NIH Investment in Single Cell Analysis Research in Human Cells and Tissues

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Abstract

The NIH "Single Cell Analysis in Human Cells or Tissues" portfolio was evaluated by a trans-NIH working group to determine the current NIH investment in this area of research, as well as identify gaps in the portfolio. This analysis was conducted as part of strategic planning to determine whether the NIH Common Fund should support a program in this area. Grant information from IMPAC II was accessed to identify active projects, which were then manually assessed to determine whether awards involved single cell analysis in humans cells and tissue. This resulted in a validated list of 169 projects totaling $97M, across 17 ICs. The main human cell and tissue types used are cancer, stem, immune, and neuronal/brain, with much of the adult human body not investigated. Primary methods for analyzing these cell and tissue types include transcriptomic, genomic, and imaging approaches. Most of these projects involve technology or method development and data generation.

Methods

To capture the active NIH portfolio in single cell analysis research in human cells and tissues, the NIH IMPAC II database was searched via Query, View, and Report (QVR) on April 27th, 2016. Project titles and abstracts from FY15 and FY16 (as of April 27th, 2016) were searched using the keyword "single cell", including all types of projects, competing and non-competing projects, active projects only, and excluding T, F, and K mechanisms (Figure 1). This search generated a list of 736 projects, which were filtered by text searching titles and abstracts (via IN-SPIRE) for the word "human" and selecting projects that were marked for use of human subjects (via QVR), resulting in 367 projects. 78 additional projects were added from NIH programs that support single cell analysis. The preliminary portfolio (pre-validation) contained 445 projects that were coded and validated by six individuals by using project titles, abstracts, specific aims, and summary statements (Figure 1):

- Single cell analysis proposed? Single cell analysis was defined as "the examination of the biological properties of a single cell, or an individual cell within a population, not characterization of clonal populations or populations of cells assumed to be same"
- Human cells or tissue? (excludes commercially available cell lines)
- Cell or Tissue Type: cancer, immune, stem, blood, neurons/brain, breast, lung, digestive, pancreas, eye, kidney, skin, fat, reproductive, bone, synovium, urinary tract, liver
- Project Focus or Technology: genomics, transcriptomics, proteomics, imaging, biological question, clinical application, physiological measurement

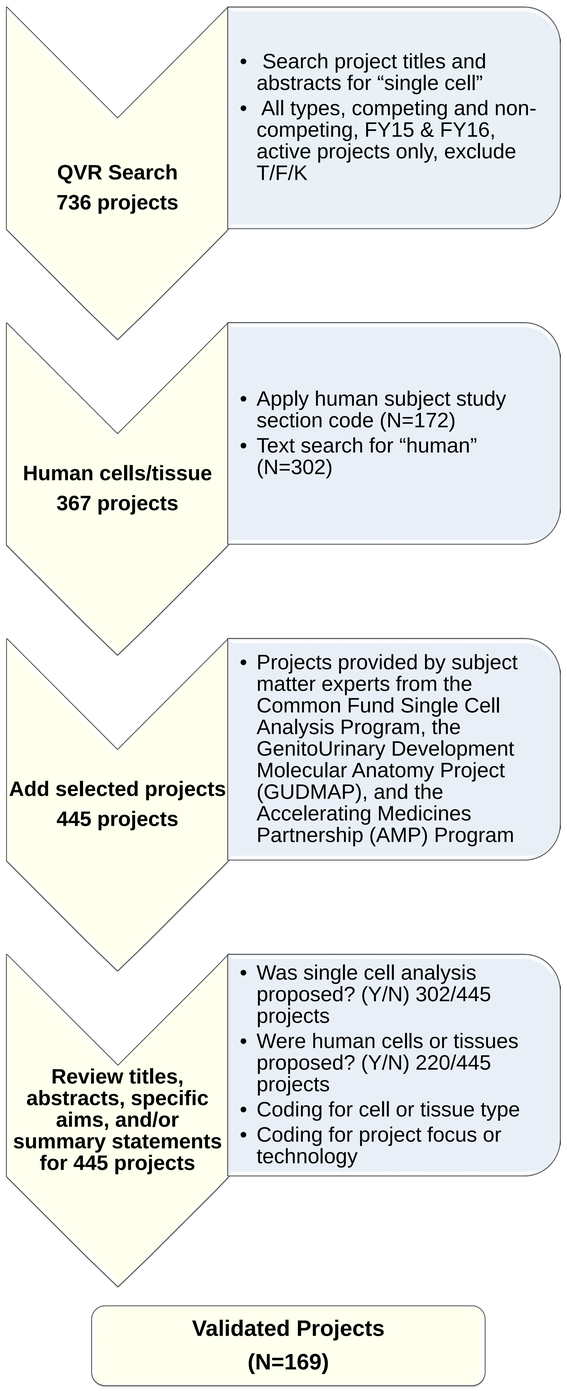

Figure 1. Identification of the single cell analysis research in human cells and tissues portfolio.

Results

Number of Projects	169
Number of Institutes/Centers	17
Investment	$97,064,782

For the FY15 and part of FY16 (up to April 27th, 2016) the NIH invested $97M in single cell analysis research in human cells and tissues, across 17 ICs. The main human cell and tissue types studied are cancer, stem, immune, and neuronal/brain (Figure 2). Primary methods of analysis include transcriptomic, genomic, and imaging approaches (Figure 2).

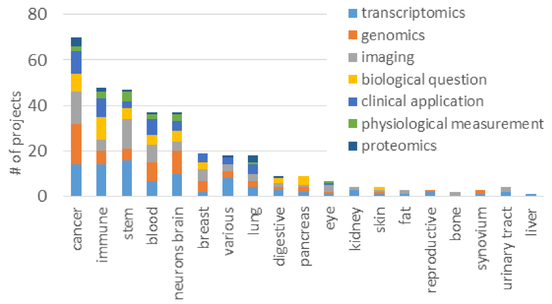

Figure 2. Human cell or tissue type, project focus or technology. Correlations were generated using IN-SPIRE.

A number of ICs invested in this portfolio of research; NCI ($24.1M, 52 projects), NIMH ($14.3M, 15 projects), NIAID ($12.5M, 23 projects), and NIDDK ($11.3M, 20 projects) are the top funders (Figure 3).

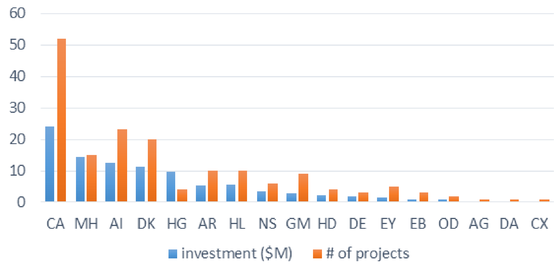

Figure 3. Investment by Institute or Center (IC).

The slight majority of investment in this portfolio was in 116 research projects ($47.5 million), while over $45 million was invested through 44 cooperative agreements and 4 research program projects (Figure 4). The R01 mechanism is used the most frequently in this portfolio (69 projects, $22.3M), followed by R21 grants (23 projects, $3.8M), then U01 grants (22 projects, $15.3M).

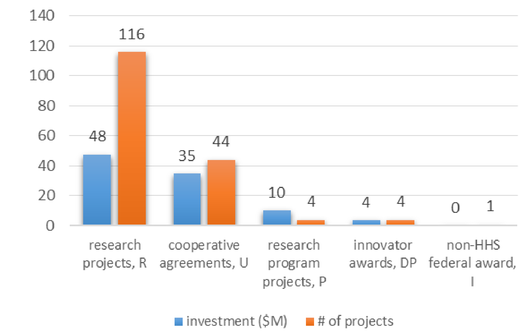

Figure 4. Investment by funding mechanism.

The majority of research projects (R) in this portfolio use cancer, immune, and stem cells and/or tissues (Figure 5). Cooperative agreements (U) largely involve studies using neuron/brain, stem, immune, and blood cells and/or tissues. Projects involving breast, digestive, fat, and bone cells and/or tissues are absent in the U mechanism.

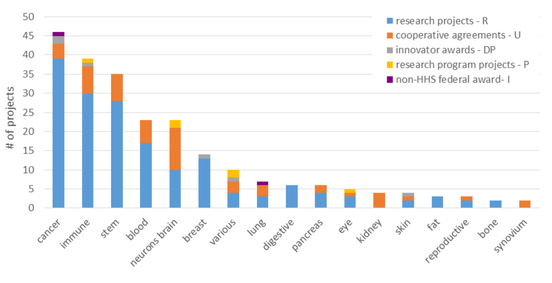

Figure 5. Cell or tissue type and funding mechanism. Correlations were generated using IN-SPIRE.

Conclusions

The following conclusions were made based on this portfolio analysis and additional strategic planning activities that included communication with internal and external subject matter experts:

- Most of these projects involve technology or method development and data generation.
- Much of the adult human body is not being investigated.
- The investment in this area is relatively modest and fragmented.
- A Common Fund program based on common goals and shared scientific principles could have a transformative impact on ability to integrate our current piece-meal understanding of the human body.

The Human Biomolecular Atlas Platform (HuBMAP) program was developed in response to this and is aimed at characterizing and understanding organization of primary, single cells in human tissues using high throughput approaches.