



Agrigenomics solutions

Total support from the first step to the next advancement

applied biosystems

Our commitment to you

We're dedicated to partnering with you to find the right solution for your needs. Whether you're looking to streamline marker-assisted breeding programs or perform accurate genomic evaluations, we provide simple, scalable, and affordable solutions that help agricultural scientists accelerate their research programs. Our comprehensive portfolio of Thermo Scientific™, Applied Biosystems™, Invitrogen™, and Ion Torrent™ products and services offers an unmatched

CTTACGTT combination of innovation, convenience,
TGCCCAT affordability, and support.

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Leading-edge solutions tailored for you to address today's agricultural challenges

Unprecedented population growth, urbanization, and climate change are contributing to an increasingly complex and dynamic agricultural landscape. You are striving to improve productivity and efficiency to meet the world's growing food supply demands. Implementing a breeding program to meet these challenges requires a significant investment of time, resources, and budget. That's why having the right partner can give you that competitive advantage to succeed in today's market.

With more than 20 years of agrigenomics experience, Thermo Fisher Scientific has a proven track record of collaborating with agricultural industry and researchers to understand their specific needs and tailor a pathway to success that is cost-effective and delivers the right results for projects big, small, or anywhere in between. With a comprehensive portfolio of solutions and a superior service and support structure, we're here to put the power of agricultural genomics in your hands.

Overview of our comprehensive portfolio of solutions supporting agrigenomics applications

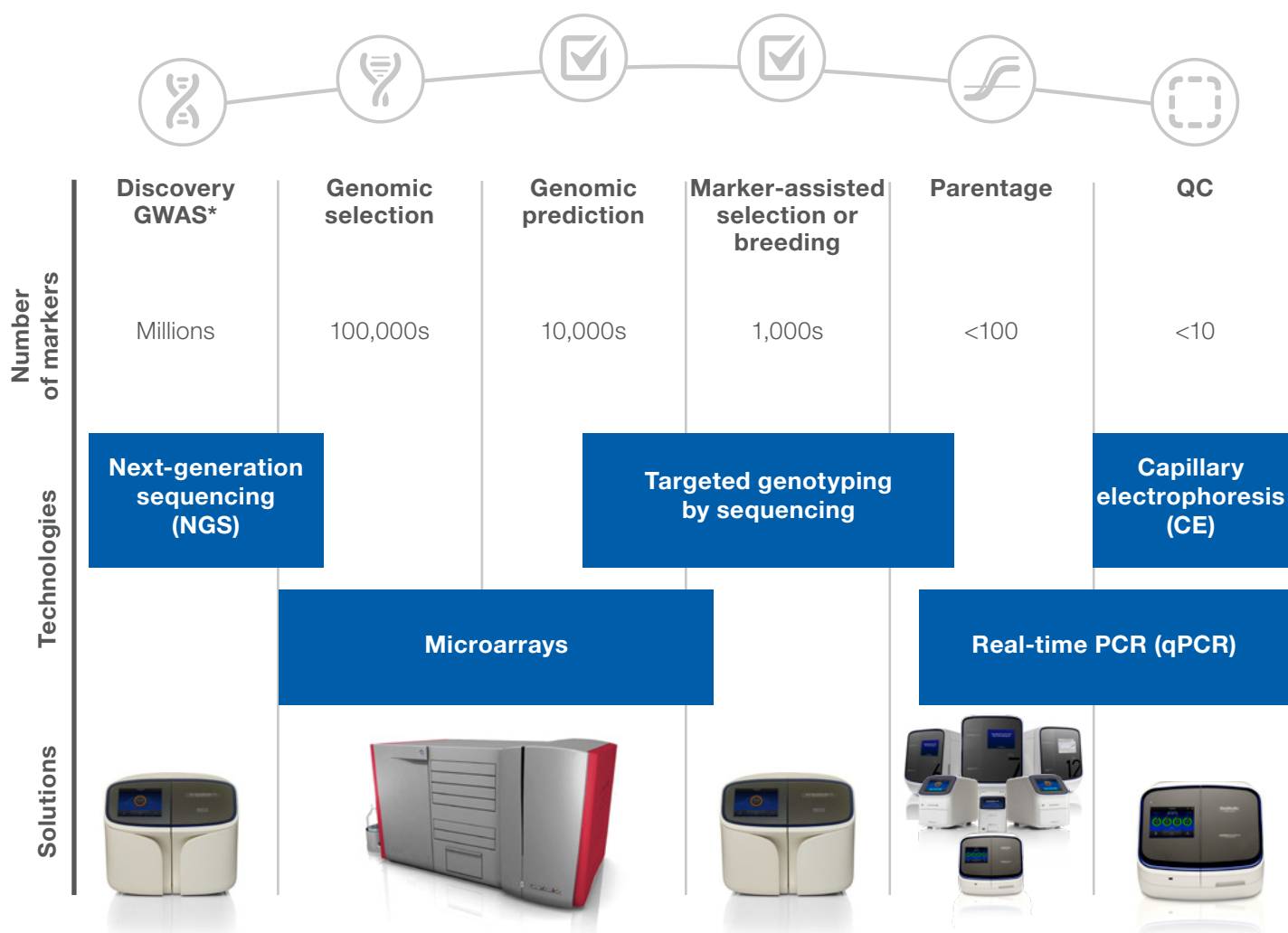


A breadth of state-of-the-art platforms to suit your molecular breeding needs

Our family of brands offers a wide range of technologies to facilitate molecular breeding and functional genomic efforts. Selecting an appropriate technology is largely driven by the throughput need of the researcher and the number of markers being interrogated. The charts below provide a high-level representation of the different technologies we offer for your genotyping projects.

Each technology has been designed for maximum accuracy, robustness, and compatibility across varied plant and animal workflows. Whether you need to discover new genetic variants through *de novo* genomic sequencing, confirm the identity of a few markers across a large number of samples, or do anything in between, our extensive portfolio of instruments and consumables can help you get there quickly and efficiently.

Thermo Fisher Scientific offers solutions across the agrigenomics continuum:



* GWAS = Genome-wide association studies.



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Genome sequencing

Ion Torrent next-generation sequencing systems

Genome sequencing allows researchers to uncover the genetic makeup of plants and animals and discover new important markers for agricultural studies. Advancements in Ion Torrent™ semiconductor sequencing are improving the simplicity and cost-effectiveness of sequencing, whether it be for genome sequencing or for exome, transcriptome, or targeted resequencing applications. Our integrated suite of next-generation solutions, including the Ion GeneStudio™ S5 systems and the Ion Chef™ System, enables accurate results with industry-leading speed and affordability.

Key features include:

- Automated template preparation and chip loading
- Cartridge-based reagent system
- Up to 130 million reads per chip
- 2.5-hour sequencing run time
- Simplified NGS data analysis with end-to-end bioinformatics solutions



Ion Chef System

Ion GeneStudio S5 System

Find out more at thermofisher.com/genestudio

SeqStudio Genetic Analyzer

Same workflow, same trusted technology—now with an innovative all-in-one cartridge that reduces setup time from hours to minutes. The Applied Biosystems™ SeqStudio™ Genetic Analyzer is a low-throughput, easy-to-use, and convenient benchtop system that delivers gold-standard Sanger sequencing and fragment analysis with just a simple click. It is easily used across a broad range of applications by multiple users.



SeqStudio Genetic Analyzer

	Convenient and easy-to-use cartridge system includes the capillaries, polymer, and buffers required for each run
	Combine Sanger sequencing and fragment analysis reactions in the same instrument run
	Fast turnaround with a run time as low as 30 minutes
	Set up and monitor your runs; view, manage, and share your data from anywhere, using your phone, tablet, or computer*
	In-lab application training will get you up and running quickly
	Secondary analysis software package included with system purchase

* Internet connection and a Thermo Fisher™ Connect account required.

 Find out more at thermofisher.com/seqstudio

Microarrays

Our portfolio of array-based genotyping and expression solutions, for applications ranging from genome-wide analysis to routine screening, delivers high accuracy and reproducibility. Our solutions also offer a straightforward workflow and low cost per sample.

Affordability

- Cost-effective genotyping and expression tools to identify, validate, and screen complex genetic traits in plants and animals

Simplicity

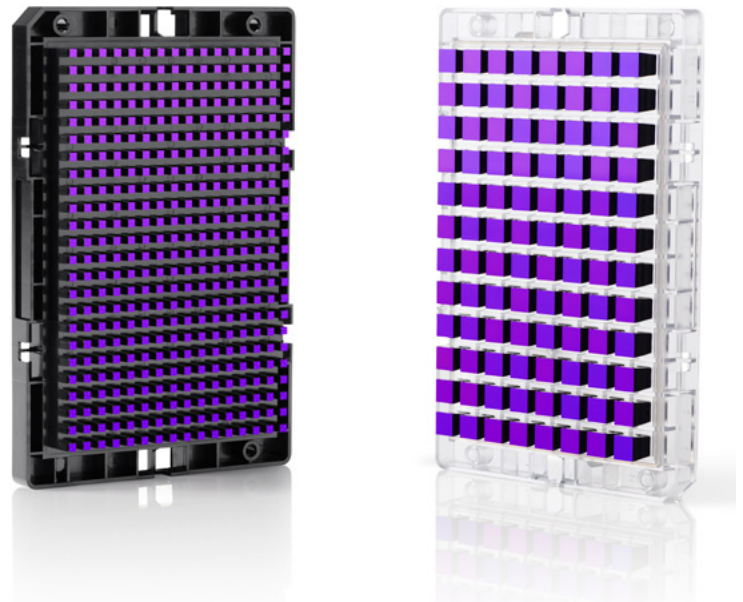
- Consolidate multiple applications under a single technology platform
- Easy-to-use, simple workflow
- Enables accurate answers in a few hours

Flexibility

- High-throughput tools for low- to high-density genotyping applications and genome-wide gene expression analysis
- An assay for genotyping of all relevant markers of interest
- Low sample volume commitment

Robust assays

- Start genotyping with only 7.5–10 ng/ μ L of gDNA from a variety of sample types
- Use as little as 100 pg of total RNA for expression analysis
- Compatible with indels and candidate single-nucleotide polymorphisms (SNPs) that have high GC content or interfering SNPs in the flanking sequences



The Applied Biosystems™ GeneTitan™ Multi-Channel Instrument is the only integrated and fully automated microarray processing system available for simple, flexible, high-throughput genotyping analysis, and genome-wide gene and miRNA expression profiling.

Key features include:

- Automated target hybridization, washing, staining, and array scanning
- Flexible 16-, 24-, 96-, and 384-array plate formats
- 30 minutes of hands-on time
- Scalable workflows for medium- and high-throughput applications

Axiom genotyping solution

Accelerate phenotype–trait association and selection efforts with our robust technology

The Applied Biosystems™ Axiom™ genotyping solution offers:

Superior customization

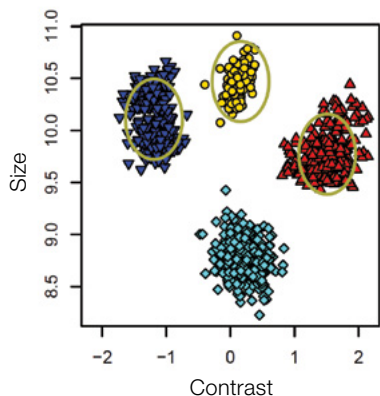
- Fully customizable content on multiple array formats
- Multispecies capability, with no limit on the species or number of markers per species
- Applied Biosystems™ Axiom™ 384HT and Mini-96 format arrays are ideal for breeding programs that need high-throughput and flexible solutions

Consistency and ease of use

- Axiom arrays offer up to 100% manufacturing fidelity with no dropped SNPs, so all of your designed markers are on every array
- Applied Biosystems™ Axiom™ Analysis Suite and microarray analysis algorithms provided as command-line tools, offering ease of analysis across multiple platforms
- Fully automated cluster and genotype calling on diploid and polyploid species

Efficiency and speed

- Receive your custom array in less than six weeks after finalizing the content, and reorder arrays in as few as two weeks



The Axiom automated genotype clustering and genotype assignment algorithm automatically classifies the markers into six different categories for ease of visualization and analysis. This cluster plot represents the off-target variant category.

Access custom and expert designs for your species of interest

Select from our diverse catalog of genotyping arrays, or get experienced advice on array design and support. The professionals at Thermo Fisher Scientific work with you to understand the goals and objectives of your breeding program or research when designing your Axiom arrays. This is one way we've enabled industry, consortia, and academic institutions to advance the use of genomics in agriculture and to address global food security.

- Axiom aquaculture arrays have allowed scientists to integrate genomic technologies into aquaculture breeding programs for a variety of species such as salmon, tilapia, catfish, sea bass, herring, carp, and trout
- Axiom genotyping arrays are used for genotyping a variety of diploid and polyploid species, including sugarcane, wheat, rapeseed, strawberry, citrus, pear, and trees with very large genomes such as pine and cedar
- Axiom animal genotyping arrays have been developed by partnering with scientists and breeders from various academic institutions and consortia to design multiple arrays for a diverse set of animals

“Development of SNP arrays and automated genotyping in Atlantic salmon is complicated by the autotetraploid whole genome ... the unparalleled design support and expertise from [your] bioinformatics scientists helped tremendously to cope with these obstacles.”

Dr. Sigbjørn Lien
Professor and Assistant Director
Norwegian University of Life Sciences (NMBU)
and Centre for Integrative Genetics (CIGENE)

Find out more at thermofisher.com/microarrays

Targeted genotyping by sequencing

Targeted genotyping by sequencing (GBS) is the latest innovation in genomics-assisted breeding programs. Targeted GBS uses a powerful multiplexed approach that enables users to interrogate large panels of markers across hundreds to thousands of samples simultaneously. The table below highlights the strengths of the Applied Biosystems™ AgriSeq™ technology as an approach to targeted GBS. The technology has a simple, high-throughput workflow to deliver consistent genotyping calls for markers of interest.

Applications

- Evaluating population structure
- Parentage and traceability
- Marker-assisted selection and breeding

	AgriSeq GBS solution
Sequencer and chemistry supported by Thermo Fisher Scientific	Yes
Ability to discover new variants	Yes
Panel design	2–6 weeks for custom panel
SNPs per panel	50–5,000
Expected call rates*	~95%
Processing time	2 days
Sample throughput/week	Up to 18,000**

* Depends on the level of genome annotation.

** Based on panel size with one instrument and one technician.

AgriSeq targeted GBS solutions

The AgriSeq targeted GBS solution allows for high-throughput analysis of plant and animal genotypes in a flexible and cost-effective manner. Leveraging a highly efficient multiplex chemistry, hundreds to thousands of genetic loci can be simultaneously targeted and efficiently amplified in a single reaction. Then libraries can be processed for NGS where hundreds of samples can be barcoded and sequenced in the same run. Capable of generating up to 2.6 million genotypes per day from high-quality NGS data at pennies per data point, AgriSeq targeted GBS represents the future of technology to help advance your plant and animal research.

Customized panels designed to target your relevant markers

AgriSeq chemistry is designed for analysis of panels ranging from 50–5,000 markers. Thermo Fisher Scientific has a dedicated team of agrigenomic bioinformatics professionals who have designed hundreds of successful panels for organisms ranging from corn and cattle to soybean and salmon, and many more.






Consistent performance across samples with high marker call rates

Unlike other nontargeted GBS approaches (e.g., RAD-Seq) that can be susceptible to variable performance and missing data between samples, AgriSeq GBS consistently generates high marker call rates across diverse sample sets. For well-designed panels such as the Applied Biosystems™ Bovine ISAG SNP Parentage Panel (2013), >98% marker call rates can be achieved with >99% concordance with orthogonal technologies.

Fast workflow for cost-effective high-throughput genotyping

The AgriSeq workflow is simple, taking approximately two days from sample to results, including library prep, automated template preparation, sequencing, and data analysis. Up to 3,072 samples can be processed per day with only a few hours of hands-on time. The system is also flexible for users who wish to use larger panels and fewer samples. With low all-inclusive sample prices and specific targeting of your most relevant markers, AgriSeq technology is an economical way to generate high-throughput genotyping data for plant and animal research.

The 2-day AgriSeq GBS workflow:

Customize targets	Construct library	Prepare template	Run sequencer	Analyze data
Sample to results in 2–3 days*				
 Custom bioinformatics design service	 AgriSeq library kits IonCode Barcode Adapters	 Ion Chef Instrument	 Ion GeneStudio S5 Prime System with Ion 550 Chip kit	 Torrent Suite Software
Hands-on time	<3 hr (manual) <1 hr (automated)	<15 min	<15 min	<15 min
Total time	6–7 hr	Overnight	2.5 hr	6–24 hr

Workflow is achievable with 1 FTE
Highly scalable, with automation to help reduce hands-on time

* Automated template preparation on the Ion Chef Instrument is performed overnight to achieve a 2-day workflow.

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Real-time PCR

Prepare a reaction plate using TaqMan Assays and TaqMan GTXpress or TaqPath ProAmp Master Mix, along with your DNA samples; no additional reagents required








Genotyping by qPCR

Genotyping by qPCR is a well-known and reliable approach that is used widely in both research and industrial settings for the confirmation of SNPs and to screen panels of markers in hundreds or even millions of samples. We offer qPCR instruments, Applied Biosystems™ TaqMan™ Assays, and reagents that are designed to generate reliable results for validation and screening.

QuantStudio qPCR systems

The Applied Biosystems™ QuantStudio™ family of real-time and digital PCR systems offers superior flexibility, connectivity, speed, and precision. Contact a sales representative to personalize a solution to meet your needs, or use our online product configuration tool to easily configure the QuantStudio system that's best for you.

Overview of the Applied Biosystems workflow for genotyping by qPCR:

				
<p>Prepare samples We provide multiple solutions to isolate and purify DNA. The Applied Biosystems™ DNA Extract All Reagents Kit provides PCR-ready DNA from a wide variety of samples in about five minutes.</p>	<p>Select assays Choose from predesigned or custom assays for a wide variety of applications. Assays are available in single tubes, 96- and 384-well plates, 384-well microfluidic cards, and Applied Biosystems™ TaqMan™ OpenArray™ plates.</p>	<p>Set up reactions Prepare a reaction plate using TaqMan Assays and Applied Biosystems™ TaqMan™ GTXpress™ or TaqPath™ ProAmp™ Master Mix, along with your DNA samples. No additional reagents are required.</p>	<p>Run PCR Amplify DNA and achieve allelic discrimination by running the PCR reaction on an Applied Biosystems™ qPCR system and/or thermal cycler.</p>	<p>Analyze data Analyze and interpret qPCR data with intuitive software tools including Applied Biosystems™ TaqMan™ Genotyper Software or our cloud-based Genotyping app available on the Thermo Fisher™ Connect Platform.</p>



Custom TaqMan SNP Genotyping Assays

The Applied Biosystems™ Custom TaqMan™ SNP Genotyping Assays provide a highly flexible technology for detection of polymorphisms within any genome. Create your own assays by submitting target sequences to our secure assay design pipeline using the Applied Biosystems™ Custom TaqMan™ Assay Design Tool. This pipeline has successfully generated millions of assay designs by utilizing heuristic rules deduced from both manufacturing and assay performance data. TaqMan Assays can be run on any of our qPCR instruments or used as an endpoint assay on other third-party systems, including the Array Tape™ platform.

TaqMan Gene Expression Assays

In addition to custom design options, we offer Applied Biosystems™ TaqMan™ Gene Expression Assays that are predesigned for a wide variety of agricultural species, including soybean, corn, rice, wheat, cattle, pig, sheep, goat, and chicken. TaqMan chemistry remains the gold standard for gene expression analysis.



Which TaqMan master mix is right for you?	
TaqMan GTXpress Master Mix	
Use for most applications	Delivers accurate genotyping results with robust performance in less than 50 minutes
TaqPath ProAmp Master Mix	
Use where inhibitors are an issue	We've taken the best of TaqMan GTXpress Master Mix and added additional capabilities such as inhibitor tolerance for your genotyping experiments
	Excellent manufacturing consistency; manufactured in an ISO 13485–certified facility
Custom master mix	
Have a specific need that requires a custom pack size or formulation?	We offer a range of custom product and service options to provide you the best fit for your specific needs; explore our options at thermofisher.com/qpcrcustomservices

Together, the custom TaqMan SNP Genotyping Assays and QuantStudio systems provide the flexibility and throughput you need for your project. Contact your sales representative to discuss your needs.

Find out more about plant and animal analysis by qPCR at thermofisher.com/agrigenomics



Capillary electrophoresis and STR analysis

Animal STR genotyping kits

Short tandem repeat (STR) loci, or microsatellites, are a class of nuclear DNA markers consisting of tandem repeated sequence motifs of two to seven base pairs in length. Alleles of STR loci vary by the number of times a specific sequence motif is repeated. STR alleles are detected using PCR and electrophoretic separation of amplification products. Due to their high level of informative polymorphism and Mendelian inheritance, STR loci have become the markers of choice for parentage testing and individual identification.

We offer several animal STR genotyping kits for bovine, canine, and equine parentage. These kits contain all the reagents necessary for multiplex amplification of target STR loci, including PCR master mix, fluorescently labeled primer pools, and control DNA. When multiplex PCR reactions are completed, amplification products are separated and analyzed in a single injection using

an automated capillary electrophoresis instrument. Markers in these kits are based on the recommendations set by the International Society for Animal Genetics (ISAG) and have been pre-optimized to perform robustly for signal height and allele discrimination.

Key features include:

- Simple, fast workflow that can be completed in <1 day
- Accepted, ISAG-approved markers for animal parentage
- Easy interpretation of allele calls
- Economical, fit-for-purpose approach

Nucleic acid isolation for plants and animals

Performance in downstream applications is often influenced by the quality of the starting nucleic acid being analyzed. We offer kits for purifying genomic DNA from a variety of plant and animal samples. Our portfolio includes a broad range of technologies that are optimized for different features, such as sample type compatibility, speed and throughput, and performance across varying applications. We have several products that can address the unique challenges of isolating DNA from plants with abundant phenolics and carbohydrates that can inhibit downstream reactions, including the Applied Biosystems™ MagMAX™ Plant

DNA Isolation Kit, which can be easily automated on Thermo Scientific™ KingFisher™ magnetic particle processors without the need for phenol–chloroform extraction or alcohol precipitation.

We also offer an expansive portfolio of kits, reagents, and devices for the isolation, purification, analysis, and quantitation of genomic DNA from plants and animals, as well as total RNA, mRNA, and microRNA.

Features of recommended nucleic acid preparation kits for agrigenomic applications:

Product	Plant DNAzol™ Reagent	PureLink Genomic DNA Mini Kit	PureLink Genomic Plant DNA Purification Kit	DNA Extract All Reagents Kit	MagMAX DNA Multi-Sample Ultra 2.0 Kit	PureLink Pro 96 Genomic DNA Purification Kit	MagMAX Plant DNA Isolation Kit
Recommended for plant samples	√		√	√		√	√
Recommended for animal samples		√		√	√	√	
High throughput-compatible				√	√	√	√
Isolation method	Organic extraction	Silica spin column	Silica spin column	Lysis solution	Scalable, flexible format with magnetic beads	Filter plate	Scalable, flexible format with magnetic beads
Compatible applications	Cloning, qPCR, sequencing	Cloning, qPCR, sequencing, genotyping	Cloning, qPCR, sequencing, genotyping	qPCR	Cloning, qPCR, sequencing, genotyping	Cloning, qPCR, sequencing, genotyping	Cloning, qPCR, sequencing, genotyping
Prep time	60 min	15 min	40 min	5 min	60 min	35 min	40 min

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