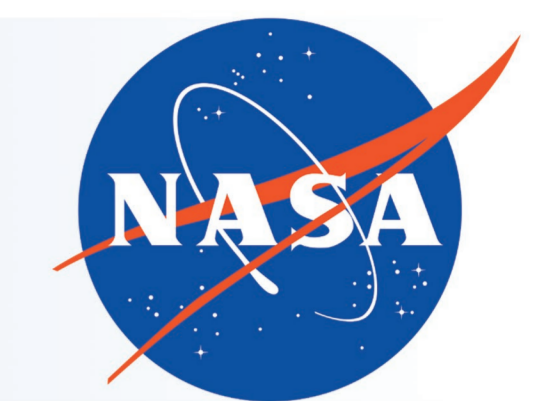


Apollo Botany Experiments and Artemis: Discussion of Botany Experiment Records Digitized as Part of the Apollo Records Synthesis Project (ARSP)

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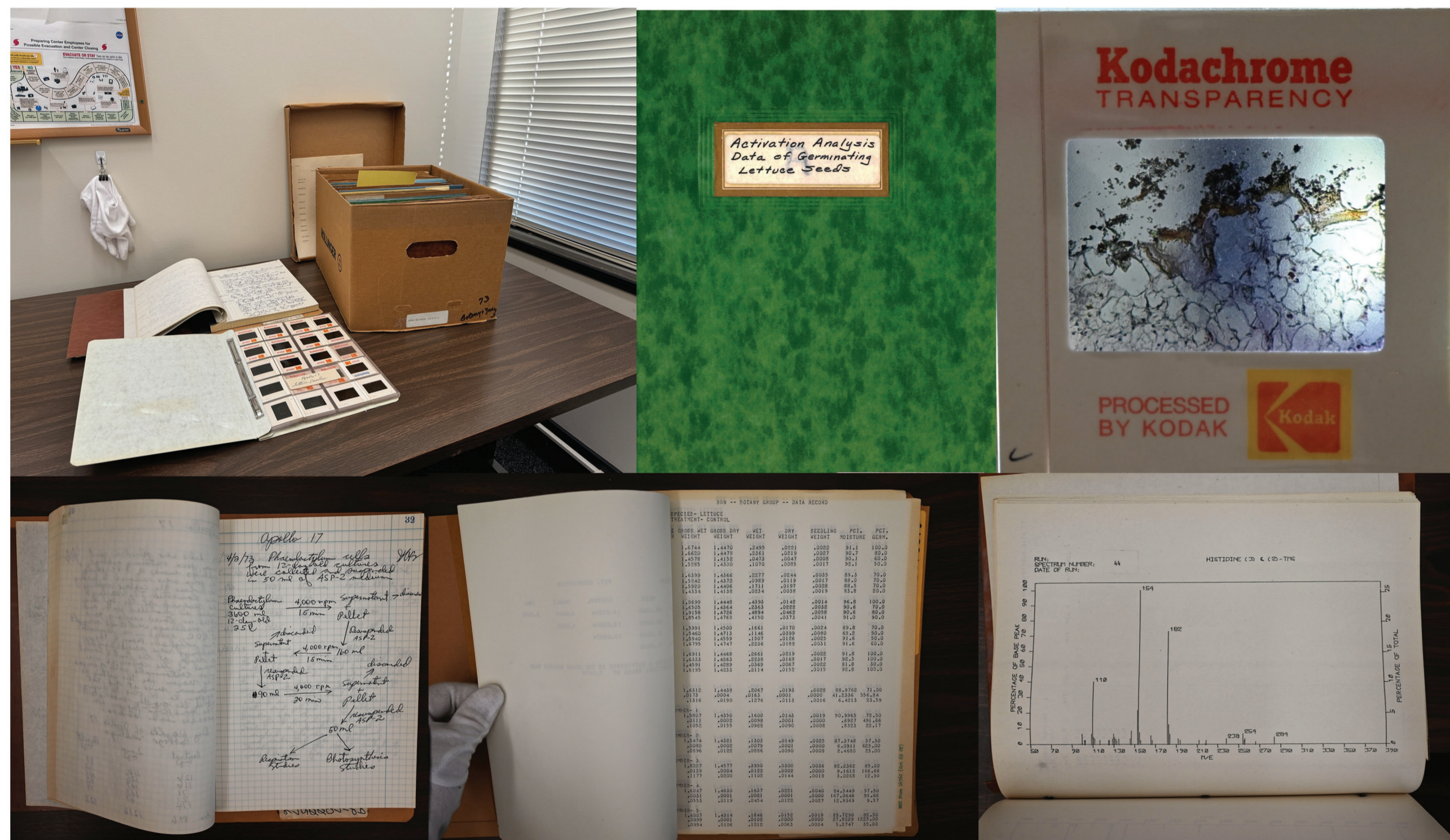
Introduction

The Artemis Program, with its objective of establishing a sustained human presence on the moon, has rekindled interest in lunar botany as an area of inquiry. Limited availability of collected lunar regolith samples for plant growth experiments underlines the need to leverage all existing historic datasets. As part of NASA's Life Sciences Data Archive's (LSDA) Apollo Records Synthesis Project (ARSP), a collection of historic Apollo era botany experiment records from the former Space Life Sciences Archival Library (SLSAL) collection has been digitized to improve access for data reuse. The records are related to post-mission quarantine experiments conducted to characterize any pathogenic effects of lunar regolith on exposed plant specimens. The record set includes several possible dataset sources such as microscopy photos, laboratory notebooks, correspondence, data sheets, and gas chromatography results. This collection includes the output of investigations of taxa previously under-investigated in the context of space biology. An unusually phylogenetically-diverse group of plants are represented in this dataset (including Pinaceae, Poaceae, Solanaceae, Apiaceae and more). This poster discusses the contents of the collection, their historic context, the digitization of the collection, and how to access these digitized datasets.

The Space Life Sciences Archival Library (SLSAL) Collection

SLSAL was a project active towards the end of the Skylab program. In addition to collecting and managing Skylab data, the project collected data from earlier NASA human space flight programs such as the Apollo program. SLSAL assembled research data and related documentation, including: raw and processed data from experiments, environmental data, planning and requirements documents, engineering documents, experiment documents, reports, still photos, and reference materials. The collection covers a broad range of space life sciences research areas.

LS-73 Botany and Zoology



During a comprehensive inventory and assessment of the SLSAL collection, a box of Botany and Zoology records with research data from Apollo plant studies was found. These studies challenged different types of plants with lunar regolith that had been collected during the Apollo missions to the lunar surface. The aim was to understand how lunar regolith impacted a plant's health and growth.

The experiments from this box are primarily associated with the Botany Group of the Lunar Receiving Laboratory (LRL) at the Manned Spacecraft Center (now Johnson Space Center). The primary challenge protocol involved exposing germ free plant tissue cultures and seedlings to a small sample of lunar regolith and then monitoring the growth. Control arms of the study were exposed to sterile terrestrial material (Basalt or Iowa soil). An additional control arm of unexposed plants were also monitored. The records include several different record types:

- Tabular data sheets
- Offprint journal articles
- Correspondence
- Gas chromatography and mass spectrometry reports
- Experiment procedure notes
- Laboratory notebooks
- Photobooks
- 35 mm Slides
 - Experiment imagery
 - Microscopy imagery

Digitization of the Records

LSDA archivists, working with the JSC Photographic Laboratory and the Document and Data Conversion Services Groups, arranged for these records to be scanned. Paper documents, photographic prints, and slides were scanned as a part of this collaboration.

This collaboration leveraged the Photographic Laboratory's existing expertise and infrastructure for large scale digitization projects and transmissive media scanning.



Plant Species Covered by the Collection

Species Name	English Name	Species Name	English Name
<i>Abelmoschus esculentus</i> (<i>Hibiscus esculentus</i>)	Okra	<i>Lycopodiella cernua</i>	Staghorn clubmoss
<i>Albizia julibrissin</i>	Mimosa tree	<i>Marchantia polymorpha</i>	Common liverwort
<i>Arabidopsis</i> sp.	Cyanobacteria	<i>Nicotiana tabacum</i>	Tobacco
<i>Aphanotheca nidulans</i> (<i>Anacystis nidulans</i>)	Cyanobacteria	<i>Nastex</i> sp.	Cyanobacteria
<i>Apium graveolens</i>	Celery	<i>Onoclea sensibilis</i>	Sensitive fern
<i>Arachis hypogaea</i>	Peanut	<i>Oryza sativa</i>	Rice
<i>Auxenochlorella pyrenoidosa</i> (<i>Chlorella pyrenoidosa</i>)	Green algae	<i>Oscillatoria</i> sp.	Cyanobacteria
<i>Avena sativa</i>	Oats	<i>Petroselinum crispum</i>	Parsley
<i>Brassica oleracea</i> var. <i>acephala</i>	Collard greens	<i>Phaeodactylum tricornutum</i>	Diatom
<i>Brassica oleracea</i> var. <i>capitata</i>	Cabbage	<i>Phaseolus vulgaris</i>	Common bean
<i>Brassica oleracea</i> var. <i>gemmifera</i>	Brussels sprouts	<i>Pinus elliotii</i>	Slash pine
<i>Brassica oleracea</i> var. <i>italica</i>	Broccoli	<i>Pinus lambertiana</i>	Sugar pine
<i>Brassica rapa</i> subsp. <i>perviridis</i> (<i>Brassica perviridis</i>)	Mustard	<i>Pinus palustris</i>	Longleaf pine
<i>Capsicum frutescens</i>	Chili pepper	<i>Pinus strobus</i>	Eastern white pine
<i>Chlamydomonas</i> sp.	Green algae	<i>Porphyridium cruentum</i>	Red algae
<i>Chlorella kessleri</i> (<i>Chlorella vulgaris</i>)	Green algae	<i>Porphyridium</i> sp.	Red algae
<i>Chlorella miniata</i>	Green algae	<i>Pteridium aquilinum</i>	Bracken
<i>Cichorium endivia</i>	Endive	<i>Raphanus sativus</i>	Radish
<i>Citrus limonia</i>	Lime	<i>Solanum lycopersicum</i>	Tomato
<i>Cucumis sativus</i>	Cucumber	<i>Solanum melongena</i>	Eggplant
<i>Cynara scolymus</i>	Artichoke	<i>Solanum tuberosum</i>	Potato
<i>Daucus carota</i>	Carrot	<i>Sphaerocarpos donnelli</i>	Liverwort
<i>Euphorbia lasiocarpa</i> (<i>Euphorbia terracina</i>)	Carnation spurge	<i>Spongiococcum applanosporum</i> (<i>Chlorococcum applanosporum</i>)	Green algae
<i>Fragaria</i> sp.	Strawberry	<i>Todea barbara</i>	Royal fern
<i>Glycine max</i>	Soybean	<i>Trebouxia</i> sp.	Green algae
<i>Gossypium herbaceum</i>	Levant cotton	<i>Triticum</i> sp.	Wheat
<i>Helianthus annuus</i>	Common sunflower	<i>Vicia faba</i>	Fava bean
<i>Hordeum vulgare</i>	Barley	<i>Xanthisma gracile</i> (<i>Haploppappus gracilis</i>)	Slender goldenweed
<i>Kalanchoe delagoensis</i> (aka <i>Kalanchoe verticillata</i>)	Bryophyllum	<i>Zea mays</i>	Corn
<i>Lactuca sativa</i>	Lettuce		

*Names in parentheses reflect reclassification of species since this research was conducted. At the time of research, species currently classified as cyanobacteria were thought to be green algae.

Examples of Digitized Objects



Selected Slides from binder titled Apollo 16 Challenge PxS Slides

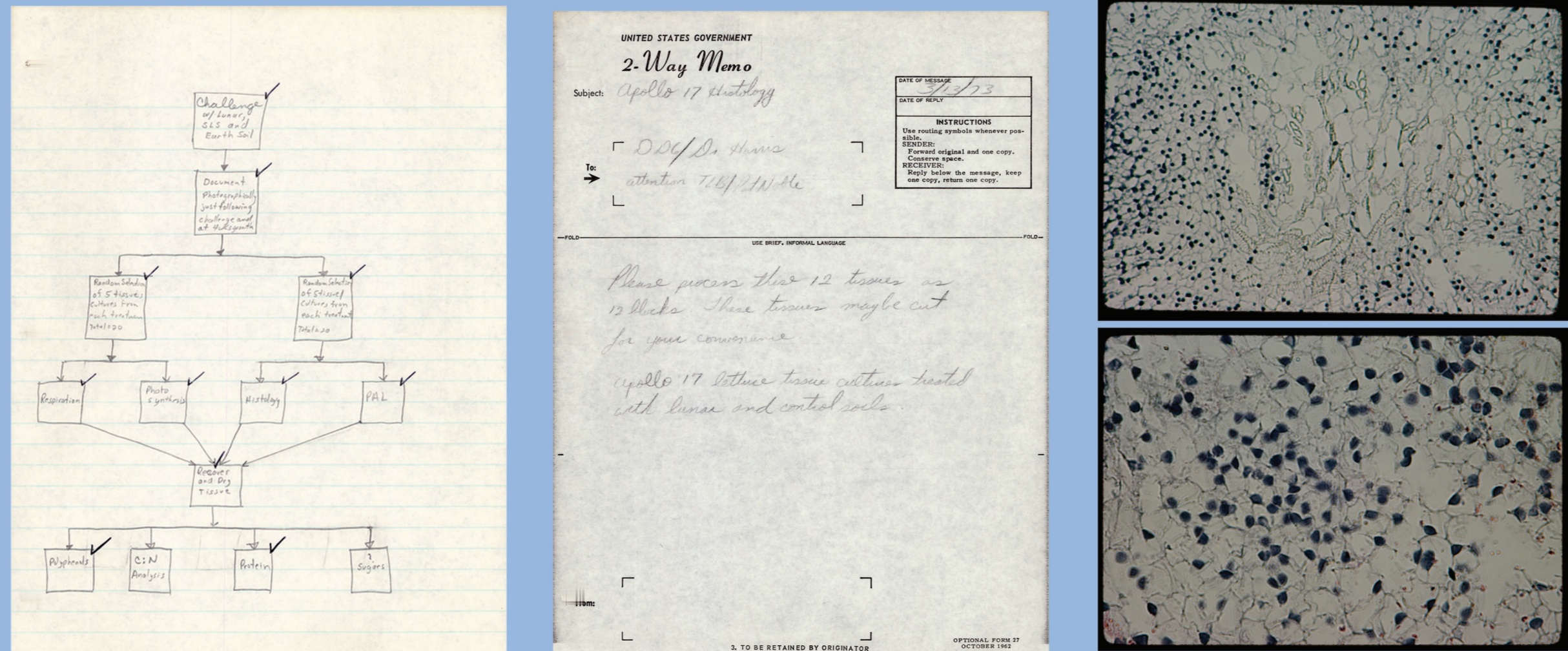
Apollo 17 Lunar Soil/Plant Growth Studies Data									
Sample	Height	Weight	Volume	Area	Perimeter	Length	Width	Depth	Volume
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Tabular data from binder titled Apollo 17 Lunar Soil/Plant Growth Studies Data

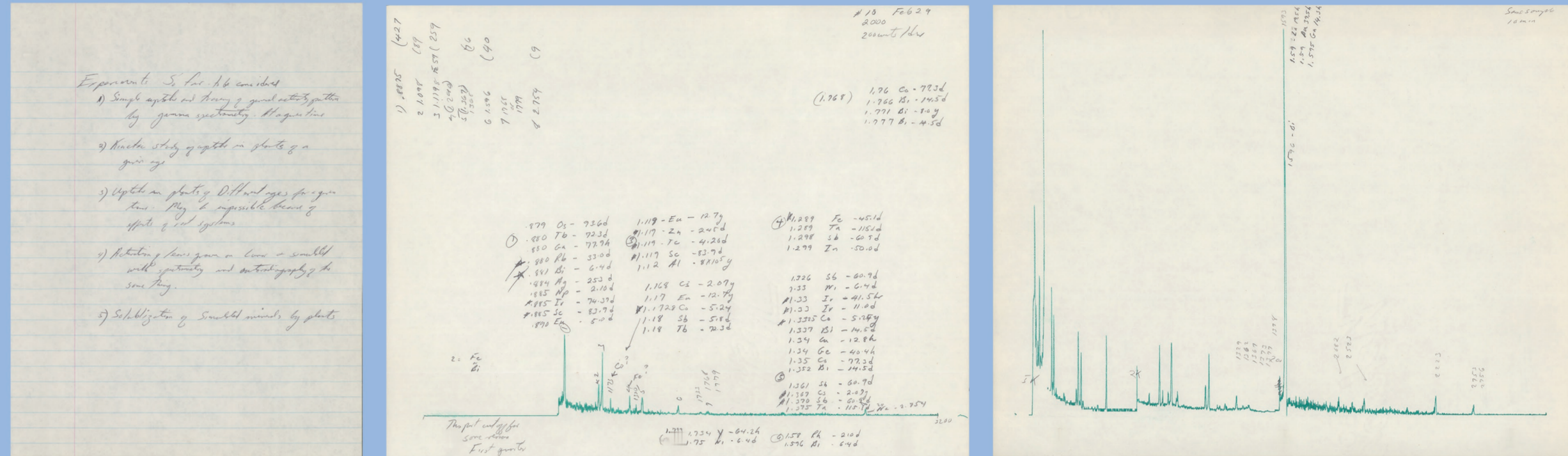


Slides from binder titled Apollo 16 Challenge PxS Slides

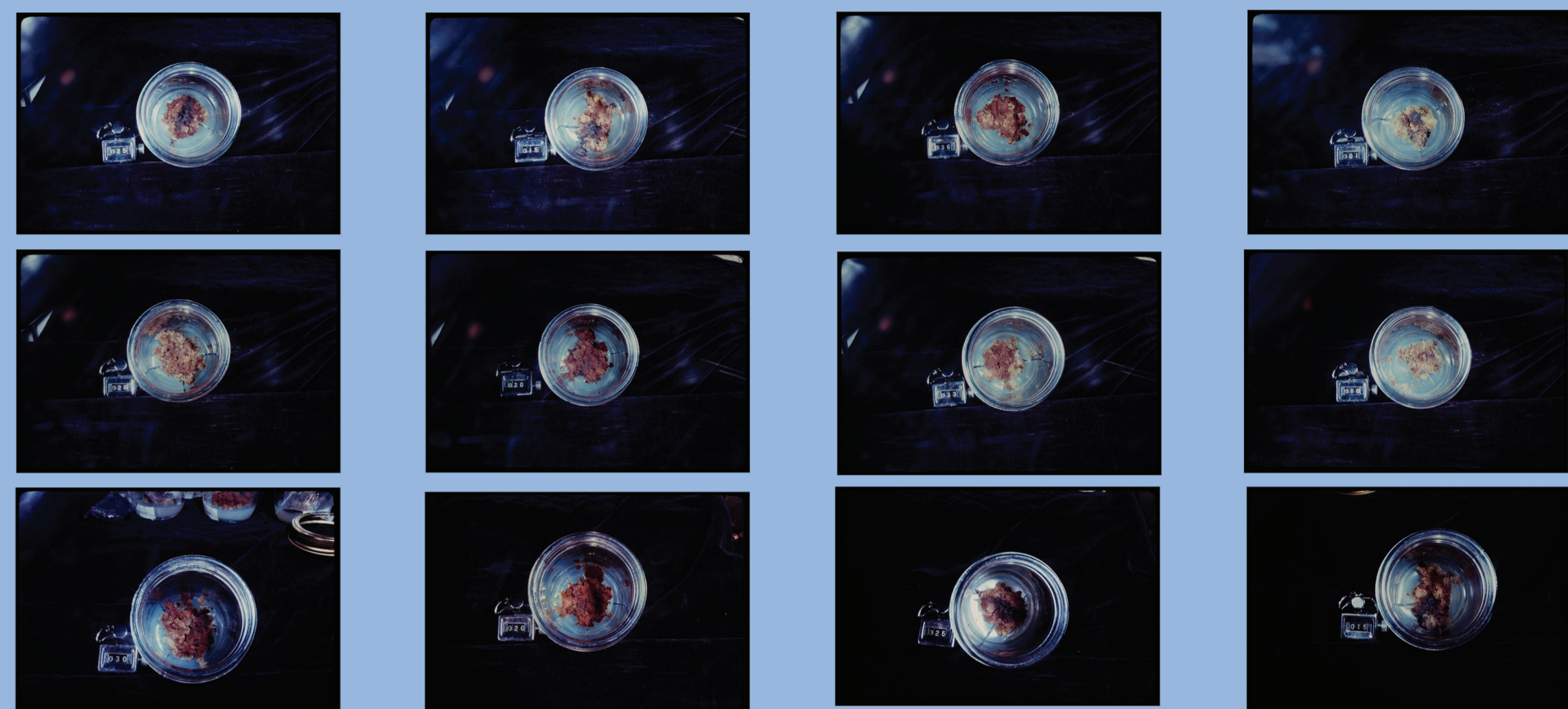
Sample	Height	Weight	Volume	Area	Perimeter	Length	Width	Depth	Volume
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0



Selected pages and slides from lab notebook titled Long Range Germfree Experiment with Lettuce Seedlings



Selected pages and graphs from binder titled Activation Analysis Data of Germinating Lettuce Seeds



Selected slides from binder titled Apollo 16 Challenge PxS Slides Pine Tissue Cultures

About the Apollo Records Synthesis Project

With the dawn of the Artemis era, the space medicine and research communities seek to buy down human system risks for crewed landings on the surface of the moon. These efforts include the reuse of historic Apollo datasets, the only data available for understanding human life on the Moon. Archivists with NASA's Life Sciences Data Archive (LSDA) and epidemiologists with the Lifetime Surveillance of Astronaut Health (LSAH) are collaborating on the Apollo Records Synthesis Project (ARSP), a project designed to improve access to historic datasets from the Apollo Program. ARSP is assessing the physical media collections held by LSDA and LSAH to identify records that contain Apollo biomedical data and working to make these records available to reserachers by digitizing the records to enable reuse.

About LSDA



Life Sciences Data Archive

Based at NASA's Johnson Space Center, LSDA is the primary data repository for human subject science data resulting from Human Research Program (HRP) funded experiments. With datasets spanning the breadth of human spaceflight from Project Mercury to the International Space Station (ISS) along with spaceflight analogs, the archive is one of the most complete collections of human spaceflight data. In addition to LSDA's digital data repository collections, LSDA holds physical media collections that include historic research data. LSDA contains both publicly available and privacy-protected datasets. LSDA's experiment catalog can be found on the NLSP website via the QR code to the left.



So How to Access these Data?

Apollo Botany Data:

Archivists are currently working to publish these digitized datasets on LSDA's new data portal, the NASA Life Sciences Portal (NLSP) where they will be available for public download. In the interim, data from these records are currently available via data request. Researchers wishing to access these records can submit a data request via the data request portal on NLSP. Archivists will then arrange work to arrange access for the researcher via box file share. When submitting a request please include the phrase "Apollo Records Synthesis Project Botany Records" in the data request description field.

Human Datasets from the ARSP:

Human data archived with LSDA and LSAH are often not publicly available due to privacy concerns. Datasets from this project will become available for researchers to access by filing a data request with the help of an LSDA Archivist or LSAH Epidemiologist. Researchers wishing to express interest and/or inquire about Apollo records from this project can submit a data request via the data request portal on NLSP. When submitting a request please include the phrase "Apollo Records Synthesis Project" in the data request description field.

