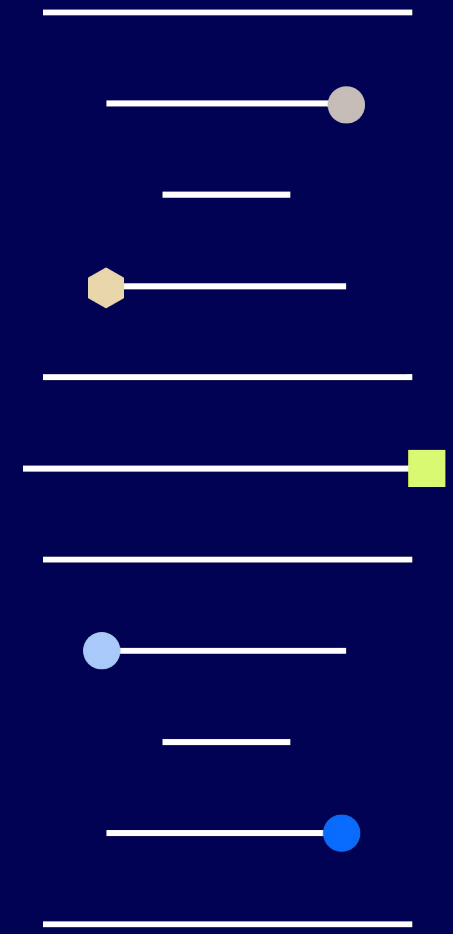
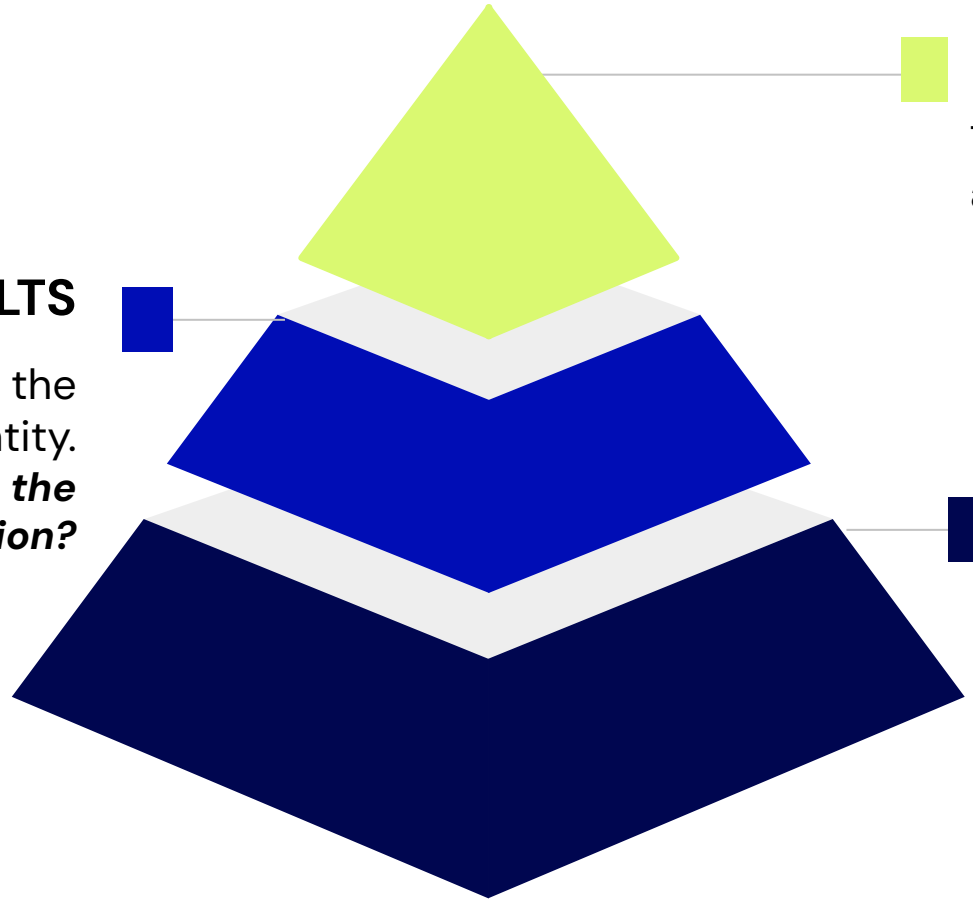
Results Foundations & Best Practices

Benchling

Results Foundations



Sample Tracking in Benchling



INVENTORY

Tracks physical entities in your fridges and freezers.
Where is it? When was it frozen?

RESULTS

Stores assay data produced after the creation of the entity.
How pure is it? What is the concentration?

REGISTRY

Catalogues a biological sample by capturing its characteristics.
What is it? Where did it come from?

Benefits of Leveraging Results

Structured Data Capture

- Standardizing result capture enables easy data comparison
- Templates can be embedded in notebooks and templates to document assays contemporaneously
- Structured data is logged in the data warehouse for downstream analytics

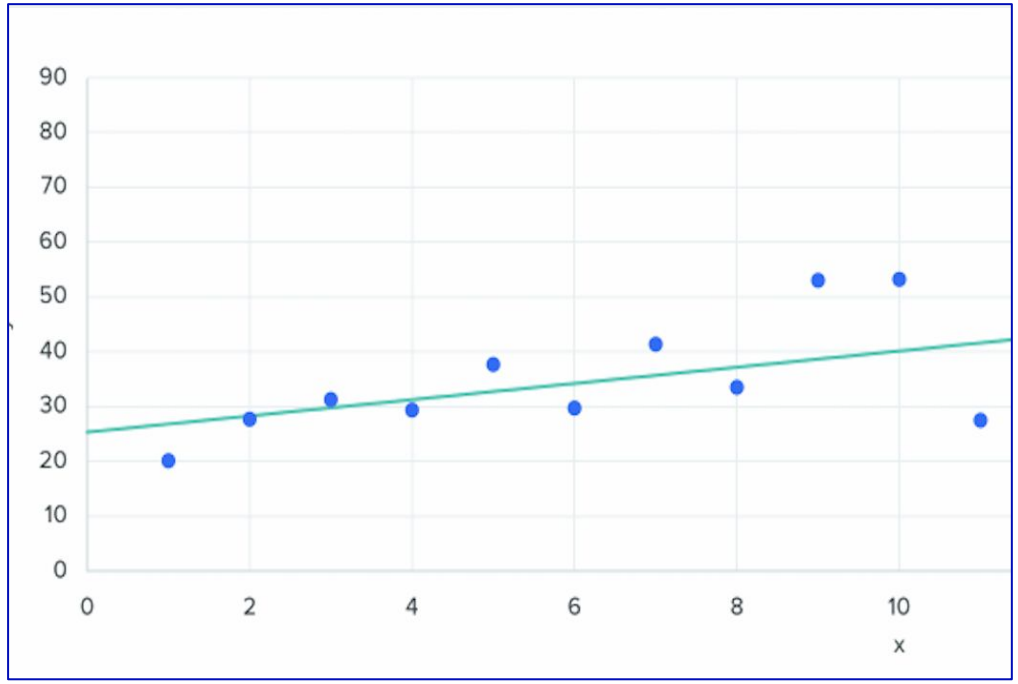
Compliance

- Validate results alongside notebook entries through the witness and review process
- Eliminate manual transcription of result data via automation

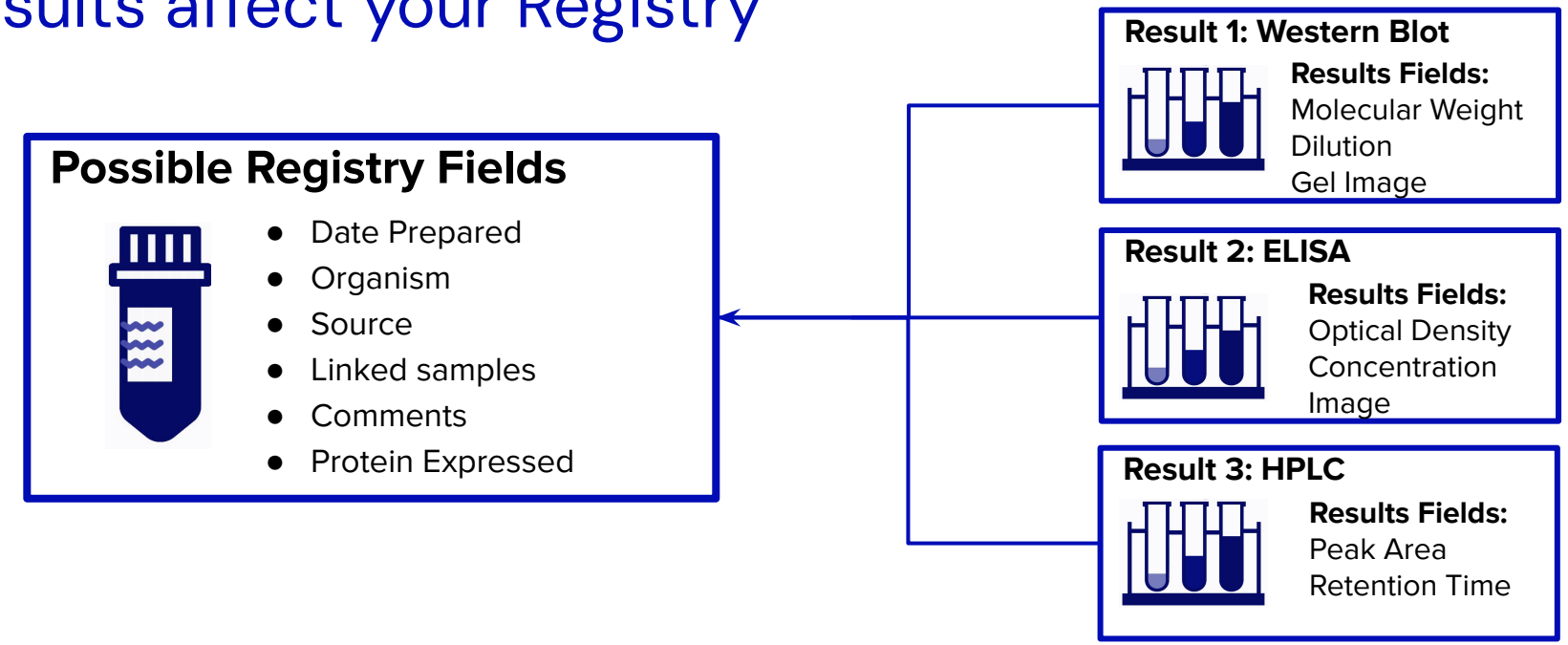
Analytical

- Identify notebook entries associated with particular results
- Leverage the SQL Warehouse to aggregate results and generate visualizations

Training Plasmid Lot	Concentration	a260/280
TPL025	50	1.2
TPL083	50	1.2
TPL185	48	1.2
TPL332	52	1.2
TPL299	52	1.2



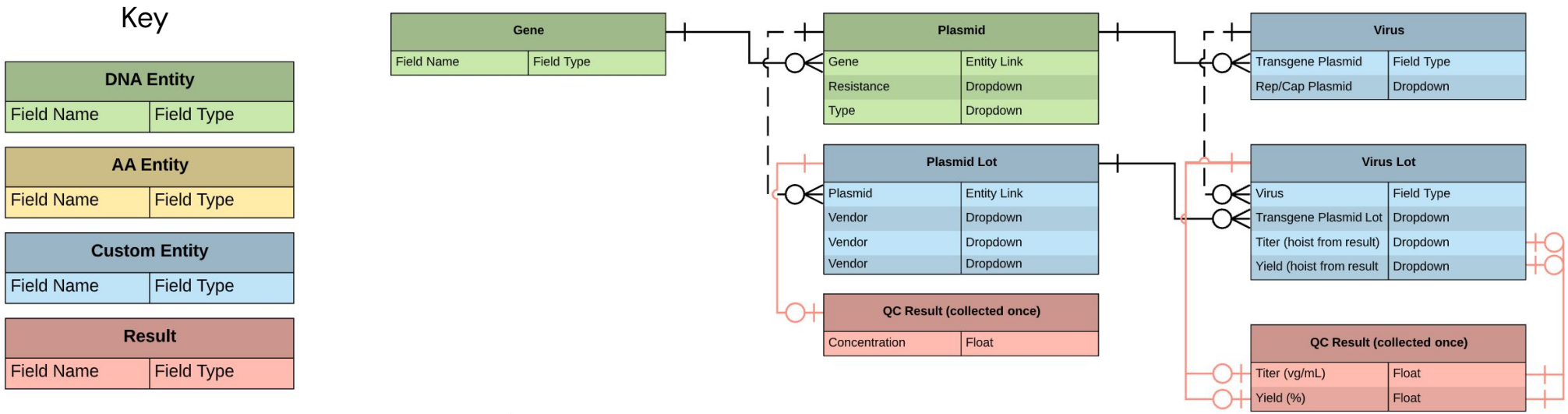
How Results affect your Registry



Results are an equally important part of your data model as the entity schemas themselves. Results *should* be associated to a registered entity or container:

- Entities can be associated with multiple types of result schemas
- Entities may have multiple results logged against them

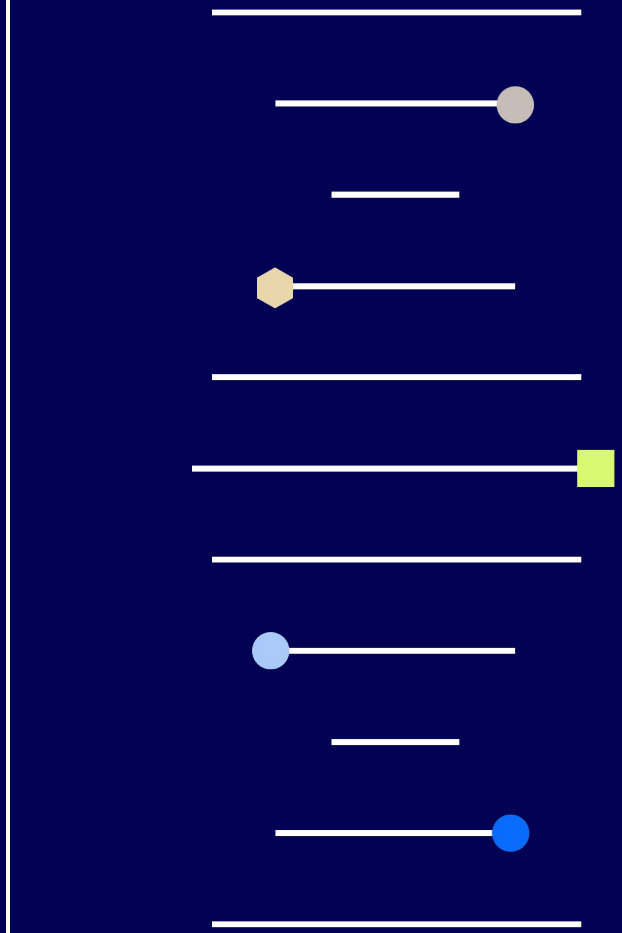
How Results affect your Registry – Downstream Effects



Data scientists (or other data enthusiasts) will be able to pull data against your registered entities and results to:

- Query and compare results from different results schemas across registered entities
- Aggregate large data set from a single result schema from one or many registered entities
- Analyze result data against upstream metadata

Results Best Practices



Best Practices: Using Results vs Registry

It can often be complicated deciding on where metadata should be placed. However, to achieve long-term optimization of a data model, consider the following: **Registry fields describe the characteristics of the sample, while Results fields record data produced after registration of an sample.**

Registry Metadata Guidance:

- Measured/Recorded at time of Creation
- Inherent part of Registry Structured Data
- Best to measure one-time values that will not change often

Results Metadata Guidace:

- Measured/Recorded at time of assay
- Connected to Registry via entity, not an inherent quality of entity
- Can have multiple measurements against one entity

Plasmid Lot (Registry)

Entity fields +	Definition
Parent Plasmid	Plasmid
Prep	Prep Type
Date	Date
Resistance f_x	Resistance

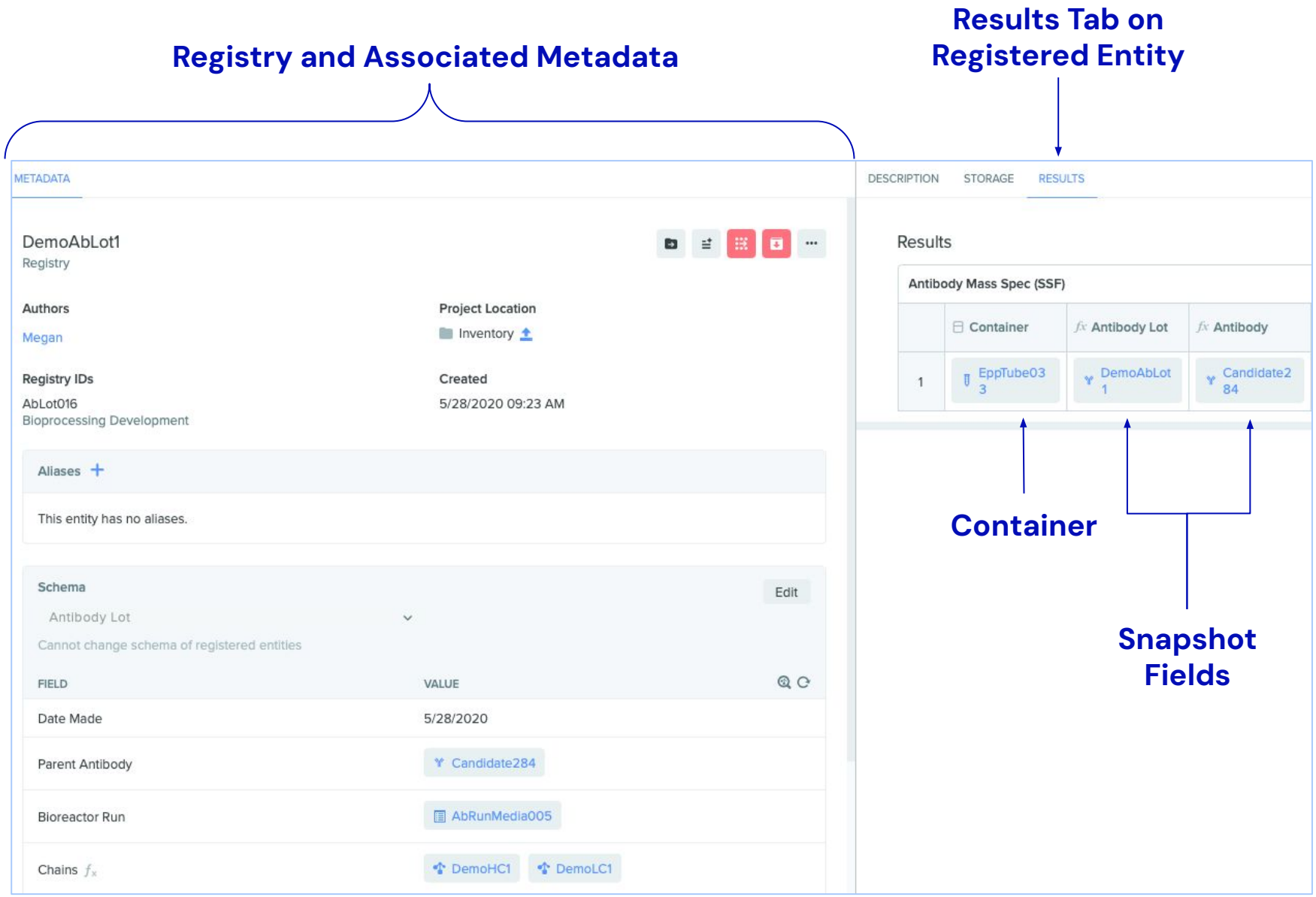
Nanodrop (Result)

Result fields +	Definition
Entity	Any entity
Date Created	Date
Concentration	Integer
A260/280	Decimal

Best Practices: Snapshot Fields

Snapshot fields are computed fields on a Result schema that pull data linked to inventory or registry items, **at a specific point in time**. This will provide a **one-off snapshot** rather than something that updates dynamically.

Snapshot fields, for example, can capture a ‘freeze frame’ of **what *entity is in a container you are testing at the time the Result is captured***



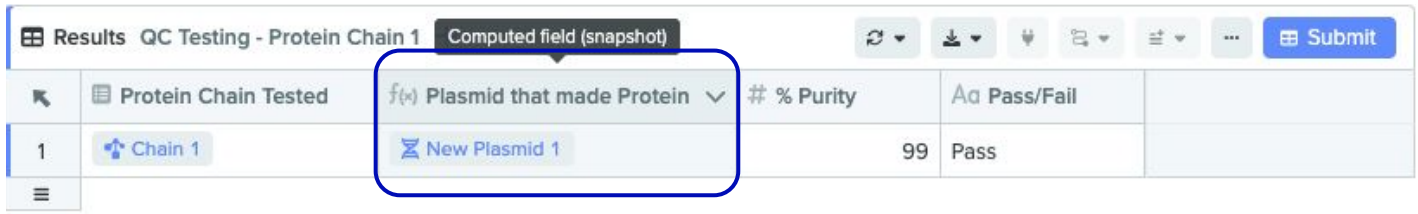
Snapshot Fields vs. Lookup Columns

Use Snapshot Fields to <u>record</u> data in a predefined way for Results:

- Data needs to be **measured at a single point in time** and not dynamically updated
- Configured in **Registry Settings**

Use Lookup Columns to <u>view</u> data from variety of sources:

- Users need **reference information** in notebook tables that **doesn't belong on the schema** the table represents
- Configured in the **Notebook or Templates**



fx Snapshot Field

Lookup Column

Best Practices for Results Against Containers

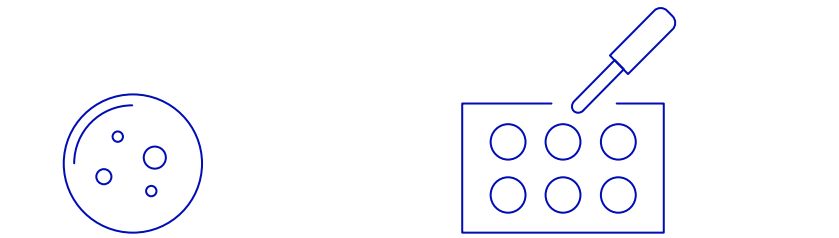
Results against Containers are an example of leveraging Snapshot Fields to automatically surface information about contents of containers. Results can then be captured against containers, as well as registered entities. Tracking results against containers is useful for:

- Improved Sample Tracking and Auditing
- Measuring results against physical objects and their location metadata
- Scanning container labels into result tables

Real Examples:

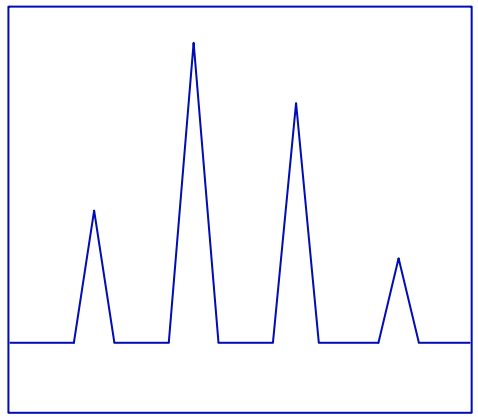
Tumor cells are cultured in multiple wells of a plate

Wells have different chemical treatment applied to test for tumor cell survival



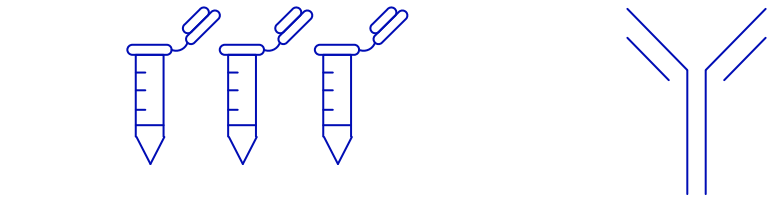
Example 1

Results against containers allow for tracking of entities and conditions in both of these examples



Containers are stored at different conditions to test stability

Production lot of mAb is aliquoted into multiple containers



Example 2

Best Practices for Results in Templates

Standardizing Data Capture

Templates ensure your standardized processes are followed. If you are looking to improve your result tracking adoption, adding Results **Structured Tables** to your templates will make it easier for users to have "ready-to-go" results tables in their entries.

Results OD Measurements 1 +

	Container*	Container Sample	Esimtated Timepoint (hours)	Datetime	OD600 (dilution)	Dilution Factor	OD600 (calculated)
1	E_Test Protein-001	Test Protein-001	1	3/20/2023 01:05:19 PM -0700	10	10	100
2	E_Test Protein-002	Test Protein-002	1	3/20/2023 01:05:19 PM -0700	10	10	100
3	E_Test Protein-003	Test Protein-003	1	3/20/2023 01:05:19 PM -0700	10	10	100
4	E_Test Protein-004	Test Protein-004	1	3/20/2023 01:05:19 PM -0700	10	10	100
5	E_Test Protein-005	Test Protein-005	1	3/20/2023 01:05:19 PM -0700	10	10	100
6	E_Test Protein-006	Test Protein-006	1	3/20/2023 01:05:19 PM -0700	10	10	100
7	E_Test Protein-007	Test Protein-007	1	3/20/2023 01:05:19 PM -0700	10	10	100
8	E_Test Protein-008	Test Protein-008	1	3/20/2023 01:05:19 PM -0700	10	10	100
9	E_Test Protein-009	Test Protein-009	1	3/20/2023 01:05:19 PM -0700	10	10	100

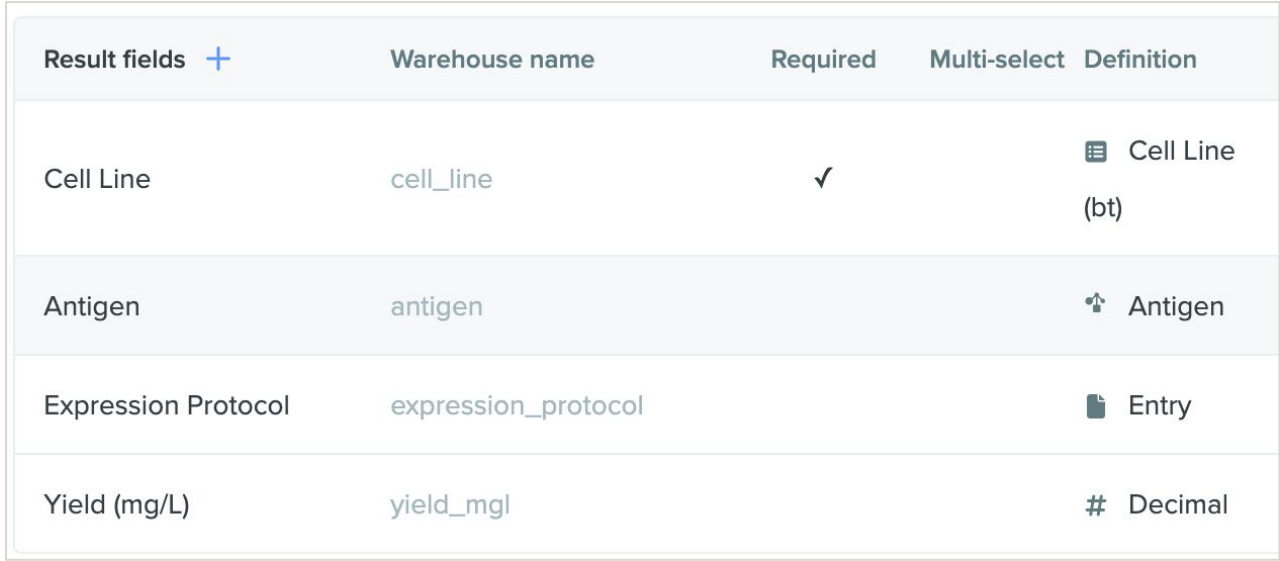
Tips and Tricks: Try adding a pre-built formula to a result table in a template to save your scientist time from recalculating in their entry

Best Practices: Required Fields

	Required Fields for Results
Benefits	+ Standardize the inputs of your registry schema + Define what "complete" metadata is + Commit to data quality up front
Trade-offs	– Required fields can make results submission difficult, particularly if data is gathered at different times or if some fields only pertain to certain teams – Notebook entries cannot be submitted for review if they contain unsubmitted tables

On a Results Schema, you have the option to designate fields as "Required", meaning you cannot Submit your results without that value being inputted.

When designing a Result Schema, consider this decision carefully. You **cannot** retroactively mark a field on a Result Schema as required if there are already results submitted to that schema.



Result fields +	Warehouse name	Required	Multi-select	Definition
Cell Line	cell_line	✓		Cell Line (bt)
Antigen	antigen			Antigen
Expression Protocol	expression_protocol			Entry
Yield (mg/L)	yield_mgl			# Decimal

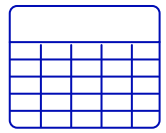
Growing with Results

Best Practices for Different Stages

Basic Focus on Adoption	Develop Result Schemas for your established assays Train users on Result Table usage or add them to Notebook Templates Communicate value of adding results into Benchling
Intermediate Focus on Optimization	Version control your Result Schemas as processes evolve Use Lookup Tables to quickly communicate results to downstream stakeholders Create a functional group responsible for communicating changes needed for schemas
Advanced Focus on Technical Maturity	Build Insights dashboards to visualize Result data Utilize Developer Platform functionality to import and analyze Result dathta Apply change management for new Result functionality/process implementation Create team-based Result Schemas and implement tighter permissions around results

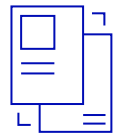
Resources for Results

[Creating Result schemas and tables]



[Create equations for Results tables in an entry template]

[Configuring Snapshot fields]



[Using Results tables]