo-conjugate offerings, Miguel A. Tam, Senior Product Realization and Marketing manager at BioLegend, told IBO, "We currently offer more than 170 conjugates and keep on expanding our portfolio. Our goal is to facilitate biomedical discovery by making available as many conjugates as possible, based on the needs of the scientific community."

Utilizing new experimental methods, antibody conjugates have become key to addressing single-cell proteomic analysis. "Analytical tools such as flow cytometry or Western blot can be used to study and characterize proteins, whereas NGS can efficiently be employed to quantify mRNA at a high-throughput scale, and even at single-cell levels," explained Dr. Tam. "Protein analysis technologies have been lagging behind in their capacity to visualize multiple targets, as compared to single-cell RNA sequencing, for example, that can retrieve thousands of RNA readings in a single experiment."

New methods are enabling even higher-throughput, highly multiplex measurement of both mRNA and surface-cell proteins in tens of thousands cells.

But new methods are enabling even higher-throughput, highly multiplex measurements of both mRNA and surface-cell proteins in tens of thousands cells. These techniques include CITE-seq [cellular indexing of transcriptomes and epitopes by sequencing] and REAP-seq [RNA expression and protein sequencing assay], which are essentially the same, according to Dr. Tam. "Last year, in October, two paperswere published describing a tremendously innovative approach to apply the high-throughput capacity of NGS to protein analysis," he explained. "The authors linked oligonucleotides that mimic mRNA to antibodies, and used single-cell platforms and NGS to convert the linked oligo into a readable sequencing signal."

The methods mark a leap forward in the speed and number of cells that can be analyzed at the same time for mRNA and surface cell proteins as part of a scRNA-seq protocol. "As the oligo-antibody conjugates can be integrated into the single-cell workflow, both transcriptomics and protein data can be obtained in the same experiment, with the high-throughput capacity inherent to this process," stated Dr. Tam. The methods are also more accessible, as CITE-seq is compatible with existing RNAseq protocols.

Earlier this year, BioLegend announced an exclusive agreement with the New York Genome Center (NYGC) to commercialize static barcodes for its oligo-conjugated antibodies, creating a standardized approach for CITE-seq. "We have been since working in close collaboration with this group, and BioLegend is currently offering antibodies directly conjugated to oligonucleotides compatible with single-cell platforms based on poly-T capture systems. Conjugates can be found under our TotalSeq brand," noted Dr. Tam. New developments in the design of oligo-conjugated antibodies address the need for faster, lower-cost analysis. "We are also offering what is known as Hashtag conjugates, which allow researchers to process multiple samples in the same experiment, mixed together, to optimize their protocol and minimize the costs."

In addition to BioLegend's antibodies, the NYGC is using the 10x Genomics Solution as part of its commercial offerings. In July, 10x Genomics announced an agreement with BioLegend to become a member of the 10x Compatible Partners program. BioLegend's forthcoming ready-to-use TotalSeq B and TotalSeq C oligo-conjugated antibody products will be compatible with 10x Genomics' droplet-based instrumentation, consumables for scRNA-seq, and analysis and visualization tools for ready to use solutions. Specifically, the assays will work with 10x's Chromium Single Cell Gene Expression Solution and Chromium Single Cell Immune Profiling Solutions in combination with its new Feature Barcoding technology, which will be released later this year.

"The Feature Barcoding technology from 10x Genomics enables simultaneous analysis of a specific biological features of interest together with either unbiased gene expression or immune repertoires within that same cell."

Describing the Feature Barcoding technology, Giovanna Prout, director of Strategic Marketing, 10x Genomics, told IBO, "The Feature Barcoding technology from 10x Genomics enables simultaneous analysis of a specific biological features of interest together with either unbiased gene expression or immune repertoires within that same cell." Such biological features include surface cell proteins. "Feature Barcoding technology allows the researcher to increase the complexity of their analysis, by simultaneously measuring gene expression profiles and cell surface protein expression in the same cell at high cell throughput scale," she added. "By enabling the detection of protein isoforms or post-translational modifications, researchers now can use additional data points to identify cells, adding more dimensions to their cell profiling analyses."

In addition to unbiased mRNA and surface cell protein measurements, Feature Barcoding technology enables simultaneous highly multiplexed single-cell characterization of other cellular contents and functions. "The new technology can support a wide variety of research applications depending upon which biological feature is being targeted, and can include cell surface proteins, MHC [major histocompatibility complex] receptors, CRISPR-mediated perturbations or other targets of interest to the researcher."

Featuring Barcoding technology is compatible with multiple single-cell analysis solutions offered by 10x Genomics, complimenting and extending the scientific applications of their current offering for single cell analysis. "The Feature Barcoding technology used with the Chromium Single Cell Gene Expression Solution moves beyond methods published in peer-reviewed publications, like CITE-seq, REAP-seq, CROP-seq [CRISPR droplet sequencing] and Perturb-seq [which combines single-cell RNA-seq and CRISPR-based perturbations]," explained Ms. Prout. To make the methods more accessible, 10x has partnered with established reagent companies. "10x Genomics has partnered with key providers to complement these applications for the Single Cell Gene Expression and Immune Profiling Solutions, including products for oligo-conjugated antibodies (BioLegend), guide RNA with complementary feature barcode sequences

embedded, and oligo-conjugated Dextramers (Immudex) that are compatible with Feature Barcoding technology."

For measuring gene expression and protein characterization, Feature Barcoding technology and the Chromium Single Cell Gene Expression Solution can be used with BioLegend's TotalSeq B oligo-conjugated antibody or researcher's own custom conjugated antibodies.

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For characterizing MHC complexes, the Chromium Single Cell Immune Profiling Solution and Feature Barcoding technology can be used with Immudex's dCODE oligo-tagged dextramers, which enables the detection of antigen-specific T cells using MHC molecules and fluorochromes. Describing this application, Ms. Prout told IBO, "A researcher has the capability to simultaneously profile immune cells at much higher resolution by measuring unbiased gene expression, the complete T- and B-cell repertoire, and the clonotype-specific mapping of MHC complexes from each single cell." These capabilities differentiate the offering from similar products. "When we refer to the complete T- and B-cell repertoire, it is important to know that this includes the paired and full-length nucleotide sequences of expressed T- and B-cell receptors. This is very unique, and all other commercial methods include only some aspect of this capability," she stated.

Analyses of T- and B-cells at the molecular and cellular level are one of the single-cell applications addressing current trends in immuno-oncology research. Other applications in immuno-oncology research for 10x's Single Cell Feature Barcode technology described by Ms. Prout were to: "map the immune response in the tissue microenvironment; determine the identity and heterogeneity of cell types in the tumor microenvironment; screen antigens with high specificity and sensitivity in the context of the immune response; characterize the molecular genetic basis for cancers; and identify potential candidates for targeted and/or immune-therapies and tumor sub-clones and clonal evolution that may evade immuno-therapies."

"While single-cell RNA-seq and flow cytometry have each made significant strides towards understanding the heterogeneity within complex biological samples, the convergence of these two methods under a single solution can provide even greater insight in the rapidly expanding field of genomic cytometry."

BD is addressing the simultaneous high-throughput measurement of mRNA and surface cell proteins in single cells using a standardized platform for the analysis of tens of thousands of cells. This fall, the company

launched the BD AbSeq assay for use with its BD Rhapsody microfluidic system, which is utilized for targeted single-cell gene expression analysis for RNA-seq. The assay complements traditional techniques for mRNA- and protein-based single cell analysis offerings from BD, according to Brian Lilhanand, Global Platform Lead, Single Cell Multi-Omics at BD. "While single-cell RNA-seq and flow cytometry have each made significant strides towards understanding the heterogeneity within complex biological samples, the convergence of these two methods under a single solution can provide even greater insight in the rapidly expanding field of genomic cytometry," he said. In this way, the BD AbSeq assay combines many of the same principles as other BD cellular measurement techniques. "In this workflow, cells are incubated with BD AbSeq antibody-oligonucleotide conjugates in the same way that cells are labeled with antibodies before typical cytometry workflows. When run through the BD Rhapsody single-cell analysis system, multi-omic-driven projections revealed cleaner cell separation and more defined cell clustering," he continued.

Oligo-conjugated antibody technology from BD incorporates antibody-specific sequences. "BD AbSeq assay utilizes monoclonal antibodies conjugated to unique DNA barcodes called Ab-Oligos. This allows for the profiling of many cell surface proteins using high-throughput sequencing where detection of antibody-specific DNA sequences is used to infer the amount of each target protein," explained Mr. Lilhanand.

"This ability to examine cell surface proteins directly, rather than deducing protein levels based on mRNA information, is advantageous in situations where mRNA is difficult to detect due to low expression or mRNA level does not correlate with protein expression."

Access to proteomic information in the same cell supplements the insights gained through the use of targeted scRNA-seq, such as for more complete mRNA detection. "This technology, when used with the BD Rhapsody platform, can identify novel biomolecules that cannot be defined by RNA-seq alone. This ability to examine cell surface proteins directly, rather than deducing protein levels based on mRNA information, is advantageous in situations where mRNA is difficult to detect due to low expression or mRNA level does not correlate with protein expression," said Mr. Lilhanand. "The ability to concurrently examine protein and mRNA expression is important when studying responses to cell stimulation and gene regulatory mechanisms."

Compared to methods such as CITE-seq and REAP-seq, the BD Abseq assay provides important differentiators, specifically its integration with the BD Rhapsody system, according to Mr. Lilhanand. "Although the BD AbSeq assay is designed to be platform agnostic, combining this assay with the automated, microwell-based BD Rhapsody single-cell analysis system can provide an improved workflow and QC." The system also offers distinct features for workflow monitoring, "In addition, the microwell configuration within the BD Rhapsody technology includes an optically clear cartridge-based technology that allows for visualization during the workflow to ensure maximal experimental control," he noted. "This enhances data

quality by providing valuable information about cell counts and viability by simple automatic imaging during the multiple QC steps of the process. "

Applications in immuno-oncology for scRNA-seq include the investigation of immune cell subpopulations. As an example, Mr. Lilhanand described the study of the FCD4+ T-helper cell population. "[It] was once assumed to consist of only a few cell subtypes, but with single-cell methods novel intermediate subtypes and subpopulations have been identified." Such discoveries have opened new avenues for immuno-oncology research. "By being able to look at individual cells in parallel rather than the response of an entire heterogeneous cell population, researchers have been able to untangle the incredible complexity and uniqueness at the cellular level of the immune system. This has led to new findings about the kinetics of gene expression, differential splicing pattern, the immune response in single T-cells and much more."

With proteomic data, single-cell analyses can further explore tumor heterogeneity and its role in immune-oncology. "In addition to providing a deeper understanding of the immune system, single-cell analysis is also applicable for protein profiling in heterogeneous biological systems, such as tumors. Through the data that the BD AbSeq assay provides at both the RNA and protein level, immuno-oncologists can now make progress in cancer research by understanding more about tumor heterogeneity, cancer progression, associated immune responses and responses to immuno-therapeutics."

New Biotech, Pharma and Academic Labs Announced

In the second half of IBO's biannual coverage of major new labs, we take a look at biotechnology, pharmaceutical and academic laboratory buildings planned for or under construction.

Biotechnology

German Company Opens Lab for Microbiome Research

Organization: Jennewein Biotechnologie

Location: Mildred-Scheel-Straße, Bonn Bad Godesberg, Germany

Lab Size: 10,763 ft² (1,000 m²)

Lab Cost: approx.. €3.6 million ($4.2 million)

Estimated Opening Date: October 2018

Industrial biotechnology company Jennewein Biotechnologie specializes in the production of rare functional sugar molecules for a variety of applications, such as pharmaceutical and nutritional products. In June, the German company announced that it will be relocating its R&D lab from Rheinbreitbach to Bonn Bad Godesberg due to the company's growth, which has required more space for R&D. The new lab will house microbiome research and designer microorganisms. In the new lab, Jennewein Biotechnologie will also focus on developing new technologies in order to create organisms with synthetic genomes.

Biotech Leader To Construct New Biomanufacturing Plant

Organization: Amgen

Location: West Greenwich, RI

Lab Size: 120,000 ft² (11,148 m²)

Lab Cost: approximately $200 million

In July, Amgen broke ground on a new next-generation biomanufacturing plant that will be the first of its kind in the US. The plant will create nearly 150 new jobs, and will incorporate many technologies into the one facility. This way, the building will be constructed in half the time at about 50% of the traditional operating costs, and will have many environmental benefits, including reduced water and energy consumption. Moreover, the equipment within the plant will be smaller and more portable than in traditional plants, with some disposable components. According to the company, this is for reducing expensive retrofitting necessities that crop up in traditional plants. The multi-technology facility will allow Amgen to continue focusing on biologics production, but at a much greater speed and efficiency.

Pharmaceutical

Leading Chinese Pharma Company to Establish "One-Site Solution"

Organization: STA Pharmaceutial (WuXi STA)

Location: Jinshan District, Shanghai, China

Lab Size: 322,917 ft² (30,000 m²)

Estimated Opening Date: 2020

STA Pharmaceutial (WuXi STA), a subsidiary of Wuxi AppTec, announced in April its plans to build a new R&D facility next to the company's API intermediates manufacturing site. The R&D lab will offer a "one-site solution" for companies that want to advance their projects from the preclinical stage to commercialization. The site will also offer access to various technology platforms, including systems for biocatalysis, flow

chemistry and high-potency testing, from a lab to commercial scale. WuXi STA plans to employ 500 scientists to the location over the next 2–5 years.

PRA Health Sciences Adding to Kansas Footprint

Organization: PRA Health Sciences

Location: Lenexa, KS

Lab Size: 48,000 ft² (4,459 m²)

Estimated Opening Date: NA

Another company expanding its local footprint is PRA Health Sciences, which already employs approximately 680 people in Kansas. The company plans to expand its research offerings with its upcoming bioanalytical lab and add another 80 jobs over the next 5 years. The new lab will be used to explore biomarkers for detecting small and large molecules in medications. Additionally, the company will provide QC, pharmaceutical manufacturing and safety testing services at the facility.

New Alzheimer's Research Lab Opening in Cambridge

Organization: Eisai Inc.

Location: Cambridge, MA

Lab Size: 50,000 ft² (4,645 m²)

Lab Cost: Over $100 million

Estimated Opening Date: Early 2019

The US subsidiary of Japanese pharmaceutical company is planning to launch the Eisai Center for Genetics Guided Dementia Discovery to drive research into Alzheimer's and other dementias. The Center's aim is to develop next generation medicines for dementia through specializing in immuno-dementia drug discovery. Constructed in the Alewife Research Center in Cambridge, the Center will be centered around four major functions: data sciences, immuno-dementia, discovery technologies and precision chemistry.

Boston Pharma Company Expands California Presence

Organization: Vertex Pharmaceuticals

Location: San Diego, CA

Lab Size: 170,000 ft² (15,793 m²)

Estimated Opening Date: 2018

Vertex Pharmaceuticals' new research lab in California will double the company's footprint in the state. The Boston-based company's new facility has will dedicate approximately 70% of the building to lab and research space that is focused on cystic fibrosis, building upon the three cystic fibrosis medicines the company has worked on San Diego labs. The area will also include a 1,500 ft² (139 m²) education lab promoting arts, engineering, math and technology to students, as well as a 4,000 ft² (371 m²) incubator to foster collaboration with other organizations. Vertex has a 16-year lease on the facility.

Academic

Multi-Science Building Planned at EWU

Organization: Eastern Washington University

Location: Cheney, WA

Lab Size: 100,000 ft² (9,290 m²)

Lab Cost: $60.5 million

Estimated Opening Date: May 2020

The new Interdisciplinary Science Center at Eastern Washington University will replace a 47-year-old science building, and will house programs for biology, chemistry, engineering, geology, mathematics, physics and technology. Fostering EWU's STEM programs, the Center will promote student-faculty research and encourage cutting edge research. The Center will be connected by enclosed walkways to the original science building, which is also planned for renovation in the future, with the addition of research labs and classrooms to the structure.

University of Vienna Gets New Biology Center

Organization: University of Vienna

Location: Vienna, Austria

Lab Size: 129,166 ft² (12,000 m²)

Lab Cost: €146 million ($171.6 million)

Estimated Opening Date: Spring 2021

The University of Vienna is constructing a new state-of-the-art research and education building to promote life science research at an internationally competitive level. The new Biology Center will be located near the Vienna Biocenter, the largest life sciences cluster in the country, and will support the Faculty of Life Sciences. The modern building will include the latest scientific instrumentation and shared labs.

Indiana Institute Lab to House New NMR Site

Organization: Rose-Hulman Institute of Technology

Location: Terre Haute, IN

Lab Size: 60,000 ft² (5,574 m²)

Lab Cost: $29 million

Estimated Opening Date: 2021–22 school year

The new academic building will house collaborative workspaces, design studios, classrooms, chemistry labs and innovation spaces for faculty. Engineering design students will have access to a variety of spaces, including a prototyping lab, laser cutting tools, machine devices and a woodworking shop. Chemistry labs will be available for science students, providing hands-on learning of general, organic, analytical and physical chemistry, as well as biochemistry. An instrument lab and a site for NMR equipment will also be part of the new building.

California State Plans New Natural Sciences Complex

Organization: California State University

Location: Sacramento, CA

Lab Size: 96,631 ft² (5,574 m²)

Lab Cost: $91.5 million

Estimated Opening Date: June 2019

A new science facility providing teaching and research labs for the University' College of Natural Sciences and Mathematics in scheduled to be finished by next summer. The Ernest E. Tschannen Science Complex will be a five-story building providing collaboration spaces, teaching and research labs, classrooms, a rooftop observatory and a 120-seat planetarium. The instructional labs will have large glass expanses near the public corridors to promote "science on display."

University Helps Boost Chicago Bioscience Industry with New Research Building

Organization: Rosalind Franklin University of Medicine and Science

Location: North Chicago, IL

Lab Size: 100,000 ft² (9,290 m²)

Estimated Opening Date: Summer 2019

A four-story new addition will be coming to Rosalind Franklin University campus and will feature state-of-the-art labs, as well as office space for faculty, commercial startups, and both national and international health care and life science companies. The Innovation and Research Park will boost the established bioscience sector

in Chicago, providing the industry with access to the University's research programs. The building may be part of a multiphase development, which is forecast to generate approximately 500 direct and indirect jobs, with an annual economic development projection of $117 million on Lake County and the surrounding region. Approximately half of investigators will be working in the new Brain Science Institute and its three research centers focused on disease research, as well as three other centers specializing in genetic diseases, cancer cell biology, and proteomics and molecular therapeutics.

US Department of Energy Budget Gets 3% Increase for FY19

Earlier this month, the US Senate Appropriations Committee announced an agreement had been reached on the first of three FY2019 minibus appropriations packages for the US federal budget. On September 21, the package became public law.

This first package consists of appropriations bills for Energy and Water Development, Military Construction and Veterans Affairs, and Legislative Branch. The information below has been extracted from various federal documents, including explanatory reports and appropriations bills.

Selected DoE Programs

The DoE has been allotted $35.7 billion in funding for fiscal 2019, an increase of 3.4%, for science, energy, environmental and national security programs. According to senate documents, the DoE is required to sustain a diverse portfolio of early-, mid- and late-stage R&D and "market transformation activities."

For the Energy Efficiency and Renewable Energy (EERE) program, $2.4 billion was allocated to implement funded programs and projects in FY19, a 2.5% increase, with a priority of managing the assets and improving operations of EERE user facilities. Additionally, $20 million of the EERE's budget is to be used for early-stage technology R&D for cybersecurity that will be built into all EERE programs.

DoE Vehicle Technologies received a 1.9% budget increase to $344 million, $163.2 million of which goes towards Battery and Electrification Technologies; $38.1 million for electric drive R&D, of which $7 million is for researching fast charging and advanced battery analytics; and $30 million for Materials Technology. Technology Acceleration activities were provided $21 million, which includes $3 million for manufacturing R&D and $7 million for industry-led initiatives to develop a system for hydrogen-focused renewable energy

production, storage, and transportation fuel distribution and retailing. The Hydrogen and Fuel Cell Technologies budget recorded a 4.3% bump in its budget to $120 million.

With a 1.5% increase, funding for Renewable Energy now totals $527.5 million. This small increase comes from a 3.8% increase for the geothermal technologies budget, with solar, wind and water energy funding remaining flat. Advanced Manufacturing received a 3.4% boost in funding to $888 million, which includes $5 million for catalyst science for directing chemical reactions in industrial manufacturing and developing new industrial product applications.

DoE Office of Science

The DoE Office of Science received a 5.1% budget increase to $6.6 billion for FY19. The budget for Basic Energy Sciences research rose 1% to $1.8 billion, which includes funds to make instrument repairs, replacements and improvements. Biological and Environmental Research (BER) funding jumped 4.5% to $705 million, with its only directives to prioritize optimizing operations of BER user facilities and maintain a focus on Genomic Science. Of the available funding, $100 million will go towards the four Bioenergy Research Centers; $90 million is for Foundational Genomics Research; $34.9 million is for Biomolecular Characterization and Imaging Science; and $70 million is for the Joint Genome Institute. The Environmental Molecular Sciences Laboratory was provided $45 million. Additionally, $10 million was allocated for the establishment of a national microbiome database.

Fusion Energy Sciences research received a moderate budget boost, up 5.3% to $434 million. Plasma science is highlighted in the bill, with $286.7 allotted to burning plasma science foundations; $61.2 million for burning plasma science long pulse; and $84.1 million for discovery plasma science. Moreover, $18 million of funds was designated for High Energy Density Laboratory Plasmas, while $25 million is for Scientific Discovery through Advanced Computing.

Funding for the Advanced Research Projects Agency–Energy (ARPA–E) jumped 3.6% to $366 million. The explanatory documents explicitly stated that the DoE is not to use any funds to either plan for or execute the termination of the ARPA–E program.

Agilent Technologies Enters Flow Cytometer Market

Santa Clara, CA 9/25/18—Agilent Technologies has agreed to acquire ACEA Biosciences for $250 million in cash. ACEA Biosciences supplies the NovoCyte benchtop flow cytometer, including a clinical system, as well as the xCELLigence instruments for monitoring of cell growth, cell function, and cellular responses. "ACEA represents a unique opportunity for Agilent to expand its team and broaden its portfolio with highly complementary technology, increasing the relevance and impact we can have with our customers in the cell analysis space," stated Todd Christian, vice president and general manager of Agilent's Cell Analysis Division. "We share the same passion around the need for and innovation of live-cell, kinetic and label-free approaches to cell analysis extending beyond traditional end-point measurements." Based in California, ACEA Biosciences also has manufacturing and R&D operations in China. Over 2,500 ACEA Biosciences instruments are installed worldwide.

The acquisition contributes to Agilent's goals to expand its cell analysis business and its clinical business in China. In China, ACEA Biosciences sells a China FDA-approved clinical flow cytometer system, which will now use flow cytometer reagents from Agilent's (formerly Dako's) Reagent Partnership business. This is Agilent's eighth acquisition announced this year, and the second dedicated to cell analysis (see IBO 1/15/18).

Lab Automation Specialist TTP Labtech Acquired

Cambridge, UK 9/27/18—Battery Ventures has purchased TTP Labtech from TTP Inc. Financial details were not disclosed. TTP designs and develops automated instruments and consumables, including sample handing and management systems, for use in life science research. "This underpins our ambitious growth plans and enables us to further strengthen our position in the life science market and expand into new application areas," said TTP Labtech Managing Director David Newble. "TTP Labtech now has a partner to support their growth vision and extend their industry reach through investment in R&D and acquisitions," commented TTP Group Chairman Peter Taylor. Future investments will include expansion of the company's headquarters and manufacturing facilities.

TTP Labtech has 149 employees, including its US and India staff, according to a TTP Labtech spokesperson. Asked about complementary acquisitions as part of the company's growth strategy, she told IBO, "TTP Labtech will continue to focus on growing our business in the pharmaceutical, biotechnology and academic-research markets. We will be expanding our portfolio of products, which minimize assay volumes, improve workflows and minimize costs within drug discovery, structural biology, molecular biology and genomics applications."

TTP Labtech generated revenues of £18.7 million ($30.2 million) for the year ending March 31, 2015, the most recent financial information that is available. Its product lines include liquid handling systems, cytometers, and automated sample storage and management systems.

LGC Adds to Oligo Business

London, UK 9/27/18—LGC has purchased Berry and Associates, which sells specialty oligo reagents to pharmaceutical, clinical diagnostics and academic research customers, oligonucleotide synthesis firms, and CMOs. "Berry and Associates is a natural US counterpart to our UK-based LINK business and it will become an important center for our North America business," commented Brian Kim, president and managing director, Genomics division, LGC. "Furthermore, Berry and Associates will increase supply chain resilience for our customers through multi-site manufacturing as well as local customer service and technical support in the US market." Based in Michigan, Berry and Associates has 14 employees. Its product lines include more than 400 phosphoramidites and solid phase-linked monomers for oligonucleotide synthesis, as well as nucleosides, spacers, fluorescent markers, quenchers and heterocycles.

The company will become part of LGC's NAC (Nucleic Acid Chemistry) business unit, part of its Genomics division. Consisting of the Genomics division and Standards division, LGC generated £331.2 million ($441.6 million = £0.75 = $1) in sales for the year ending March 31, a 17.7% increase (see Bottom Line). LGC's NAC business also includes Biosearch Technologies, Prime Synthesis, LINK Technologies and BioAutomation.

QIAGEN to Sell Novel PCR Instrumentation

Hilden, Germany and Ann Arbor, MI 9/17/18—QIAGEN has announced that it plans merge with molecular diagnostics firm NeuMoDx, acquiring the 80% of the company it did not already own for $234 million. QIAGEN will distribute NeuMoDx's automated PCR testing systems in Europe as well as other countries, excluding the US, in which NeuMoDx distributes them directly. QIAGEN chemistries will also be added to the platform. "Molecular diagnostic labs are demanding a true next generation of solutions for molecular diagnostic testing with features such as full automation, fast turnaround time, scalability, cost efficiency and ease of use," commented QIAGEN CEO Peer M. Schatz. The systems feature fully automated workflow, the ability to run both commercial assays and LDTs and can test 42 patient samples in an hour. The NeuMoDx systems is available in a high-throughput model (NeuMoDx 288), accommodating reagents for as many as 30 tests, and mid-throughput model (NeuMoDx 96) with reagents for up to 20 tests. Initially, QIAGEN will distribute the company's CE-IVD assays for Group B Streptococcus (GBS) and Chlamydia trachomatis/Neisseria gonorrhoeae (CT/NG) infections. This summer, NeuMoDex received US FDA 510(k) approval for the GBS assay.

Thierry Bernard, senior vice president of Molecular Diagnostics at QIAGEN, told IBO, "With the addition of NeuMoDx to its Sample to Insight portfolio, QIAGEN is now the only company that can address the needs of any lab worldwide with highly complementary automation systems, ranging from low-plex to high-plex, from low throughput to high throughput, and covering the most important technologies with PCR [and] NGS." These systems include the QIAsymphony, which, with the Rotor-Gene Q PCR, works with both commercial assays and LDTs; the QIAstat-Dx, a one-step, PCR-based multiplex molecular diagnostic system for syndromic testing in near-patient settings; and the GeneReader NGS System.

Describing why NeuMoDx chose the GBS test as its initial assay to commercialize, NeuMoDx Molecular Chairman and CEO Jeff Williams said, "As a new company entering the molecular diagnostic market, NeuMoDx wished to validate the technology in the market by obtaining FDA clearance to market in an efficient manner with a valuable assay. The regulatory clearance pathway for Group B Strep is well defined, and testing for Group B Strep using molecular methods has grown rapidly over the last decade. We estimate nearly 4 million molecular Group B Strep tests are conducted every year in the US alone." Commenting on QIAGEN's investment, he noted, "QIAGEN has the ambition to establish a footprint very quickly, so offering LDT and a combination with first approved FDA tests was necessary."

Regarding the CT/NG assay, Mr. Williams told IBO, "CT/NG as our second assay was an even more obvious choice. An estimated 80% of the single-to-low multiplex, multi–billion dollar clinical molecular market is

comprised of testing for five assays: HCV, HIV, HBV, HPV and CT/NG, with the most common assay in all of molecular diagnostics being CT/NG." He added, "Given the ease of use, low cost and high throughput of the fully automated NeuMoDx 288 and 96 Molecular Systems, QIAGEN and NeuMoDx believe these systems have the opportunity to become true workhorses within the central lab, allowing laboratory personnel to finally consolidate all common molecular tests onto a single platform. To achieve this vision, the NeuMoDx Systems will offer the five major assays, certain esoteric and unique tests, and market leading LDT capability."

Waters' TA Instruments Buys Dilatometer Company

New Castle, DE 9/25/18—TA Instruments, a Waters company, had purchased certain assets of Theta Industries for an undisclosed amount. Theta Industries provides instrumentation for high-temperature thermophysical property measurements, including dilatometers and viscometers. "We are excited to work with Theta customers, to introduce them to our expert global support network, and TA's advanced technologies for thermophysical measurements," stated TA Instruments President Terry Kelly.

Asked if the acquisition adds new capabilities to TA Instruments' product lines, Arthur Kravchenko, vice president of Marketing at TA Instruments, told IBO, "TA instruments is continuously improving our products and technologies to serve our customers better, and this transaction will help facilitate that cycle of innovation. In addition, the employees of Theta are joining TA Instruments. These employees bring with them years of experience building, testing, installing and servicing dilatometers and high-temperature viscometers."

Mr. Kravchenko declined to disclose which assets were acquired, but stated, "While the specific terms of our transaction with Theta are confidential, the assets we acquired will allow us to open new opportunities for our company, extend our leadership in the thermophysical property measurement area and support the existing customer base." He added, "We are excited to introduce Theta customers to the diverse technologies of our company and help them become familiar with our broad product lines in thermal analysis, rheology and other analytical instrumentation areas."

Management Partners with Private Equity to Buy Out Antibody Maker

St. Louis, MO 9/17/18; St. Louis, MO 9/19/18—Thompson Street Capital Partners (TSCP) and management have partnered to purchase LifeSpan Biosciences (LSBio). Based in Washington, LSBio develops and distributes antibodies, kits, proteins and additional biological reagents. Financial information was not disclosed. "The Company fills a highly specific niche in its industry and enjoys a well-deserved reputation for excellence, innovation and customer service," commented Bob Dunn, a managing director and head of Acquisitions at TSCP. LSBio plans to grow through both internal investments and acquisitions. TSCP has named Dale Gordon as CEO of the company, replacing Bertram Polan, who remains chairman. Mr. Gordon most recently was with GE Healthcare Life Sciences.

Regarding LS Bio's differentiating factors compared to competitors, a Thompson Street Capital Partners spokesperson told IBO, "LSBio is focused specifically on providing antibodies and related reagents. They have one of the industry's broadest catalogs with over 500,000 reagents available and researchers have long relied on LSBio's expertise in immunohistochemistry (IHC) to validate high-quality antibodies." The company employs 40 people. Thompson Street's other biological reagent company holding is BioreclamationIVT.

Private Equity Invests in Cell Culture Products

New York, NY 9/14/18—BelHealth Investment Partners has purchased Gemini Bio-Products for an undisclosed amount. Based in California, Gemini Bio-Products provides biological reagents, including cell culture media and sera. "We developed a thesis to invest in supplying the burgeoning field of cell therapy and regenerative medicines. Gemini is the perfect investment for our thesis," said Harold S. Blue, managing partner of BelHealth. "As the biotechnology field continues to evolve, these companies will require more quality biological reagents to create world-class therapies, and will look to rely on high-quality, experienced vendors like Gemini. The company has proven its high-touch service and ability to make customized solutions, which positions it very well for robust growth." BelHealth plans to supplement the investment with acquisitions of other biological reagent firms.

Established in 1985, Gemini Bio-Products currently has a sales staff of 15, according to its website. BelHealth's first investment in a lab reagent company, according to the portfolio companies listed on its website.

Physical Properties Testing–Instrument Firms Join Forces

Boston, MA 9/17/18—Battery Ventures, through James Heal, part of its Physical Properties Testing platform (PPT), has agreed to acquire UK-based Mecmesin. Financial details were not disclosed. Mecmesin supplies equipment for force and torque testing that are used in industrial and consumer applications. "We are pleased to welcome Mecmesin to the PPT family, where its force-and-torque testing expertise with various types of products will complement James Heal's focus on textile testing," stated PPT Chairman Don Templeman.

Asked how Mecmesin's product offering complement James Heal/PPT's existing product lines or operations, a Battery Ventures spokesperson told IBO, "Mecmesin's equipment, used in R&D and quality control labs as well a manufacturing plants, tests raw materials, components and finished products in a variety of industries, ranging from pharmaceuticals to consumer-packaged goods, to automotive, aerospace and construction. James Heal's products focus R&D and quality-control testing of physical properties specifically with the textile and rubber markets, making the two companies complementary." She said Battery Ventures plans to grow the company through R&D and engineering investments for new products and increased market share.

Lab Water Company Continues to Expand

Waterford, WI 9/24/18—Laboratory water purification system provider Avidity Science has purchased CT Chemicals for an undisclosed amount. CT Chemicals is a manufacturer and provider of filtration products for water applications. "By expanding Avidity's portfolio of water purification solutions to include ion exchange and filtration media and cartridges, this acquisition supports our objective of becoming a more valuable research tools partner and is another step forward in our mission of enabling science to improve the quality of life," said Avidity Science CEO Doug Lohse.

Avidity Science, the new name for the company encompassing the former Edstrom Industries and Triple Red brands, has 275 employees, according to BizTimes, In addition to lab water systems, the company also provides environmental control systems and automated watering systems for livestock. Private equity firm Shoreview Industries acquired shares in Edstrom Industries in 2016, growing the company with the addition of Triple Red last year (see IBO 9/30/17).

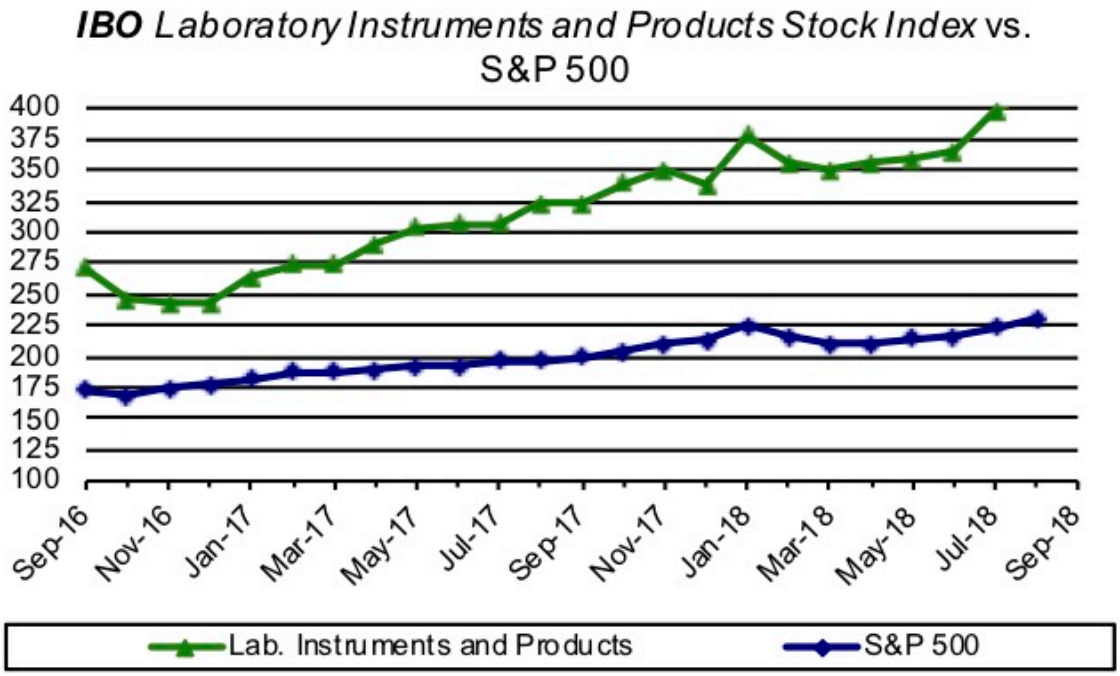
IBO Stocks Stay Afloat Through a Strong, But Cautious Market

Tariffs. This has been the buzzword in the financial news in September, not to mention the entire year thus far. News stories of the US-China trade dispute led many economic experts to believe that the US imposing 10% tariffs on $200 billion worth of Chinese goods this month would significantly impact the US stock market for the worse. The opposite happened. The stock market performed well in ways that were unexpected; however, investors are still cautious. Financial analysts credited the market's strong performance to the corporate tax rate cuts from last year.

Other positive news for the month included the Federal Reserve voting unanimously to raise short-term interest rates by another quarter-percentage point on September 28. The Fed increased the rate between the range of 2% and 2.25%. This is the first time that the benchmark's rate has been above 2% since 2008. Despite concerns from businesses about the new US trade tariffs, the Fed's reasoning for raising the interest rates was the encouraging second quarter GDP (4.2%), a sliding unemployment rate and a promising economic performance forecast for the country. The Fed is expected to also raise interest rates later this year. Another positive development is the current unemployment rate of 3.9% (last calculated in August 2018) throughout 2018. The movement of the unemployment rate has become cyclical throughout 2018, hovering between 3.8% and 4.1%.

On September 28, the Commerce Department released its August US consumer spending report which reported a 0.3% rise from the prior month. Despite being lower than June (0.4%), July (0.4%) and May (0.5%), surveys from the University of Michigan and the Confidence Board reported that US households are confident that the economy will grow.

For the month, both the Dow Jones Industrial Average and S&P 500 had gains, rising 1.9% and 0.4%, respectively. The NASDAQ was the only US major stock index with a loss, slipping 0.8%. Year to date, the Dow is up 7.0%, the S&P 500 is up 9.0% and the NASDAQ is up 16.6%.



Laboratory Instruments and Products Stock Index

The Index advanced 1.9% in September to 422.75 and is up 25.3% for the year. The Index's performance was mixed with most companies trading higher this month. The top performing company for the month was Quanterix, which jumped 28%.

In other news, Pacific Biosciences, which advanced 8.4% for the month, announced on September 12 a public offering of 14.1 million shares of common stock at $4.25 per share. The company expects to receive gross proceeds of $60 million to use for general corporate purposes, such as capital expenditures and working capital, as well as investing in complementary businesses, technologies, product candidates or other intellectual properties.

On September 7, Thermo Fisher Scientific's Board authorized the repurchase of $2.0 billion of shares of its common stock. The company plans to buy back the stock in the open market or through direct negotiations with investors. The repurchase authorization has no foreseen expiration date. Separately, on September 17, Goldman Sachs downgraded Thermo Fisher's stock from a "buy" rating to a "neutral" rating. The company's shares slid 1.9% after Goldman Sach's announcement that day. On that same day, Goldman Sachs removed the company from its American Conviction List and added Agilent Technologies.

In other ratings news, on September 20, Bruker was downgraded from an "equal weight" rating to an "underweight" rating by Morgan Stanley. The analyst target price was $32, a 2.9% downside from the September 20 price of $32.96.

QIAGEN has begun the repurchasing process, announced earlier in the year, of 1.65 million common shares of the company. The company stated the repurchasing of shares would happened between September 5 and November 14 through the Frankfurt Stock Exchange. The purpose of repurchasing the stock is to store them in the company's treasury and use them for their employee share-based compensation plans. The total purchase price for the stock is expected to be up to $50 million.

On September 25, Kewaunee Scientific announced its Board approved a 12% increase in the company's quarterly dividend. As a result, stockholders will receive quarterly cash dividends of $0.19 per outstanding share instead of $0.17.

On September 14, Becton Dickinson (BD) entered into a 364-Day Term Loan Agreement with Wells Fargo Bank for $750 million. BD is partially refinancing a previous loan from last year.

Diversified Laboratory Stock Index

The Index advanced 3.8% in September to 288.85 and is up 6.2% year to date. Most of the companies traded higher this month. Corning recorded the most substantial gain, rising 5.3%, while Xylem followed with a 5.2% gain. On September 5, Raymond James gave Xylem an "Outperform" rating with a $90 price target. The only company that suffered a loss was Roper Technologies, which slid 0.7%. The company was downgraded from an "overweight" rating to a "neutral" rating by JPMorgan Chase. The analyst target price was $305 on the stock, a 0.3% downgrade from the September 21 price of $305.98. Nonetheless, Roper Technologies has risen 14.4% year to date.
On September 28, Honeywell declared a $0.82 dividend, a 10.1% increase from the prior dividend of $0.75.

International Stocks

For the month, the Asia Pacific markets were mixed. Japan's Nikkei and China's Shanghai Composite expanded 6.8% and 3.5%, respectively, but Hong Kong's Hang Seng and India's Sensex declined 0.4% and 4.7%, respectively.

Prices for most of the Pacific region companies in the IBO Stock Table decreased this month, with the most significant decline for HORIBA, sliding 15.2%. In contrast, JEOL recorded the fastest expansion, rising 113.5%.

European equity markets were also mixed in September. France's CAC 40 Index and Italy's FTSE MIB expanded 1.8% and 0.9%, respectively. London's FTSE 100 and Germany's DAX each contracted 0.1% and 0.10%, respectively.

Prices for the European stocks in the IBO Stock Table were mixed, with many companies showing declines in September. Biotage was the biggest loser this month with a 7.9% decrease. In contrast, Datacolor was the top performing company, registering a 2.5% increase.

On September 17, Horizon Discovery's six-month interim report showed a net loss per share of 5.1 pence ($0.07), a 40.7% decrease. This improvement is due to the company acquiring Dharmacon (see IBO 7/31/17) and investing in its operations. However, Horizon Discovery still ended the month with a contraction of 3.2%.

On September 10, Abcam reported first-half results of 32.4 pence ($0.43) per share adjusted EPS, a 27.1% increase. On September 11, the company also announced an annual dividend of 8.58 pence ($0.11), a 17.9% increase to 12.00 pence ($0.16) per share. According to Abcam's report, its strong financial performance was due to various corporate strategies, which included digital marketing, expanding into related growth markets for antibodies and investing in improving operating capabilities. Nonetheless, Abcam ended the month down 5.5%.

Company: Exchange	Market Value (US M)	52-Week Range Low ($)	High ($)	Price 9/28/18	Change 1 Month	Change YTD	P/E (ttm)	EPS (ttm)
Laboratory Instruments and Products								
Agilent Technologies: n	$22,569	60.42	75.00	$70.54	4.4%	5.3%	27	2.65
Becton, Dickinson and Company: n	$69,740	192.99	264.47	$261.00	-0.3%	21.9%	25	10.44
Bio-Rad Laboratories: n	$7,731	214.44	345.15	$312.99	-3.8%	31.1%	60	5.22
Bio-Techne: o	$7,669	120.26	206.04	$204.11	6.2%	57.6%	46	4.47
Bruker: o	$5,366	28.13	36.53	$33.45	-6.0%	-2.5%	26	1.29
Enzo Biochem: n	$160	3.80	10.75	$4.12	-10.2%	-49.4%	NM	-0.09
Fluidigm: o	$219	4.43	8.62	$7.49	-5.4%	27.2%	NM	-0.91
Harvard Bioscience: o	$189	2.95	6.70	$5.25	-7.9%	59.1%	29	0.18
Illumina: o	$53,958	197.45	372.61	$367.06	3.4%	68.0%	68	5.43
Kewaunee Scientific: o	$86	24.56	38.80	$31.50	-1.3%	8.6%	13	2.35
Luminex: o	$1,347	18.62	35.37	$30.31	7.4%	53.9%	17	1.79
Mettler-Toledo: n	$15,464	540.24	697.26	$608.98	4.2%	-1.7%	33	18.72
MTS Systems: o	$976	42.00	57.50	$54.75	1.2%	2.0%	31	1.79
NanoString Technologies: o	$459	5.87	18.86	$17.83	10.3%	138.7%	NM	-2.34
Pacific Biosciences: o	$713	2.20	5.82	$5.41	8.4%	104.9%	NM	-0.74
PerkinElmer: n	$10,761	68.07	97.77	$97.27	5.2%	33.0%	30	3.24
QIAGEN: o	$8,582	30.20	39.45	$37.88	-2.8%	22.5%	28	1.34
Quanterix: o	$418	13.00	24.81	$21.42	28.0%	9.6%	NM	-8.30
Thermo Fisher Scientific: n	$98,199	181.51	245.00	$244.08	2.1%	28.5%	24	10.35
Waters: n	$15,252	178.21	220.20	$194.68	2.7%	0.8%	25	7.82
Diversified Laboratory								
AMETEK: n	$18,323	65.45	81.92	$79.12	2.8%	9.2%	27	2.97
Corning: o	$29,311	26.11	36.56	$35.30	5.3%	10.3%	22	1.61
Danaher: n	$76,035	83.81	109.32	$108.66	4.9%	17.1%	25	4.33
Honeywell	$123,570	139.20	167.63	$166.40	4.6%	8.5%	22	7.67
Illinois Tool Works: n	$47,806	134.45	179.07	$141.12	1.6%	-15.4%	19	7.28
Roper Technologies: n	$30,557	240.85	312.65	$296.21	-0.7%	14.4%	28	10.56
Teledyne Technologies: n	$8,822	158.41	250.87	$246.68	4.0%	36.2%	31	8.00
Xylem: n	$14,370	62.19	82.44	$79.87	5.2%	17.1%	30	2.65
Laboratory Instruments and Products				$422.75	**1.9%**	**25.3%**	**32**	
Diversified Laboratory				$288.85	**3.8%**	**6.2%**	**25**	
Dow Jones Industrial Average				26,458.31	1.9%	7.0%		
S&P 500				2,913.98	0.4%	9.0%		
NASDAQ Composite				8,046.35	-0.8%	16.6%		
Region	**Market Value**	**52-Week Range**		**Price**	**Change**	**Change**	**P/E**	**EPS**
Company	(Local M)	Low (L)	High (L)	9/28/18	1 Month	YTD	(ttm)	(ttm)
Pacific Shares								
GL Sciences: t	¥19,381	1,211	2,345	¥1,732	5.7%	-19.2%	12	¥144.19
Hitachi High-Technologies: t	¥539,252	3,660	5,680	¥3,915	-10.3%	-17.6%	14	¥288.98
HORIBA: t	¥256,031	5,930	9,590	¥6,020	-15.2%	-11.3%	17	¥361.68
JEOL: t	¥240,978	1,090	2,595	¥2,466	113.5%	285.9%	345	¥7.14
Precision System Science: os	¥9,136	370	791	¥396	-6.8%	-40.1%	NA	-¥26.32
Shimadzu: t	¥1,054,009	2,184	3,670	¥3,560	10.7%	39.0%	41	¥87.56
Techcomp: hk	HKD 892	1.55	5.20	¥3	-0.6%	81.0%	42	HKD 0.01
European Shares (London)								
Abcam: l	£2,936	9.47	15.88	£14.32	-5.5%	35.7%	29	£0.49
Halma: l	£5,486	10.97	14.70	£14.45	0.9%	14.7%	43	£0.34
Horizon Discovery: l	£294	1.28	2.66	£2.10	-3.2%	-12.5%	NA	-£0.14
Oxford Instruments: l	£569	6.76	11.16	£9.91	2.3%	16.5%	NA	-£0.44
Scientific Digital Imaging: l	£38	0.12	0.47	£0.42	0.6%	71.5%	17	£0.02
Spectris: l	£2,755	22.44	29.57	£23.37	-0.7%	-6.0%	95	£0.24
European Shares (Other)								
Biotage: st	SEK 7,713	60.75	136.80	SEK 119.20	-7.9%	41.9%	48	SEK 2.50
Datacolor: s	CHF 139,473	735.50	900.00	CHF 830.00	2.5%	-1.2%	21	CHF 40.18
Merck KGaA: g	€ 11,438	75.26	97.76	€ 88.50	-2.2%	-1.4%	23	€ 3.84
Sartorius: g	€ 4,717	68.14	140.50	€ 126.00	-7.4%	67.1%	57	€ 2.23
Tecan: s	CHF 2,728	178.60	256.00	CHF 232.20	0.3%	14.6%	48	CHF 4.85

The ***IBO*** *Stock Indexes* are weighted by marked capitalization. The *Indexes'* averages for the financial ratios presented are also weighted statistically to reflect the relative sizes of the constituent companies. *Laboratory Instruments and Products Index*: 12/30/11 = 100. *Diversified Laboratory Index*: 12/30/11 = 100. Exchanges: n = NYSE; o = NASDAQ; t = Tokyo; hk = Hong Kong; l = London; g = Germany; s = Switzerland; st = Sweden; no = Nordic Market; os = Osaka Securities. N/A = not available; NM = not meaningful.

Human Microbiome Testing

Microbiota analysis, which is the study of microbial communities, is a quickly growing and developing area of scientific interest, with broad implications in human health and disease. These communities consist of bacteria, archaea, protists, fungi and viruses. The majority of non-pathogenic microbiome species form a commensal (mutually non-harmful) relationship with their human host. Others have mutualistic or symbiotic relationships; for instance, by producing vitamins used by the host. On the other hand, some non-pathogenic species are known to produce metabolites that are harmful to the host.

Research has only begun to unravel the effects and importance of microbiome composition on human health and disease, some of which have been unexpected. In addition to digestive and intestinal conditions, the human microbiome has been implicated in a diverse range of health issues such as metabolic conditions, cardiovascular disease, kidney disease, cancer and even psychiatric health.

The area receiving the most research and clinical attention is the microbial community living in the gastrointestinal tract, known as the gut microbiome, of which over one thousand bacterial species have been identified thus far. Other tissues on which microbiomes reside include skin, lungs, saliva, placenta and the female reproductive tract.

Gut microbiome testing services are rapidly gaining popularity. Following the trend set by genetic testing services, the majority of testing companies offer direct-to-consumer services, without requiring physician approval. Consumers or patients submit a stool sample for analysis in the hopes of gaining insights into health conditions. Some companies also provide personalized dietary and lifestyle recommendations for health and weight loss based on gut microbiome analyses. While the gut microbiome is by far the most frequently commercially tested, services can also test skin, an oral swab or saliva.

There are varying opinions within the medical community as to the value of microbiome testing for most patients and consumers, and clinicians have voiced concerns about patients left to interpret results without medical guidance and how meaningful the data are. The cost and level of analysis provided by commercial testing services can vary widely, depending on the testing method being used.

There are several approaches used for research, clinical diagnostic and direct-to-consumer testing to either identify or profile the microbial composition present in a sample. Identification determines whether a microbial species is present or absent in a sample, while profiling determines the relative expression levels of microbes under experimental conditions. NGS methods are the most common approach, but microarrays are also used.

There are two common NGS-based methods for analyzing the human microbiome: shotgun metagenomic sequencing and 16S rRNA sequencing.

Shotgun metagenomic sequencing randomly shears the total DNA of all organisms in a microbiome sample into short fragments, sequences the fragments and relies on bioinformatics to reconstruct them into a consensus sequence, yielding genes present in the sample. This provides information not only about microbiome species composition, but also the possible metabolic processes encoded by the genes present in the community. Shotgun metagenomic sequencing is the most in-depth of the commonly used profiling methods, and the most expensive to perform. Because of the huge amount of sequencing data generated, this method requires a large-scale NGS sequencer or a higher-end benchtop sequencer.

16S rRNA sequencing takes advantage of the 16S ribosomal RNA gene sequence, thought to be present in all bacteria. The gene has highly conserved regions that are targeted by sequencing primers, as well as hypervariable regions that provide species-specific signatures by which bacterial species can be identified. This is the quickest and most inexpensive method for identifying bacterial members of a microbiome sample. However, this method has several limitations. Compared to shotgun metagenomic sequencing, 16S rRNA sequencing has lower resolution and sensitivity, capturing less diversity. Also, the technique is limited to identifying bacteria, and cannot detect viruses or fungi. 16S rRNA sequencing can be conducted using a benchtop NGS sequencer.

Microbiome arrays are collections of DNA probes, consisting of species-specific sequences from known microorganisms, fixed onto a glass slide. DNA from a microbiome sample is hybridized to the array, creating a signal if binding has occurred, which indicates the presence of a specific microbial species. Microbiome arrays are more sensitive than 16S rRNA sequencing, allowing detection of greater diversity. Comprehensive coverage includes archaea, bacteria, fungi, protozoa and viruses, encompassing over 11,000 species. However, detection is limited to known species that are specifically included on the array. Unknown species and species that have not been included cannot be detected.

The human microbiome has become a hot area of interest for researchers, clinicians and the general public, contributing to the strong demand for high-throughput sequencing and microarray technologies. As research continues to uncover how the microbiome affects health and disease, consumer demand will only grow.

Microbiome Testing at a Glance:

Leading Vendors

- Illumina
- Thermo Fisher Scientific
- QIAGEN

Largest Markets

- Hospital and Clinical
- Direct-to-consumer
- Academia

Instrument and Array Costs

- Microbiome Arrays: $2,000/plate (24 arrays per plate)
- Microarray Scanner Instrument: $35,000–$175,000
- Benchtop Sequencer: $80,000–$250,000
- Large-scale Sequencer: $125,000–$400,000

Food and Beverage

Over the past year, the 100 largest global food and beverage companies brought in combined revenues of $61 billion, with an average of approximately $689 million per company. The growth comes despite smaller volumes, increased regulations, higher consumer expectations and uncertain economic conditions.

Anheuser-Busch InBev, which ranked third on the top 100 companies list, recorded the fastest sales growth over the past year, adding $10.92 billion in sales to reach a total of $56.44 billion, with its acquisition of SABMiller helping boost the company's revenue growth. Nestle topped the list with $91.62 billion in sales over the past 12 months, even with an $817 million decline in revenues. The company was affected by subpar sales developments near the end of 2017, which contributed to the loss of revenue, as well as a problematic

trading situation with Brazil and the US. PepsiCo., which had sales of $63.53 billion, ranked second on the top 100 list. The company recently introduced more nutritious products to transform its portfolio.

Coca Cola, in sixth place, had the sharpest decline in revenues, which dropped 15.4% to $35.41 billion. Debates around the health effects of sugar, falling sales of carbonated soft drinks, and taxes implemented on sugar-sweetened drinks in countries like Ireland, South Africa and the UK contributed to the company's sales losses. Conagra Brands also reported a revenue decline, losing over $3.8 billion in sales and falling 20 places on the top 100 list to rank 50th. This was largely due to the spinout of Lamb Weston, occurring in the middle of the financial year, which, as a separate company, reported more than $3.17 billion in sales. The sale of Spicetec and JM Swank also negatively affected Conagra, as turnover in the company's Commercial Foods unit dramatically dropped from $4.4 billion in 2015–16 to $71 million in 2016–17. Conagra will likely be ranked higher next year, as it plans to acquire Pinnacle Foods, for which it will pay $10.9 billion, boosting revenues to approximately $11 billion.

Source: Food Engineering

Energy

According to the International Energy Agency (IEA), within the next three months, world oil spending will top 100 million barrels per day (bpd). This rise in spending is forecast to put pressure on rising prices, but issues in the market and disagreements surrounding trade may affect demand. The IEA forecasts demand to grow 1.4 million bpd in 2018 and 1.5 million bpd in 2019.

The balance between supply and demand has been tightening due to declining output in Venezuela and the US sanctions on the energy industry of Iran, which are to be implemented in November but have already cut back oil supply to lows not seen in two years. According to the IEA, the trade war between the US and China has unsettled equity markets and the rising US dollar is pressurizing currencies of emerging markets, which is costing leading global oil importers more than usual. Oil demand from non-OECD countries is estimated to grow 1.1 million bpd this year and 1.2 million bpd to 52.8 million bpd in 2019. This demand from non-OECD countries is led by China and India.

In the fourth quarter of 2018, global oil demand is forecast to reach 100.3 million bpd before stabilizing at around 99.3 million bpd in the first quarter of 2019. Demand for crude oil from the Organization of the Petroleum Exporting Countries will settle at 31.9 million bpd in 2019, down 1.2% from 2018 levels.

Source: Reuters

Chemicals

According to new data, chemical distributors in the US would be forced to deal with a $1.277 billion cost increase if the federal government moves ahead with a third set of tariffs on China. If the tariffs are enacted, over $200 billion worth of products imported from China will have a 25% tariff imposed.

In 2017, the US imported $5.109 billion in chemicals and polymers from China, Macau and Hong Kong; future imports would be affected by the potential new tariffs. Chemicals and polymers imported from China account for 9% of total US imports for those types of products. After deducting costs for freight and insurance, the product value of the imports drops 4.3% to $4.857 billion. If the 25% is applied to this figure, that would reflect a price increase of $1.214 billion, with the costs for the transportation margin raising the price an additional $1.277 billion for chemical distributors.

If evenly spread throughout the market, the tariff cost would also drive up the price of chemicals by 5.3%. The rise in prices would likely affect demand, with sales estimated to potentially decline over 7.22 million tons, which, for chemical distributors, would translate to a 12% drop in sales. The effects of this decline in demand would be vast, even affecting staffing of truck drivers, clerks and warehouse staff. Over 5,900 jobs may be lost for chemical distributors, and this figure may rise when including businesses that support chemical distributors.

Source: Independent Chemical Information Service

UK

The UK is working out a deal with the EU as part of its Brexit negotiations to keep in place the funding and collaborative relationships that British researchers have with their European counterparts, but the possibility of a "no deal Brexit" is also looming. The government has underwritten the nation's participation in the EU-based Horizon 2020 program until the program is over; in a no deal situation, the UK would be classified as a third country, a category including a few non-EU countries, such as Norway and Switzerland. The UK government is now stating that UK researchers and businesses may be able to apply to Horizon 2020 programs as a third country. However, the UK has not yet discussed its possible participation in the program under that status with

the European Commission. Moreover, the UK would not be able to meet all the requirements for the Horizon 2020 initiatives it currently participates in as a third country.

Without a deal with the EU, the UK will become ineligible for many programs under Horizon 2020 that it has benefitted from until now. These include grants from the European Research Council, the Marie Skłodowska-Curie actions, and the small- and medium-enterprise program for small businesses. The UK has received €2.1 billion ($2.5 billion) of Horizon 2020 grants awarded across the continent, which equals 45% of the approximately €5 billion ($5.8 billion) in total grants.

Without a deal, the UK will no longer be part of the EU's regulatory framework that determines the safety and efficacy of medicines, and data sharing will cease. Instead, the UK's Medicines and Healthcare Products Regulation Agency (MHRA) will be required to serve as the regulatory body for all medicines in the UK, which will require legislative changes that are in process. While the MHRA is already the main regulator for many approvals for the European Medicines Agency (EMA), it is not well-equipped for regulating pediatric and rare disease medications, which are currently handled by the EMA.

Source: Chemistry World

China

Many US-based biotech companies are receiving funding from Chinese and Hong Kong investors. So far in 2018, $4.2 billion from Asian companies has been invested into US biotech firms, totaling more than 43% of total venture capital invested in the entire biotech sector. In 2016, this figure was only 11%. As a result, biotech funding rounds have been robust for US biotech companies, with companies able to raise money quickly, especially for biotechs offering licensing deals for China.

Investor companies from China include 6 Dimensions Capital and Hillhouse Capital Group, and Blue Pool Capital from Hong Kong. Extremely high valuations in China's biotech sector have led investment companies to look for better returns in the US. The skyrocketing biotech valuations have largely been driven by the Made in China 2025 initiative established a few years ago, in which biotech plays a key role as a strategic industry, leading to fast-tracked development and investments in the sector.

Another incentive to invest in US biotech companies is a change in the rules governing the Hong Kong stock exchange that now allows global biotech companies to list on the exchange, even if they do not have revenues or profits. This provides investors the opportunity to exit their investment quickly.

Source: Reuters

France

The French government has proposed a 2% increase its higher education and research budget for 2019, which would total €25.1 billion ($29 billion) not accounting for inflation. Of this figure, €8.8 billion ($10.34 billion) will be set aside for research and innovation, a 4% jump, including a 2% rise, €6.9 billion ($8.1 billion), for basic science. Approximately €6.0 billion ($7.1 billion) of the total budget will be allocated to France's public research agencies, including the French National Center for Scientific Research (CNRS) and the French National Research Agency (ANR), although the details of each allocation are not yet clear.

If the proposal is approved, the research ministry's budget will have risen 5.3% over the past two years, while the funds for basic research and the ANR will jump 8.0% and 9.3%, respectively. The research ministry manages the vast majority of the country's public expenditures on higher education and research, although the ministries of economy and finance, ecology transition, agriculture and food, and defense and culture also receive funds for carrying out research. In 2019, these funds will total approximately €2.8 billion ($3.3 billion).

Despite the proposed increases, innovation spending is a major concern for scientists and economic leaders in the country. It is difficult to determine if innovation spending has increased, as it is handled by multiple ministries and supported indirectly by tax breaks. The latest budget proposals include €386 million ($453.7 million) investments in direct subsidies for companies accelerating innovation, as well as €250 million for startups from the Innovation and Industry Fund, which was established at the beginning of 2018. A new AI program will also obtain €17 million ($20 million) from the research ministry budget, and an additional €12 million ($14.1 million) under the Prime Minister's Investments for the Future initiative, which usually provides funds for higher education and developing applications from research data.

Source: Nature

Life Science Instruments

Company Announcements

TTP completed in July a new extension of its life sciences development facility. The additional multi-disciplinary suite of lab space provides a Class II biohandling and tissue culture laboratory and a dedicated facility for diagnostic system development under ISO 13485:2016.

In August, NanoString Technologies added Oregon Health & Science University and the Broad Institute of MIT and Harvard as Centers of Excellence for its Digital Spatial Profiling platform. As part of its early access launch, the company will select five additional sites to receive beta instruments beginning in the fourth quarter.

NanoString Technologies launch in September the GeoMx Priority Site (GPS) program for its GeoMx Digital Spatial Profiler. GPS status will be limited to the first 20 participants who purchase the commercial system. The system is expected to be available for early-access instrument placements late in 2018, followed by a full commercial launch in 2019.

Product Introductions

In July, BioTek Instruments launched the Synergy LX Multi-Mode Microplate Reader, an affordable, easy-to-use system for UV-Vis, absorbance, fluorescence and luminescence assays.

Gene-based Instruments

Company Announcements

IBJS Biotechnologies in May named Techcomp as the exclusive distributor of its xxpress qPCR thermal cycler in China, Hong Kong and Taiwan.

In July, PathogenDx, a provider of DNA-based pathogen testing technology, announced a $3.4 million capital raise, co-led by Altitude Investment Management and the Panther Opportunity Fund, which completes the company's convertible note round.

Genomic Vision licensed its molecular combing technology for use in QC bioprocessing testing to European Equity Partners and established a dedicated entity for the venture. The new company will offer analytical services as well as licenses. Genomic Vision will receive upfront, milestones payments totaling over €500,000 ($649,351) as well as royalties on sales and services.

In September, Fluidigm announced a partnership with GenomOncology for an expanded immune-oncology gene expression workflow for RNA extraction through data analysis. The workflow combines their respective Advanta FFPE RNA Extraction Kit and GO Immuno-Oncology Workbench, which was developed in partnership with Fluidigm.

Product Introductions

In August, Eppendorf launched the CycleManager X50, a new software application that can control up to 50 Mastercycler X50 eco modules remotely. Features include booking schedule and maintenance management.

Sales and Orders of Note

In July, 3M Food Safety was awarded a contract from the US Department of Agricultural Food Safety and Inspective Services for pathogen detection instruments and kits, making 3M's Molecular Detection System the primary method used by the agency for the detection of Salmonella, Listeria monocytogenes and E. coli O157 (including H7).

Cell-based Instruments

Company Announcements

In July, Magnetic Insight secured an oversubscribed $3 million seed round led by Sand Hill Angels. Magnetic Insight is developing Magnetic Particle Imaging (MPI), a new imaging modality that directly detects magnetic nanoparticle tracers enabling deep tissue imaging of functional events and disease states.

IsoPlexis installed in July its IsoLight benchtop system for high-throughput, single-cell functional proteomic detection at Fred Hutchinson Cancer Research Center as part of the company's early adopter program.

In August, IsoPlexis announced an exclusive distribution agreement with Tekon Biotech for China.

In September, IsoPlexis placed its IsoLight platform at City of Hope.
In July, Namocell, which develops single-cell dispensing and sorting platforms, entered into a distribution agreement with BIOKÉ, a business unit of Cell Signaling Technology Europe, for the Netherlands, Belgium and Luxembourg.

In September, Fluidigm and Visiopharm announced a co-marketing relationship to automate image analysis for Imaging Mass Cytometry. Fluidigm and Visiopharm will cooperatively promote Visiopharm's image analysis

software in conjunction with the Fluidigm Hyperion Imaging System, MCD Viewer software, and related Maxpar antibodies and kits.

In September, Celldom was awarded a $1.5 million Phase II Small Business Innovation Research grant by the NIH's National Institute of General Medical Sciences to advance its next generation, high-throughput single-cell analysis platform to define heterogeneity within cell populations. The company plans to initially commercialize the technology, the TrapTx Analyzer System, as a research service in 2018 and launch its first commercial systems by late 2019 with a focus on oncology, immunology and stem cell biology applications.

Akoya Biosciences announced in September that VIB, a life sciences institute in Belgium, will be one of its first partners to use itsCODEX (CO-Detection by indexing) technology in Europe. According to the company, CODEX is the only technology available to provide spatial and quantitative analysis of up to 50 biomarkers of individual cells in complex tissues.

In September, flow cytometry firm Cytek Biosciences completed a Series C funding round co-led by Northern Lights Venturesand 3E Bioventures.

Product Introductions

In June, Bruker introduced the SKYSCAN 2214 multiscale x-ray nano-CT system, featuring a modular design which accommodates up to four detectors. Its large field of view allows for the analysis of objects up to 300 mm in size.

In September, Bruker launched the new preclinical PET/CT Si78 scanner for whole-body molecular imaging. It combines homogeneous sub-millimeter PET spatial resolution over a large field of view with minimal x-ray radiation dose.

In July, BioTek Instruments released enhancements to its MultiFlo FX Multi-Mode Dispenser for cell biology workflows. The new AMX Automated Media Exchange module automates gentle, consistent media exchanges.

ACEA Biosciences debuted in July the xCELLigence RTCA S16, an entry-level system for quantifying cell proliferation, morphology changes and adhesion in a label-free, real-time manner. The new S16 model is designed for use with PC Windows rather than Apple software, as it previously was.

In September, Sphere Fluidics released the CytoMine Studio Software Suite, an updated software for its Cyto-Mine Single Cell Analysis System. The software works with industry-standard robotic platforms and corporate databases.

Fluidigm launched in September two new total RNA sequencing applications, available on Script Hub, for its C1 system. The C1 Total Seq application enables simultaneous detection of mRNAs and ncRNAs at single-cell resolution. The RamDA-seq (random displacement amplification sequencing) application offers a comprehensive view of total RNA with highly sensitive detection of full-length mRNAs and non-poly(A) transcripts.

Sales and Orders of Note

In July, MR Solutions installed Hawaii's first preclinical cryogen-free MRI imaging system at the University of Hawaii's Biology department in Manoa. It is being used to visualize soft tissue within kidneys using a contrast agent.

MILabs announced in July the installation of its dual-energy, high-resolution microCT system at the Hebrew University of Jerusalem Israel. The University is using the system to detect novel gold-labeled probes in cancerous tissue and atherosclerotic plaques.

In August, Cell Microsystems announced the first commercial sale of its automated AIR System for the imaging, sorting and isolation of single cells and small colonies to Albert Einstein College of Medicine investigator Jan Vijg, PhD.

Protein-based Analysis

Company Announcements

In September, PathSensors partnered with Radiusen Systems, which will distribute its CANARY pathogen detection system in China.

PathSensors named in September Ensensor as its distributor in Japan. Ensensor is a biodetection company created in a joint venture with S.T. Japan.

In September, Biodesy completed a $20 million Series C financing, led by Alexandria Venture Investments, and promoted Ariel G. Notcovich to CEO. Biodesy's Delta System gives researchers the ability to monitor structural changes in real time at high throughput.

In September 12, Quanterix announced the consolidation of its licensing position and re-establishment of control of its intellectual property in the IVD field following the termination of its license agreement with bioMérieux for Simoa technology. bioMérieux continues to hold shares in the company.

Product Introductions

In July, Bio-Techne introduced Jess, the newest member of its ProteinSimple-branded Simple Western family. Jess automates both the protein separation and immunodetection elements characteristic of traditional protein analysis techniques. As many as 25 samples can be analyzed in about 3 hours.

In August, Nicoya Lifesciences released the new OpenSPR instrument, a two-channel system with greater automation than its predecessor. The technology is currently employed by over 500 users.

In September, Fluidic Analytics launched the Fluidity One system to measure the size and concentration of proteins in their native state without the need for surfaces or matrices. The system provides the full characterization of small peptides to aggregates from 0.5 nm to 20 nm (0.3 kDa –8 MDa) in size.

Sequencing

Company Announcements

In August, CRO MolecularMD announced the validation of Thermo Fisher Scientific's Oncomine Tumor Mutation Load Assay for clinical research trials to aid immunotherapy drug development programs.

In September, Thermo Fisher Scientific announced that it will work with China-based Genetron Health to develop applications for its Thermo Fisher Ion Genestudio S5 Plus platform. Genetron Health has developed and registered supporting kits on the Ion Genestudio S5 Plus platform based on clinical needs, and a series of clinical diagnostics products for different cancer types will be launched. The companies initially signed a cooperation agreement in April 2016. The 3D Genetron biochip reader, based on Thermo Fisher's technical platform, has been approved by China Chongqing Food and Drug Administration.

NRGene partnered with Israeli-based cannabis research firm RCK in September to develop a comprehensive set of DNA markers representing the broad diversity within commercial medicinal cannabis.

In September, BGI announced a collaboration with the Gabriella Miller Kids First Data Resource Center at Children's Hospital of Philadelphia on a new pediatric research initiative to understand the genetic causes of and links between childhood cancer and structural birth defects.

Seven Bridges announced in September the launch of the new Kids First Data Resource Portal with the Gabriella Miller Kids First Data Resource Center (DRC) at the Center for Data Driven Discovery in Biomedicine (D3b) at Children's Hospital of Philadelphia. Researchers will use Seven Bridges' CAVATICA platform, which is integrated with the Kids First Data Resource Portal, to access and analyze data.

In September, Seven Bridges and e-NIOS entered into a strategic partnership for data-driven discovery of biomarker signatures. e-NIOS' technology enables unsupervised, intelligent translation of -omics data through BioInfoMiner, a cloud platform that resolves biological complexity and derives molecular signatures suitable for data-driven interpretation in different conditions, physiological states and datasets.
Cogenica named in September Digital China Health Technologies as a distributor for China to hospitals.

In September, China-based Genecast Biotechnology announced a strategic partnership with Illumina to develop a cancer diagnosis system and kit targeting colorectal cancer. This is the first time that an IVD kit based on Illumina NGS technology will be developed for this type of cancer in China. Genecast will also develop a cancer diagnosis system and kit aimed at lung cancer based on Illumina's NGS technology.

Longhorn Vaccines and Diagnostics, a pre-analytical systems and molecular solutions company, announced the validation of its PrimeSeqMDR across a wide range of well characterized clinical strains of MTB from the Ukraine and South Africa. PrimeSeqMDR is a targeted gene sequencing kit developed for the Illumina MiSeq Next Generation Sequencing system to determine drug sensitivity from clinical and cultured specimens.

In September, SOPHiA GENETICS opened operations in Boston, Massachusetts. In the US, SOPHiA GENETICS supports more than one hundred university hospitals.

Genomics software firm BC Platforms announced in September the addition of the THL Biobank, hosted by the Finnish National Institute for Health and Welfare, to its Global Network of Biobanks. BC Platforms is providing its BCRQUEST.com platform.

In September, Diagenode gained exclusive rights to the ChIPmentation technology that it launched last year from the Research Center of Molecular Medicine of the Austrian Academy of Sciences. The ChIPmentation system encompasses a unique methodology that integrates chromatin immunoprecipitation with a ligation-free library preparation for high-throughput sequencing.

Product Introductions

In September, Thermo Fisher Scientific released a new workflow for its Oncomine Tumor Mutation Load Assay, featuring new software to provide customers more flexibility in their TMB experiment designs.

ABclonal Technology introduced in September a new line of NGS library preparation kits, marking the company's expansion from proteomics tools and reagents to genetic research reagents. The Rapid DNA Lib Prep Kit and StepWise DNA Lib Prep Kit are available in 8-, 24- and 96-reaction formats, starting from $218 per kit. The Stranded mRNA Lib Prep Kit and NonStranded mRNA Lib Prep Kit are available in 24- and 96-reaction formats, starting from $558 per kit.

In September, Paragon Genomics introduced the ParagonDesigner, a web-based tool that enables rapid design of CleanPlex Custom NGS Panels. The company can deliver custom NGS panels in 2–4 weeks.

Atomic Spectroscopy

Company Announcements

In September, Eurocontrol Technics, a provider of XRF instrumentation, announced an agreement to sell its Israeli subsidiaries, consisting of its Croptimal, Xenemetrix and Xwinsys Technology Development businesses, which have ceased operation, to DYG Holdings for a nominal consideration. DYG Holdings is owned by members of Eurocontrol Technics' former management team.

Product Introductions

Malvern Panalytical launched in July the third generation Empyrean XRD platform, calling it "the first fully automated multipurpose x-ray diffractometer" with no need for operators to switch optics.

XOS, a Danaher company, debuted in July the Petra MAX portable XRF analyzer for onboard fuel testing, its first product for the marine market. The instrument is fully compliant with sulfur test methods in ISO 8217 for marine fuels.

In September, XOS introduced the portable Cadence analyzer, based on its High Definition X-ray Fluorescence technology, for the simultaneous measurement of cadmium and other heavy metals in soil and agricultural products, such as rice and wheat. The company stated that the system delivers best-in-class limit of detection for cadmium in soil below the China Agricultural regulatory limit of 0.3 ppm.

In July, Teledyne CETAC Technologies released the Oils 7400 Homogenizing Autosampler for oils, wear oils and coolants for ICP-OES sample introduction. Built on the Teledyne CETAC ASX7000 automation platform, the latest system is faster than previous models and offers improved accuracy. It features the ability to switch between oil and coolant samples using the same automation.

Teledyne CETAC Technologies introduced in July the HDIP Software for laser ablation ICP-MS. The HDF (hierarchical data format)–based imaging processing software features automated image optimization, "autopilot" functions and data manipulation abilities.

In July, Hitachi High-Tech Analytical Science launched the ExTOPE Connect data management and storage services for its Vulcan and X-MET handheld and LAB-X500 benchtop XRF analyzers. It enables the management of one or multiple instruments from a central location, as well as mobile phone access and cloud data storage.

In September, Hitachi High-Tech Analytical Science released the compact FM EXPERT arc/spark OES system for metals quality assurance and production process control, as well as the analysis of nitrogen down to 30 ppm.

PAC released in September the ElemeNtS combustion analyzer for total sulfur and total nitrogen, enabling a simultaneous analysis of total sulfur and total nitrogen in hydrocarbon samples, as low as 10 ppb and up to 1%.

Analytik Jena announced in September the compEAct element analyzer for the petrochemical industry available in three models: the compEAct N for total nitrogen determination, the compEAct S for total sulfur determination, and the compEAct S_{MPO} for interference-free sulfur determination in fuels and other refinery samples.

Bruker debuted in September the new compact G4 ICARUS Series 2 combustion analyzer for carbon and sulfur concentration measurements in inorganic samples. It features the HighSense LED-powered detectors based on non-dispersive UV absorption photometry for sulfur detection.

Sales and Orders of Note

In July, the University of Melbourne in Australia and distributor AXT installed a Rigaku XtaLAB Synergy-S XRD system. The purchase was funded in part by the Australian Research Council.

Dalton Pharma Services installed in July an Agilent Technologies' ICP-MS quadrupole analyzer for compliance with updated ICH Q3D elemental impurities regulatory guidelines.

GC & GC/MS

Company Announcements

In August, Waters entered into a comarketing agreement with Restek for GC consumables. The partnership will serve food safety laboratories with training and applications support of GC/MS methods and workflows for pesticide monitoring and screening.

In September, Schauenburg Analytics, parent company of Markes International and SepSolve Analytical, officially opened new training facilities in Offenbach am Main, Germany.

Product Introductions

In August, JEOL launched the JMS-TQ4000GC, a GC triple quadrupole MS system, stating the system has fastest SRM switching speed in the industry at 1,000 channels/sec. The short collision cell technology enables both ion accumulation and pulsed ion ejection.

In September, Shimadzu introduced its GCMS NX Series GC/MS systems, consisting of three models: the GCMS-TQ8050 NX, GCMS-TQ8040 NX and GCMS-QP2020. The systems utilize the Nexis GC-2030 GC system and feature ease of maintenance.

Reported Financial Results

$USD in Millions	Period	Ended	Sales	Chg.	Op. Prof.	Chg.	Net Prof.	Chg.
Bioanalytical Systems (Products)	Q3	14-Aug	$1.2	33.0%	($0.2)	9.7%	NA	NA
Honeywell (Perf. Materials & Tech.)	Q2	30-Jun	$2.7	5.3%	$0.6	8.0%	NA	NA
HTG Diagnostics	Q2	30-Jun	$4.9	179.0%	($4.1)	26.2%	($4.1)	29.8%
IDEX (Health & Sci. Tech.)	Q2	30-Jun	$0.6	10.6%	$0.1	17.6%	$0.1	28.9%
Illinois Tool Works	Q2	30-Jun	$3.8	6.4%	$0.9	6.9%	$0.7	13.5%
Pressure Biosciences	Q2	30-Jun	$0.6	18.1%	($0.9)	23.6%	($13.1)	-2150.8%
Teledyne Technologies (Instrumentation)	Q2	30-Jun	$732.5	9.1%	$111.5	34.7%	$85.9	42.9%
Other Currencies in Millions								
Horizon Discovery	H1	30-Jun	£25.1	107.5%	(£ 7.8)	4.9%	(£ 4.7)	53.2%
Judges Scientific	H1	30-Jun	£37.0	13.0%	£6.9	48.4%	£3.8	93.5%
LGC Science Group	FY	31-Mar	£331.2	17.7%	£21.7	NM	NA	NA

NA = not available, NM = not meaningful