Technical Report: Bioneer *AccuTool*™ CRISPR-Cas9 Gene Editing Solutions

I. Overview of Bioneer's *AccuTool*™ CRISPR-Cas9 Portfolio

A. Introduction to Comprehensive Solutions

Bioneer, operating in collaboration with ToolGen, presents its *AccuTool*™ portfolio as a comprehensive suite of products and services designed to facilitate CRISPR-Cas9 based gene editing. This portfolio aims to provide researchers with an integrated platform covering the essential stages of the gene editing workflow. The offerings span from the initial design and synthesis of guide RNA (gRNA) components to the provision of Cas9 nucleases in various formats, synthesis of donor DNA templates for knock-in applications, support for cellular delivery, and services for validating the outcomes of gene editing experiments. This integrated structure potentially offers researchers a streamlined pathway for acquiring necessary reagents and support from a single source, potentially simplifying experimental planning and execution compared to sourcing components individually.

B. Supported Gene Editing Modifications

The *AccuTool*™ services primarily support the two most common applications of the CRISPR-Cas9 system: gene knock-out and gene knock-in.

- **Knock-out (Gene Disruption):** This process aims to inactivate a target gene. It relies on the cell's natural Non-Homologous End Joining (NHEJ) DNA repair pathway, which is activated following the double-strand break (DSB) induced by the Cas9 nuclease at the gRNA-specified genomic locus. NHEJ is an error-prone repair mechanism that frequently introduces small insertions or deletions (indels) at the DSB site. These indels can cause frameshift mutations within the coding sequence, often leading to premature stop codons and the production of non-functional truncated proteins, effectively knocking out gene function. This approach does not require an exogenous DNA donor template.
- **Knock-in (Gene Insertion/Replacement):** This strategy enables the precise insertion or modification of DNA sequences at a targeted genomic location. It utilizes the cell's Homology-Directed Repair (HDR) pathway, which is generally less active than NHEJ but allows for high-fidelity repair using a template. Successful knock-in requires the co-delivery of the CRISPR-Cas9 components and a donor DNA template. This template contains the desired sequence (e.g., a point mutation, tag, reporter gene, or corrective sequence) flanked by sequences homologous to the genomic regions immediately surrounding the DSB site (homology arms). The HDR machinery uses this template to accurately repair the break, integrating the desired sequence into the genome.

The focus on these foundational gene editing techniques suggests that the *AccuTool*™ portfolio is primarily targeted towards researchers employing standard gene editing methodologies for functional studies, model generation, or screening purposes.

II. Core Components: Design and Synthesis

A. Guide RNA (gRNA)

Effective and specific targeting by the Cas9 nuclease is critically dependent on the design and quality of the gRNA. Bioneer offers services and products related to both gRNA design and synthesis.

1. Custom gRNA Design Service

Recognizing the importance of gRNA performance, Bioneer provides a custom design service. This service aims to identify optimal gRNA sequences targeting a user-specified locus. The design process considers key parameters influencing editing outcomes:

- **On-target efficiency:** The service proposes 3 to 4 candidate target sequences predicted to have the highest likelihood of successful cleavage at the intended site.
- **Off-target effects:** To minimize unintended cleavage at other genomic locations with sequence similarity, the design algorithm checks for potential off-target sites with up to 3 base pair mismatches compared to the intended target sequence. This explicit consideration of potential mismatches reflects an effort to enhance the specificity and reliability of the designed gRNAs, addressing a common concern in CRISPR experiments.

2. gRNA Synthesis Options

Bioneer provides gRNAs in multiple formats to accommodate different experimental requirements and delivery strategies.

- **Chemically Synthesized sgRNA (aRGEN):** Single guide RNAs (sgRNAs) are available as chemically synthesized RNA molecules. These are supplied in a lyophilized format, ready for reconstitution and complexing with Cas9 protein for Ribonucleoprotein (RNP) delivery. Bioneer provides positive control sgRNAs targeting human *EGFP*, *CCR5*, and *HPRT1* genes. These sgRNAs are selected based on computational predictions for high on-target activity, offering researchers useful reference tools for optimizing CRISPR experiments. Custom synthesis based on user-provided or Bioneer-designed sequences is available.
- **gRNA Expression Plasmids (dRGEN):** Alternatively, gRNAs can be expressed intracellularly from plasmid vectors. Bioneer offers custom synthesis of gRNA sequences cloned into expression plasmids. Options include a basic vector utilizing the U6 promoter (dRGEN-U6-sgRNA) or a vector that co-expresses Green Fluorescent Protein (GFP) under a CMV promoter (dRGEN-U6-sgRNA-GFP-CMV). The GFP marker allows for monitoring of transfection efficiency via fluorescence microscopy. These plasmids are designed to recognize target sequences of 19-20 bp adjacent to a Protospacer Adjacent Motif (PAM) and are supplied ready for transfection. Positive control plasmids targeting *EGFP*, *HPRT1*, and *CCR5* are also available.
- **Other Formats:** The service overview also mentions the availability of 2-Part gRNA and Cpf1 gRNA. The 2-part gRNA system consists of a crRNA and a tracrRNA. Since the tracrRNA sequence is fixed, this format offers a cost-effective solution for users who need to order multiple crRNA sequences.

  Cpf1 (also known as Cas12a) is a CRISPR-associated endonuclease that utilizes a distinct

guide RNA (gRNA) structure compared to Cas9. Bioneer offers custom synthesis services for Cpf1 gRNAs, including both AsCpf1 and LbCpf1 variants. This provides researchers with a convenient and reliable solution for Cas12a-based genome editing applications.

The availability of both chemically synthesized sgRNA (aRGEN) and plasmid-based gRNA expression vectors (dRGEN) provides researchers with flexibility. RNP delivery (using aRGEN and Cas9 protein) is often preferred for its rapid action, transient nature (reducing potential long-term off-target effects), and efficacy in difficult-to-transfect cells. Plasmid delivery (using dRGEN and pRGEN) can be simpler for laboratories routinely performing plasmid transfections and allows for the use of selection markers.

Table 1: gRNA Options Summary

Product/Service	**Format**	**Key Features/Specifications**
Custom gRNA Design Service	Service	Designs 3-4 high-efficiency targets; Checks up to 3 bp mismatches for off-targets.
sgRNA (aRGEN)	Chemically Synthesized RNA (Lyophilized)	Custom synthesis & positive controls available . For RNP delivery.
sgRNA Plasmid (dRGEN-Basic)	Plasmid DNA (Ready-to-transfect)	U6 promoter driving sgRNA expression; Recognizes 19-20 bp target + PAM; Custom synthesis & positive controls available.
sgRNA Plasmid (dRGEN-GFP)	Plasmid DNA (Ready-to-transfect)	U6 promoter for sgRNA, CMV promoter for GFP co-expression; Allows transfection monitoring via fluorescence; Custom synthesis.

B. Cas Nucleases

The Cas nuclease is the effector enzyme responsible for DNA cleavage. Bioneer offers several variants of the commonly used *Streptococcus pyogenes* Cas9 (SpCas9) and one ortholog, CjCas9, in different delivery formats.

1. Enzyme Variants

Bioneer provides a range of Cas9 variants catering to different experimental needs and applications:

- ***Streptococcus pyogenes* Cas9 Wild-Type (SpCas9 WT):** The standard enzyme for inducing DSBs.
- ***Streptococcus pyogenes* Cas9 Nickase (SpCas9 D10A):** Contains a mutation (D10A) inactivating one of the two nuclease domains, resulting in the generation of single-strand breaks (nicks) instead of DSBs. Paired nickases, targeting opposite strands in close proximity using two different gRNAs, can be used to generate a DSB with potentially increased specificity compared to WT Cas9.
- ***Streptococcus pyogenes* Dead Cas9 (dCas9 D10A/H840A):** Contains mutations in both nuclease domains (D10A and H840A), rendering it catalytically inactive for DNA cleavage. It retains its ability to bind DNA in a gRNA-programmed manner. dCas9 is primarily used as a platform for targeting functional domains (e.g., transcriptional repressors/activators, epigenetic modifiers) to specific genomic loci for applications like CRISPR interference (CRISPRi), CRISPR activation (CRISPRa), or epigenetic editing.
- **Sniper Cas9:** An engineered high-fidelity variant of SpCas9 designed to exhibit significantly reduced off-target activity compared to the WT enzyme, while maintaining high on-target efficiency. The development and characterization of Sniper Cas9 are detailed in a cited publication (Lee et al., Nat Commun, 2018). The provision of Sniper Cas9 directly addresses the critical concern of off-target mutations, offering a potentially safer and more precise option for applications demanding high specificity, such as therapeutic development or the generation of accurate disease models.
- ***Campylobacter jejuni* Cas9 (CjCas9):** A smaller Cas9 ortholog (protein size approx. 1000 amino acids vs. ~1370 for SpCas9; gene size ~2.9 kb for CjCas9). Its smaller size makes it particularly suitable for delivery methods with packaging size limitations, such as Adeno-Associated Virus (AAV) vectors. Bioneer offers CjCas9 in a plasmid format (pRGEN_CjCas9_CMV).

The availability of WT, Nickase, Dead Cas9, the high-fidelity Sniper Cas9, and the compact CjCas9 equips researchers with a versatile toolbox. This extends beyond simple gene knockout, enabling strategies like paired nicking for enhanced specificity, targeted transcriptional regulation or epigenetic modification using dCas9, and potentially facilitating *in vivo* delivery using viral vectors like AAV via CjCas9.

2. Delivery Formats

Cas9 nucleases are offered in two primary formats:

- **Recombinant Protein:** Purified Cas9 proteins (WT, Sniper, Nickase, Dead variants) are produced recombinantly in *E. coli* and feature a His-tag. They are supplied as a solution at a concentration of 1 mg/ml, accompanied by 10X Reaction buffer and 1X Dilution buffer. Recommended storage is between -70°C and -20°C. This format is intended for the preparation of RNP complexes by combining the protein with synthesized sgRNA (aRGEN) prior to delivery into cells. Bioneer provides specific quality control data for these proteins, including purity assessed as >95% by SDS-PAGE, absence of detectable contaminating RNase or DNase activity, and absence of protease activity. This detailed QC information provides assurance regarding the reagent's quality and suitability for sensitive applications.

- **Expression Plasmids (pRGEN):** Plasmids encoding human codon-optimized versions of Cas9 variants (WT, Sniper, Nickase, CjCas9) are available for intracellular expression following transfection. These pRGEN vectors offer choices for promoters (CMV/T7 or Ef1α) to drive Cas9 expression. Furthermore, several vectors incorporate selectable markers fused with fluorescent proteins (Puro-RFP or Hygro-EGFP), allowing for enrichment of transfected cells or tracking; basic vectors without markers are also available. Plasmids are supplied in quantities of 5 µg or 50 µg.

Table 2: Cas9 Nuclease Options Summary

Cas9 Variant	Format	Key Specifications/Features
SpCas9 WT	Protein	1 mg/ml solution; Incl. Buffers; >95% Purity; No DNase/RNase/Protease activity; His-tag.
SpCas9 WT	Plasmid	Human codon-optimized; Promoters: CMV/T7 or Ef1α; Markers: None, Puro-RFP, or Hygro-EGFP.
Sniper Cas9	Protein	High-fidelity variant; 1 mg/ml solution; Incl. Buffers; >95% Purity; No DNase/RNase/Protease activity; His-tag.
Sniper Cas9	Plasmid	High-fidelity variant; Human codon-optimized; Promoters: CMV/T7 or Ef1α; Markers: None, Puro-RFP, or Hygro-EGFP.
SpCas9 Nickase D10A	Protein	Nickase variant; 1 mg/ml solution; Incl. Buffers; >95% Purity; No DNase/RNase/Protease activity; His-tag.
SpCas9 Nickase D10A	Plasmid	Nickase variant; Human codon-optimized; Promoters: CMV/T7 or Ef1α; Markers: None, Puro-RFP, or Hygro-EGFP.
Dead Cas9 D10A/H840A	Protein	Nuclease-dead variant; 1 mg/ml solution; Incl. Buffers; >95% Purity; No DNase/RNase/Protease activity; His-tag.
CjCas9	Plasmid	Small Cas9 ortholog (~2.9 kb); Vector: pRGEN_CjCas9_CMV.

C. Donor DNA for Knock-in

Successful knock-in via HDR requires a donor DNA template. Bioneer offers services for both the design and synthesis of these templates.

1. Custom Donor Design Service

For researchers who need assistance in creating an effective donor template, Bioneer provides a Donor Design Service. Details are accessible via the general design service page. This service presumably helps optimize homology arm length and positioning of the insert for efficient HDR.

2. Donor Synthesis Options

Bioneer synthesizes custom donor templates in two main formats:

- **Single-stranded DNA (ssDNA Donor / ssODN):** These are chemically synthesized single-stranded oligonucleotides. Available synthesis scales cover lengths up to 2,000 nucleotides (nt), with specific ranges offered (e.g., 131-150 nt, 150-400 nt, 401-2,000 nt). ssDNA donors are often preferred for introducing point mutations or small insertions (e.g., tags). They are reported to potentially enhance knock-in efficiency, exhibit minimal cytotoxicity, and minimize random integration compared to dsDNA donors in certain experimental systems.
- **Double-stranded DNA (dsDNA Donor):** These templates are provided as double-stranded DNA, typically in 2-5 µg quantities. Although the exact format (e.g., plasmid, linear fragment) is not specified, dsDNA donors are generally used for inserting larger DNA fragments, as they can accommodate longer homology arms which may be beneficial for larger inserts. This format is described as commonly used and potentially having lower synthesis costs compared to long ssDNA donors.

The provision of both ssDNA and dsDNA donor synthesis options allows researchers to select the template format most appropriate for their specific knock-in experiment, considering the size of the intended insert and potential advantages related to efficiency and off-target integration associated with each type.

III. Delivery Systems and Support Services

Efficient delivery of CRISPR-Cas9 components into target cells is crucial for successful gene editing. Bioneer supports common delivery strategies and offers related reagents and services.

A. Delivery Strategies

The *AccuTool*™ platform is compatible with the two principal methods for delivering CRISPR components into cells:

- **Ribonucleoprotein (RNP) Delivery:** Involves pre-assembling purified Cas9 protein (e.g., *AccuTool*™ Recombinant Cas9) with chemically synthesized sgRNA (e.g., *AccuTool*™

aRGEN) *in vitro* to form RNP complexes, which are then introduced into cells (e.g., via electroporation or lipid-based transfection).
- **Plasmid DNA Delivery:** Involves transfecting cells with one or more plasmids encoding the Cas9 nuclease (e.g., pRGEN) and the gRNA (e.g., dRGEN).

The choice between RNP and plasmid delivery often depends on the specific cell type, and laboratory capabilities.

B. Transfection Reagents

Bioneer offers transfection reagents designed to facilitate the delivery of nucleic acids into cells. A link to the specific product ((https://www.bioneer.co.kr/20-k-7920.html)) is provided on the main service page, suggesting reagents optimized for use with their CRISPR system components are available.

C. Transfected Cell Service

For researchers seeking assistance with cell line generation, Bioneer offers the *AccuTool*™ Transfected Cell service, which delivers knock-out cell pools.

- **Scope and Limitations:** This service is specifically available for human adherent cell lines provided by the customer. The customer's cells must undergo and pass Mycoplasma testing by Bioneer prior to initiating the service. Additionally, the cells must express endogenous *CCR5* or *HPRT1* genes, which are used for positive control validation experiments. These prerequisites define the applicable scope of the service.
- **Methodology:** The service utilizes plasmid-based delivery, transfecting the customer's cells with plasmids encoding Cas9 and the customer-specified target gRNA. Bioneer optimizes the transfection conditions for the specific cell line. The reliance on plasmid delivery for this service contrasts with the availability of RNP components, suggesting a standardized workflow perhaps chosen for scalability or cost-effectiveness within the service context.
- **Validation and Guarantees:** Bioneer validates the efficiency of their optimized transfection and editing process using positive control gRNAs targeting *CCR5* or *HPRT1*. They guarantee an editing efficiency (indel formation) of 40% or higher for these controls under the optimized conditions. However, a critical point is that the service *does not* guarantee the editing efficiency for the customer's specific target gRNA. The success of editing the intended target gene remains dependent on the intrinsic activity of the gRNA chosen by the customer. This service does not perform gRNA screening; researchers needing to identify highly active gRNAs are directed to the separate gRNA Validation service. This distinction clarifies that the service guarantees the process execution but not the outcome for a novel target.
- **Deliverables:** Customers receive two vials of the generated knock-out cell pool (1×10^6 cells/ml per vial), the sgRNA plasmid DNA (2 µg) used for the transfection, and a report detailing the transfection efficiency test results and the measured editing efficiency data for both the positive control and the customer's target.

IV. Pre-packaged CRISPR Kits

Bioneer offers pre-configured kits bundling necessary components for specific CRISPR applications, potentially simplifying ordering and experimental setup.

A. *AccuTool*™ CRISPR-Cas9 Starter Kit

This kit is designed as an introductory package for researchers initiating CRISPR experiments, particularly those utilizing plasmid-based approaches.

- **Components:** The kit includes three custom sgRNA plasmids (dRGEN, allowing for testing multiple gRNAs for a target), two vials of Cas9 expression plasmid (pRGEN-Cas9-CMV/T7), a Mutation Detection Kit (T7E1) for initial validation of editing, a positive control dRGEN plasmid (targeting *EGFP*, *CCR5*, or *HPRT1*), corresponding primers for the positive control locus, and a user manual.
- **Applications:** It provides a convenient starting point for performing gene knock-out experiments using plasmid delivery. The inclusion of multiple custom sgRNAs facilitates screening for effective guides, and the T7E1 kit allows for rapid assessment of editing activity.

B. *AccuTool*™ Safe Harbor Knock-In Kits (AAVS1/Rosa26)

These kits are specialized for targeted gene insertion into well-characterized genomic "safe harbor" loci, aiming for stable and predictable transgene expression. Separate kits are available for targeting the human *AAVS1* locus and the mouse *Rosa26* locus.

- **Components:** Each kit contains a pre-designed sgRNA plasmid (dRGEN) targeting the specific safe harbor site (*AAVS1* or *Rosa26*), a Cas9 expression plasmid (pRGEN-Cas9-CMV/T7), a donor plasmid vector containing homology arms for the respective safe harbor locus and likely a cloning site for inserting the user's gene-of-interest (GOI), primers for T7E1 analysis of the target locus, and a user manual.
- **Purpose and Applications:** Safe harbor loci like *AAVS1* and *Rosa26* are genomic locations known to permit stable, robust expression of integrated transgenes without causing apparent detrimental effects on the host cell, such as insertional mutagenesis or gene silencing often associated with random integration. These kits provide optimized reagents (gRNA, donor vector) to facilitate efficient targeted integration of a GOI into these reliable genomic sites. Applications include creating stable cell lines for gene function studies, therapeutic research requiring consistent gene expression, and lineage tracing experiments.

The offering of both a general Starter Kit and specialized Safe Harbor Kits demonstrates an effort to cater to different levels of experimental complexity and user needs. The Starter Kit lowers the barrier for entry into plasmid-based CRISPR, while the Safe Harbor Kits provide a sophisticated solution for researchers requiring reliable and stable transgene expression, addressing a common challenge in genetic engineering.

V. Validation and Quality Control

Ensuring the quality of reagents and validating the outcomes of gene editing are critical aspects of CRISPR workflows. Bioneer provides QC data for components and offers tools and services for downstream validation.

A. Component Quality Control

Specific quality control measures are reported for key components:

- **Recombinant Cas9 Protein:** Assessed for purity (>95% by SDS-PAGE) and tested for the absence of contaminating nuclease (RNase, DNase) and protease activities.
- **Positive Control sgRNAs (aRGEN):** Selected based on computational predictions for high on-target activity and have passed quality control (QC) using MALDI-TOF mass spectrometry.
- **Positive Control dRGEN Plasmids:** Supplied with corresponding primer sets for validation.

B. Post-Editing Validation Services & Tools

Bioneer offers several methods to assess the efficiency and outcomes of gene editing experiments:

- **Mutation Detection Kit (T7E1):** This kit utilizes the T7 Endonuclease I enzyme, which recognizes and cleaves heteroduplex DNA formed between wild-type and indel-containing DNA strands following PCR amplification of the target locus. Gel electrophoresis of the cleavage products provides a relatively rapid, qualitative, or semi-quantitative indication of whether editing has occurred (presence/absence and intensity of cleavage bands). This kit is included in the Starter Kit and can be purchased separately.
- **In/del Analysis Service (NGS-based):** This service provides a more quantitative and detailed assessment of editing outcomes using Next-Generation Sequencing (NGS). It involves targeted deep sequencing (targeted resequencing) of the genomic region surrounding the CRISPR target site. Bioneer guarantees specific data quality metrics for this service, including a Phred quality score (Q30) exceeding 80% and a total read depth of more than 10,000 reads. These metrics ensure high base-calling accuracy and sufficient sampling depth for reliable quantification of various indel types and their frequencies. The service delivers an analysis report designed for clarity, along with the raw sequencing data. The emphasis on specific quality thresholds (Q30 > 80%, >10k reads) underscores a commitment to providing robust, high-resolution data suitable for rigorous analysis of editing efficiency and patterns.
- **gRNA Validation Service:** This is described as an experimental service to determine the editing efficiency of specific gRNAs. It is positioned as the appropriate avenue for screening and identifying highly active gRNAs, distinct from the Transfected Cell Service which does not guarantee customer target efficiency. The sequence of guide RNA (gRNA) plays a critical role in the efficiency of CRISPR experiments. Therefore, careful design of gRNA prior to conducting CRISPR-based gene editing is essential. Although some gRNA sequences may be predicted to have high activity based on theoretical models, actual experimental outcomes can vary significantly. As a result, it is crucial to validate gRNA

efficiency experimentally to select the most effective sequence.

This service utilizes a plasmid-based delivery method to transfect the customer's cells with 4 gRNA sequences provided by the customer. The gene editing efficiency of each gRNA is evaluated using either a mutation detection kit or In/Del analysis. Through this process, customers can identify the gRNA sequence that exhibits the highest editing efficiency among the four candidates provided.

The availability of different validation methods, from the rapid T7E1 assay to the quantitative NGS analysis, provides researchers with a tiered approach. They can select the validation strategy that best fits their experimental stage, throughput needs, required level of detail, and budget – ranging from initial screening to precise characterization of edited alleles.

Table 4: Validation Methods Summary

Method/Product	**Principle**	**Output/Metrics**	**Format**
Mutation Detection Kit (T7E1)	Enzymatic cleavage (T7E1) of heteroduplex DNA at mismatch sites.	Qualitative/Semi-quantitative detection of indels via gel electrophoresis.	Kit
In/del Analysis Service (NGS)	Targeted deep sequencing (NGS) of the edited genomic locus.	Quantitative analysis of indel frequency and types; Q30 > 80%, >10k reads.	Service
gRNA Validation Service	Experimental testing of gRNA editing efficiency (Mutation Detection kit or In/del Analysis(NGS)).	Editing efficiency data for specific gRNAs (report).	Service

VI. Conclusion

A. Summary of Capabilities

Based on the reviewed technical information, Bioneer's *AccuTool*™ portfolio represents an integrated platform for CRISPR-Cas9 gene editing. It provides a comprehensive range of products and services encompassing critical steps from initial design (gRNA, donor templates) through reagent provision (diverse Cas9 variants and gRNA formats, donor DNA) and delivery support (transfection reagents, transfected cell service) to downstream validation (T7E1 kit, NGS analysis, gRNA validation service). This integrated offering aims to support researchers

throughout the gene editing workflow.

B. Highlighted Technical Features

Several technical features stand out within the *AccuTool*™ portfolio. The availability of the high-fidelity Sniper Cas9 addresses the crucial need for minimizing off-target effects. Flexibility is provided through multiple delivery formats for both gRNA (synthesized RNA, expression plasmids) and Cas9 (recombinant protein, expression plasmids), accommodating both RNP and plasmid-based workflows. For knock-in experiments, the support for both ssDNA and dsDNA donor template synthesis caters to different insert sizes and experimental strategies. The provision of specialized Safe Harbor Knock-in Kits (*AAVS1*, *Rosa26*) offers a targeted solution for achieving stable and reliable transgene expression. Finally, the validation options include both rapid screening (T7E1) and rigorous quantitative assessment via NGS, with defined quality metrics for the sequencing service.

C. Overall Impression

The *AccuTool*™ CRISPR-Cas9 solutions appear designed to serve a broad spectrum of researchers engaged in gene editing. The portfolio includes entry-level options like the Starter Kit, suitable for those new to the technology or preferring plasmid workflows, as well as advanced components and services like Sniper Cas9, Safe Harbor kits, and quantitative NGS validation, catering to more demanding applications requiring high precision, reliability, and detailed characterization. The emphasis on component quality control (e.g., for Cas9 protein) and the provision of multiple validation tools suggest a focus on enabling robust and reproducible gene editing experiments. While the portfolio is comprehensive, potential users should note that specific technical details for some services, were not available in the reviewed materials and would require direct communication with Bioneer for full evaluation.