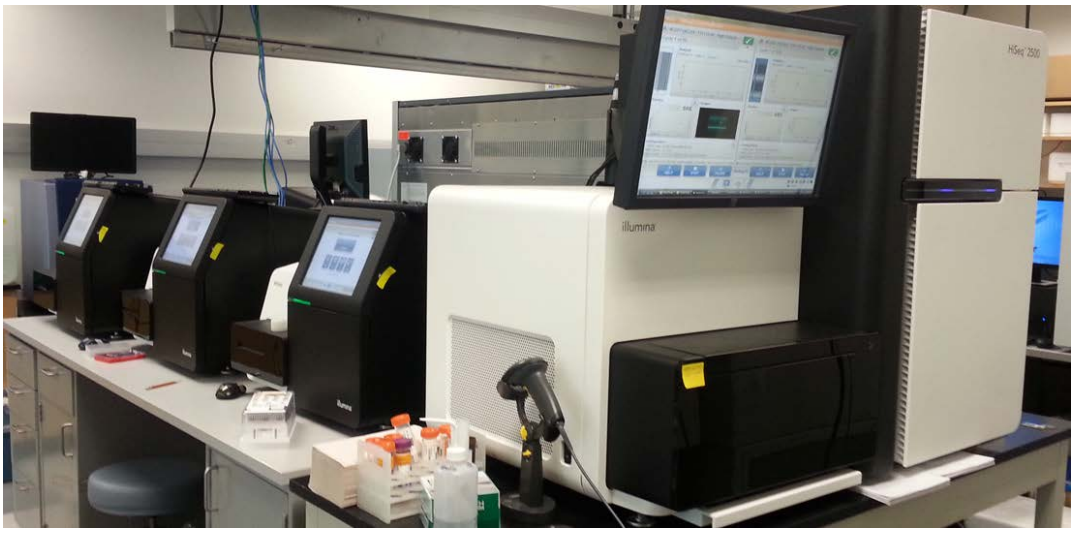


UC DAVIS CORE RESEARCH FACILITIES AND RESOURCES COMMITTEE REPORT

FEBRUARY 24 2014

Recommendations of the UC Davis Research Core Facilities Committee Review

Prepared by UC Davis Core Committee

Table of Contents

Core Facility Committee Membership

Chair: Cindy Kiel EAVC Office of Research

Members:

Bernd Hamann	AVC/Professor	Office of Research/Computer Science
Bridget McLaughlin	Technical Director	Flow Cytometry Shared Core Facility
Carol Oxford	Technical Director	Flow Cytometry Shared Core Facility
Jawdat Al-Bassam	Professor	Molecular and Cellular Biology
Jeff Gibeling	Dean	Graduate Studies
Joanna Groza	Assoc. Dean	College of Engineering
Jodi Nunnari	Professor	Molecular and Cellular Biology
Julie Leary	Professor	Molecular and Cellular Biology
Kent Lloyd	Professor	SOM: Surgery, Mouse Biology Program
Keith Widaman	Professor	Psychology
Klaus van Benthem	Professor	Chem. Eng. and Mat. Sci. (Academic Senate rep)
Lars Berglund	Assoc. Dean, Research	UCDHS: Clinical and Translational Science Center (CTSC)
Mark Redican	Director	Communications Resources, IET
Martha Krebs	Director	Office of Research
Mary Delany	Associate Dean	College of Agricultural and Environmental Sciences
Paul Dodd	AVC	Office of Research
Paul Heckman	Assoc. Dean/Professor	School of Education
Perry King	Analyst	Office of Research
Peter Siegel	Vice Provost	IET
David Britt	Chair/Professor	Chemistry
Richard Michelmore	Professor	Plant Sciences, Molecular & Cellular Biology, Medical Microbiology and Immunology
Simon Cherry	Professor	Biomedical Engineering
Susan Kauzlarich	Professor	Chemistry (representing Dean Ko)
Vikram Amar	Assoc. Dean	School of Law

Special recognition to the following individuals for providing significant contributions to and/or editing support:

Katherine Zoloty
Michelle Hammer Coffer
Mieko Chambers
Mike Legrand
Stephanie Soares
Tony Wexler
Yu-Jui Yvonne Wan

Executive Summary

In late 2011, Vice Chancellor Lewin appointed and charged the Research Core Committee ("Core Committee") to provide recommendations regarding the future success of research core facilities and resources ("Core"), including cost analyses, financial modeling options, and guidelines for research cores administration. The Core Committee included faculty, Core Directors, campus leadership and Core users from a variety of colleges and offices across campus, as well as input from several other institutions. Based on the findings of the Core Committee, the following findings and recommended action items are suggested to facilitate the oversight of Cores and create a sustainable and successful environment for Cores.

The Core Committee defined a Core as "an organized shared resource that provides access to technologies, equipment, services, and expert consultation, often on a fee or reimbursement basis, to enable, facilitate, or enhance the research mission of the university."

Although they may meet the definition of a Core, the following are not addressed directly in this report either because a separate committee was formed to address these areas, or the Core Committee believes a separate work group should be formed to further address resource concerns related to these areas.

- Animal husbandry facilities
- Natural Reserve –real property and facility/land intensive cores.
- Data Infrastructure (Big Data committee Report already complete)
- Biorepositories and Biospecimen cores (separate work group and UCOP working on report and recommendations).
- Purely educational recharge units that peripherally serve the research mission.

The following chart attempts to summarize the key observations and recommendations contained within this report. A lengthier summary with more explanation of the key items follows and the report itself delves further into the reasons and discussions related to these items. The Attachments to this report contain more detailed information about specific science and research-themed areas for consideration and action by UC Davis leadership for particular facilities and services.

Organizational Structure	
Observations	**Recommendations**
• The University lacks a comprehensive approach to strategic decision making relative to Cores • The University has historically enjoyed a primarily grass-roots approach for development of Cores that has resulted in duplicative research cores and equipment	• Establish the Research Core Governing Council ("RCGC") for strategic oversight of core resources • Support the Council with an administrative analyst in OVCR • Empower the RCGC with recommendations from faculty advisory groups to make informed decisions regarding strategic support, consolidation and sun-setting of Cores when appropriate • Develop guidelines around support for Central vs. Decentralized Cores (admin, equipment acquisition & replacement, ongoing maintenance and personnel)
Business Processes and Policies	
Observations	**Recommendations**
• The University has a basic financial recharge rate policy for Core facilities and services that reflects regulatory requirements but there remains confusion about application of these policies • UC Davis does not have comprehensive guidelines or reporting mechanisms for how to successfully manage a Core • UC Davis can be more flexible in the recharge rate setting process • There are serious issues with UC Davis' business contracting mechanisms for external recharge activities	• Charge the RCGC with establishing and providing tools and information to Cores to improve upon and establish best practices • Modify policies to allow for more flexibility for recharge rate setting relative to the three-year "break-even" requirement. (from 8% to 16% of annual operating costs) • Establish Campus-wide Core Service Contract Templates (including on-line acceptance) with delegated signature authority at the Core Director level
Technology and Promotion of Cores	
Observations	**Recommendations**
• UC Davis lacks electronic systems to inventory, evaluate, market and access Cores • It is often difficult for potential Core customers to find the resources available to them for their research; lack of visibility is also at the heart of leadership's ability to make strategic resource decisions for Cores • Cores are redundantly seeking to build or	• Build an "Administrative Backbone"; Core Facilities Management and Reporting System (including LIMS) • Deans and OVCR should pursue a robust marketing strategy to promote Cores • OVCR should establish a Core searchable website kept up to date by inventory mechanisms and annual reports of the Cores

buy IT solutions when all Cores seem to need overlapping sets of similar tools.	
Investments and Financial Support	
Observations	**Recommendations**
• The University does not have a comprehensive or strategic budget methodology for resourcing, subsidizing, and supporting Cores • A minority of Cores are able to be self-sustaining through recharge activities. The majority will require subsidies and/or equipment replacement support beyond their share of NUD • The current grant cost-share decisions in ACCD are conducted in an isolated case-by-case manner without strong consideration of the strategic institutional path for Core resources • The University faces space issues for Cores especially when unique structural requirements exist.	• Identify source of funding within the current budget model for long-term sustainable resources for Cores and to implement recommendations of the RCGC • Continue to identify collaborative opportunities with regional or national cores when appropriate to reduce costs. • Create a framework for College-supported ("Decentralized) Cores and Centrally supported Cores • Create a shared-service initiative in OVCR for Cores that require administrative support (separate from ongoing maintenance, technical or equipment financial support) • Develop and fund a Core Voucher Program • ACCD should seek recommendations from the RCGC when providing cost-share support for equipment grants that will support Core activities
People/Expertise	
Observations	**Recommendations**
• The key to success for UC Davis Cores is the excellence and expertise of its Faculty, Technicians and Managers	• Develop a Core Professional Development Program • Provide additional education programs on best practices in core management

Observation #1: UC Davis lacks electronic systems to inventory, evaluate, market and access Cores. Grant related equipment purchases, faculty start-up packages, technological change and PI transitions all contribute to a dynamic research core resource environment. The challenges this presents is the University's ability to keep and maintain an accurate, up to date inventory of equipment, services and research support activities. As an example, the inventory included in this report is already out of date. A business model and system infrastructure that is built into a Core workflow is necessary to keep information consistently up to date. Only with accurate information can leadership make timely decisions relative to resourcing research core activities without costly duplications. Only with transparent and up-to-date information about

equipment and services, can faculty prepare competitive grant proposals and access research infrastructure available to them post-award.

Action Item #1: Build an "administrative backbone" to keep Core information up to date, informative, and accessible to researchers and leadership. The backbone shall consist of a Core Facilities Management and Reporting System that should be made available for use by all Cores campus-wide, and should be made mandatory for all Cores receiving centralized support (see later). The Core Committee recommends building the system on the Kuali Coeus platform leveraging a Core Billing module already built and launched in November 2013 by the Mouse Biology Program. The existing module would need to be expanded to include recharge rate creation, reporting tools and web-interface capabilities.

- Provide IT resources to enhance the module. We anticipate an 18 month build timeline.

Observation # 2: The University lacks a comprehensive approach to strategic decision making relative to Cores. The Core Committee's initial inventory revealed over 170 active Cores with recharge rates campus-wide. A handful of these Cores are managed centrally by the Office of Research but the majority of the Cores are located in Centers, Departments and Colleges. The current model relies heavily on input from the Administrative Coordinating Council of Deans ("ACCD") relative to subsidization and equipment cost-sharing for Cores without clear guidelines about when allocation of these resources are appropriate. In some instances, lack of an administrative infrastructure or guidelines has resulted in internal competition and inconsistent recharge rates for similar services solely because one Core has received a subsidy while another has not.

Action Item #2: Establish the Research Core Governing Council ("RCGC") for strategic oversight of core resources.

- The RCGC will be made up of administrative staff and faculty experts (chairs of the expert subcommittees) who will work together towards consensus decisions and actions, including budgetary support, space allotment, and business practices, regarding establishment, maintaining, expanding, and retiring core resources.
- Implement the recommended governance structure and hire an administrative officer within the Office of Research to staff the RCGC and its governance structure.
- Identify source and amount of resources necessary to enhance future competitiveness of UC Davis for large-scale funding opportunities and emerging areas of scientific excellence that involve Cores that will serve the entire campus in a strategic manner.

- The RCGC will establish guidelines that clearly articulate and distinguish Cores that are eligible or ineligible for centralized resources, subsidies, and support and/or administrative shared service support from the Office of Research.
- The RCGC would develop a formalized annual application and report process that allows Cores to apply for centralized resources and subsidies and/or administrative shared service support from the Office of Research.
- Faculty advisory groups and Expert Subcommittees would provide informed and coordinated recommendations on applications from Cores for centralized resources, subsidies, and support including matching equipment funds and equipment replacement funds.

Observation #3: The University has historically enjoyed a primarily grass-roots approach for development of research Cores that has resulted in a number of duplicative research cores and equipment. Duplication is expensive and leads to unnecessary redundancy. Leadership has seen an increasing number of subsidization requests for technician salaries, administrative salaries and benefits and support of maintenance contracts and supplies. There are a number of areas where Cores must be strategically located close to the researchers they serve. There are other situations where geographical location is less important. This report lays out a metrics framework for decision making about when geographical or administrative consolidation might make the most sense for our Cores.

Action Item #3: The RCGC with recommendations from the Expert Subcommittees and faculty advisory groups should advise on the following, where possible and appropriate:

- Consolidation, elimination, and/or sun-setting of Cores where unnecessary redundancy exists
- Eliminate internal recharge rate inconsistencies between similar cores caused by heterogeneous subsidies from campus.
- Identify and prepare consolidation space for cores without proximity barriers.
- Create shared administrative resources to manage Cores where physical consolidation is not possible.
- Provide ongoing recommendations for co-location/collaboration/centralization or decentralization of Cores using principles herein.

Observation #4: The University has a basic financial recharge rate policy for Core facilities and services that reflects regulatory requirements but it does not have comprehensive guidelines or reporting mechanisms for how to successfully manage a Core. Many of the Cores at UC Davis have exemplary management practices, excellent marketing capabilities, faculty driven strategic goals, and technical expertise. However, the Core Committee found that these traits

are not shared across all identified Cores. This can result in sub-par service, long wait times and the inability to successfully obtain resources to build research infrastructure for UC Davis' future.

Action Item #4: Charge the RCGC with establishing and providing tools and information to Cores to improve upon and establish best practices.

- Establish faculty advisory panels for Cores.
- Develop and provide annual reporting processes with necessary data elements for strategic decision making.
- Provide and encourage the use of standardized sample tracking modules that are integrated with the billing system (see above).
- Implement five year reviews of Cores receiving centralized resources, subsidies, and support and/or administrative assistance.
- Develop a "best practices" toolkit for Core Managers and/or Directors
- Facilitate a UC Davis network of Core mentors and mentees along with an intranet discussion board for UC Davis Core Managers and Directors

Observation #5: The University does not have a comprehensive or strategic budget methodology for resourcing, subsidizing, and supporting Cores. Current practices permit duplication of resources, inequitable subsidies resulting in competition, under-utilization of equipment, and match-fund decision making without adequate information provided to campus leadership to make these resource decisions. The primary areas where this occurs are A) faculty start-up packages that include resources for equipment purchases where extant Cores already provide this equipment and expertise. B) Grant related cost share requests related to equipment purchases. (If more than 2 colleges are participating in the proposal, the cost-share request is handled by the ACCD). Additional issues relative to large equipment grants and cost-share packages that, if successful, could result in financial hardship for particular Deans in any given year. C) Ad-hoc requests to Deans, the Provost and Vice Chancellor for Research for subsidization support of facilities that are not self-sustaining or that have equipment upgrade or replacement needs that are not currently being met through recharge related equipment replacement set-asides. Many Core Directors mentioned that the small return on equipment depreciation as an equipment replacement mechanism is insufficient to keep Cores abreast of technological advances and many have resorted to simply fixing old machines that were depreciated long ago resulting in higher maintenance and technician costs to keep facilities running.

The Core Committee wanted to emphasize that while the goal for most Cores is to be self-sustaining through recharge activities, the truth is that in many areas, market reality requires

subsidization of research infrastructure. However, the institutional payoff cannot be limited to recharge rates covering expenses. Cores enable successful grant proposals and other sponsored activities. Oftentimes the expertise that resides in Cores assists faculty in the research methodology designs and analytical support for successful proposals. The Cores also provide invaluable training to students, postdocs, and staff on research methods – costs that are often absorbed by the Cores instead of being directly charged to those faculty and researchers. The new budget model at UC Davis does not account for this added value to the research enterprise.

Action Item #5a: Identify source of funding within the current budget model for long-term sustainable resources for Cores and investments identified as key strategic/interdisciplinary and emerging areas that require campus subsidies, new strategic equipment acquisition, equipment upgrading and/or facility co-location resources. This fund source would be available to the Core Managers to implement recommendations of the RCGC. A formalized process for accepting proposals and business plans for Cores requesting funding should be implemented to enable use of these funds. Additionally, the expert subcommittee infrastructure would provide informed guidance to the RCGC on grant-related equipment cost share allocations.

Action Item #5b: Develop and fund a Core voucher program.

- This will avoid purchases of redundant resources as part of faculty start-up packages and to promote Core usage.

Observation #6: The University has strong policies relative to regulations governing the financial management of Cores, but is not fully utilizing the flexibilities available within the regulations to facilitate Core success. The Core Committee reviewed current policies and procedures and identified two key business/policy areas that appear to play a limiting role on research core facilities success. First, the financial flexibility threshold related to "break even" regulations within three years (and our policies governing annual adjustments) and second, the cumbersome and dysfunctional business contract process necessary to conduct external recharge activities that hampers the ability to bring revenue in from outside UC Davis due to lengthy turnaround times, negotiation of terms irrelevant to Core activities and lack of university-wide template-based contract mechanisms for Cores.

Action Item #6: Increase Core financial policy flexibility and support.

- Modify Policies as allowable by regulatory environments to provide more financial flexibility to Cores especially in their growth years (e.g. modify threshold for adjusting recharge rates from 8% to 16%).

- Provide a standardized approach to acceptance of external recharge customers' contracts and purchase orders using contract templates and/or administrative online ordering systems that allow for credit card payments. Use of templates as-is should be allowed with delegated signature authority to the Core Directors and Managers under certain identifiable compliance criteria**.**
- Expand already existing delegation of authority relative to recharge rate setting to the Dean/Vice Chancellor level either by increasing the $50,000 threshold and/or identifying high-risk circumstances where central review of rates might be necessary.

Observation #7: The key to success for UC Davis Cores is the excellence and expertise of its Faculty, Technicians and Managers. Core Committee members repeatedly emphasized that the primary value of Cores are the individuals who oversee, design, produce and provide expertise that enhance the UC Davis research mission. Support for talent is an imperative and important part of ensuring UC Davis researchers remain competitive in the current funding environment. In essence, a piece of equipment is only as good as the person who runs it.

Action Item #7: Develop a Core Professional Development Program.

- Provide travel support for participation in professional conferences and National Core Facility organizations.
- Provide support for vendor-based technical training on new equipment for Core Employees
- Develop sustainable career paths for non-tenured faculty and technical staff that work within our cores and/or provide credit in the promotion/tenure process for engagement in these endeavors
- Provide additional education programs on best practices in core management.

Observation #8: Lack of visibility of Cores. Many members of the Core Committee noted and conducted surveys revealed that it is often difficult for potential Core customers to find the resources available to them for their research. Lack of visibility is also at the heart of leadership's ability to make strategic resource decisions for Cores. This also hampers the University's ability to bring in additional funding when excess capacity allows for externally funded recharge activities. Furthermore, the new Federal OMB Omnibus Circular A-81 applicable to campus in December 2014 will require the university to certify that grant requests for equipment paid for with federal funds is not duplicative of existing resources. Thus, an easy to use method for identifying, categorizing, reporting and looking up available Cores is imperative both for faculty support and for future federal compliance.

Action Item #8: Promote and market Cores and Identify Collaborative Regional Opportunities.

- This can be accomplished through a variety of mechanisms including support of an Annual Core Expo, provision of marketing materials, a centrally maintained website that allows users to search for core resources by keyword, location, types of service, types of equipment or thematic area and that links to the core facilities specific URL's, papers and symposium participation at professional conferences, sponsor workshops, etc. Development of this site as an expansion of the Core Facility Management System discussed earlier will allow the site to be updated as new equipment or services obtain approved recharge rates. The site should also include ordering mechanisms with web-based template agreements that utilize unilateral signatures to University terms and conditions when using Core resources.
- Core Directors and faculty advisory groups know where the competitive Cores exist regionally and nationally. Every effort should be made to coordinate and collaborate with entities that can provide research services and facilities at competitive rates compared to what UC Davis can provide (including any campus subsidies) so long as proximity and priority issues can be successfully navigated.

Executive Summary Conclusion

The above highlighted findings and recommendations are provided as a summary of some of the higher level outcomes of the Committee review. Because the nature of Cores are unique to the type of technology or service provided in a variety of research areas, it is impossible to address the nuances of particular areas of technology in the summary. Individual Core Committee members conducted research, provided information, and made recommendations for particular themed areas of Core support. The outcomes of the Core Committee reviews for each theme are included in the Appendixes to this report but, due to the ever changing landscape of Cores, both at UC Davis and by external entities, the recommendations herein should be re-evaluated and validated by the new RCGC governance structure as decisions are made regarding consolidation, co-location, shared services or sun-setting of obsolete Cores. Additionally, some of the opinions expressed in this report may not have been unanimously agreed to by all members of the Core Committee. The report tries to identify where a minority view was also expressed during Core Committee meetings and/or to provide alternatives to recommendations where there were many good ideas brought forward that also have potential for achieving a better future state for Cores at UC Davis.

Committee to Develop Recommendations Concerning Administration of Research Cores (AKA, Core Committee)

Recommendations Report

I. Committee Charge and Background

Vice Chancellor, Harris Lewin charged the Core Committee to provide sound recommendations and guidance to leadership concerning the future of sustainability, strategic resourcing and administration of the many cores on campus. The charge of the Core Committee included an analysis of the current cost and financing models (e.g., for buildings, technology, administration, maintenance and compliance issues where appropriate), and preparation of informed recommendations for criteria for having certain cores be centrally administered cores versus cores being maintained by individual colleges/schools. (Copy of Charge letter provided as Attachment 1).

UC Davis is a world-class research institution and the faculty deserve world class technologies to further their research endeavors. Historically, Cores at UC Davis have grown organically across campus often within disciplinary units and schools resulting in pockets of excellence and technological enablement across the university. Some facilities are located centrally within Organized Research Units ("ORU") but there are only four Core Facilities managed directly by the Office of the Vice Chancellor for Research ("OVCR") with an interdisciplinary focus. Generally, and especially during financially constrained times, it is difficult to invest in large-scale strategic deployment of research resources in a comprehensive campus-wide strategic approach. While the organic approach has provided faculty with resources for competitive research, at times, it has also resulted in redundant equipment purchases, duplicative use of administrative and maintenance resources and internal rate competition resulting due to inequitable subsidies or support of different Cores. Our institution can ill afford these things during economic lean budget periods.

A campus-wide inventory of core resources for research has not occurred in quite some time making it difficult for faculty and administrators alike to know what resources are available for research programs and proposal development. Better transparency, visibility and support for Cores are critical to enhanced faculty recruitment and retention, stronger, more competitive proposals for sponsored funding, and optimal use of resources in economically challenging times and meeting the Chancellor's 2020 Vision.

Methodology: The Core Committee was comprised of individuals from multiple disciplines, college and department leadership, faculty, core managers and directors, plus faculty senate representation. The Core Committee conducted a survey of both faculty and core directors in the summer of 2012, and held conversations with other Universities for benchmarking purposes and to define potential best practices in Core strategic management. The first step in the process was to develop a definition of a Core for purposes of this review. The second step in the process was developing a methodology to identify Cores at UC Davis that met the agreed upon definition. The Core Committee started with a list from Accounting and Financial Services of all entities with recharge rates. From this list, the committee pulled together thematic areas of core facilities and identified which units met the definition of a Core. This method resulted in sub-reports for each scientific core area that were relied upon by the overall Core Committee. In some areas, different committees outside of this one had been charged to develop strategic review and recommendations and thus, the Core Committee deferred to the outcomes of these separate reviews underway across campus instead of conducting a concurrent and separate review. These areas included; Animal husbandry, Big Data, Natural Reserves, Educational Units, and Biorepositories.

This Report focuses on the Core Committee's definition of a Core, the scope of the Core Committee's review, an inventory of identified Cores across campus, and recommendations for strategic management, infrastructure, identification and support of Cores for the future.

II. Definition of a Core

The Core Committee **defined a Core** as an organized shared resource that provides access to technologies, equipment, services, and expert consultation, often on a fee or reimbursement basis, to enable, facilitate, or enhance the research mission of the university.

For purposes of the Core Committee's review and recommendations, although they meet the fundamental definition of a resource and should eventually be recognized in any searchable web-based system of resources that support faculty, Core Resources that are facility/land intensive such as the Natural Reserve System, animal care and use husbandry facilities, Big Data resources, Biorepositories, and Educational Entities were excluded from the purview of this report. The Core Committee recommends separate reviews of animal research infrastructure and management and independent assessment of the land-rich facilities, such as field stations and preserves.

III. Current State of Cores at UC Davis

For the most part, Cores have grown up organically throughout UC Davis due to an eclectic mix of faculty needs, successful applications for grant and contract opportunities and awards,

faculty start-up support and strategic initiatives by Deans and University leadership over time. These various avenues all have merit but lack sufficient overall guidance for how UC Davis, as a whole, can more strategically invest in infrastructure and technologies in a manner that allows us to be more competitive in an increasingly competitive funding environment. The availability and viability of Cores is in a constant dynamic flux due to changing funding models, leadership and faculty transitions, and constantly changing state-of-the-art technologies in several scientific fields. The primary difficulty in assessing the current state of Cores at UC Davis is the lack of any comprehensive inventory process or systems that track or coordinate cores as they appear, disappear, or change technologies over time. An inventory of core facilities and services will likely be significantly inaccurate within six months to a year and then the inventory must start over again. Thus, it is extremely difficult for leadership to make overall strategic resource investment decisions to avoid duplicative or redundant technologies, internal inconsistencies in rate structures, and damaging internal competition due to differences in subsidized and unsubsidized usage fees. Additionally, the visibility and marketability of UC Davis research cores - both on- and off-campus was stated as another challenge for many of the Cores.

UC Davis currently has an approval process for setting recharge rates for Cores run by Budget & Institutional Analysis ("BIA") that ensures financial regulations and policies are followed. However, this process is not designed to strategically assess research Cores, nor does it identify Cores that provide faculty with services without assessing recharge rates. One strategic entity utilized as a mechanism to request support for Cores is the Administrative Coordinating Council of Deans ("ACCD"). When an opportunity or need for support for an interdisciplinary Core arises (usually involving faculty usage from two or more colleges and/or Cores located within the Office of Research), a Core director approaches the ACCD with a request for cost share – in the event of funded opportunities – or other financial needs. The ACCD then determines if, how much, and for what, the impacted Deans and Office of Research will support the request based on numbers of faculty in each college supported by the Core activities and/or by faculty usage of the Cores. This is a strategic start, but, due to its ad-hoc and formulaic nature, it does not go far enough to ensure the University is using scarce resources in a manner that avoids duplicate investment or addresses long-term scientific and research goals of the University overall. There have been instances where a departmental core received cost-share support for equipment acquisition based on a grant application. This subsidy resulted in a departmental Core providing lower cost to departmental faculty that reduced the client base for an interdisciplinary Core that could not compete on pricing simply due to unequal subsidies of the competing Cores.

Consolidation of Cores is not always viable. The Core Committee recognized that due to the large variety of resources and the technologies they support, different types of technologies

logically need to be treated in different ways. For example, some Cores require close proximity to faculty users due to sample useful life, other Cores could be co-located a significant distance from users so long as affective data or sample shipping options are functional. Some Cores support relatively stable technologies that may change only slightly over time resulting in a need for more maintenance funding and less frequent equipment replacement needs, while other technologies evolve so quickly, that replacement of equipment every few years is a necessity in order to remain competitive. Regardless of the nature of technologies however, one theme appeared relatively constant throughout research cores – expertise of facility personnel and faculty is a primary key to success. There are also situations where, due to demand from a single or small group of faculty, it may be desirable to have duplicative resources due to capacity and priority issues. Sometimes, equipment calibration and sensitivities for particular types of research make it necessary for investment in duplicative technologies. Nonetheless, there may still be instances where co-location, co-maintenance, or co-administration of these resources could result in greater efficiencies and lower overall costs to researchers. The recommended metrics, reporting and the business structure sections of this report offer potential solutions to identifying Cores where consolidation may be beneficial.

IV. Faculty, Core Director and Benchmark Survey Results

The Core Committee conducted two surveys in 2012, a faculty survey and a Core Director survey. Significant results and comments from the surveys are identified below.

a. <u>Faculty Needs & Recommendations</u>

Faculty find the Cores used in the past year at UCD to be of above average satisfaction (76% rated facilities above average or high in satisfaction). Less than 7% rated the UCD Cores as unsatisfactory (6% low; <1% none). Of the Cores used in the past year, faculty rated 83% as essential facilities for UCD. The most commonly used technology in the past 12 months was DNA sequencing in the four facilities.

According to the results of the survey, the most common Cores service needs not currently available at UCD or elsewhere are a wider range of imaging tools, nanoSIMS equipment, and greater mass spectrometry technologies. The most common Core services received outside of UCD are X-ray tools, high-throughput/next-generation sequencing technology, and ion microprobe instruments. The Core Committee is aware that UC Davis has one of the best mass spectrometry equipment in the world. Thus, we surmise that the survey

results point to either faculty not knowing about existing technologies or faculty have other access concerns relative to the technology.

A few faculty commented that the definition of a Core was not inclusive enough for their discipline. In particular, the library came up as a key research resource tool for certain disciplines that would not typically be identified as a Core at most universities.

More than one in five faculty members find prohibitive costs the top obstacle to making the most effective use of UCD's available Cores. Other major obstacles include the Core's budget model (14%) and long wait-times to use facilities (13%).

Primarily, faculty would like to be more informed on what Core and services are available to them, often commenting that an updated list of facilities and services would be of great use. Another recommendation is to keep the Cores cost-effective. Generally, faculty are pleased with current rates, but worry that rates may increase in the future, prohibiting them from completing their research.

A summary of findings from the faculty survey is provided below:

Top 10 Most Used Cores in Past 12 Months by Faculty		
Core	**% of respondents who used Core**	**% of respondents who rated as above average satisfaction**
DNA Sequencing Facility*	15.1%	69.0%
Controlled Environment Facility	14.3%	85.0%
Greenhouses	7.2%	55.0%
Genomics Facility*	6.8%	57.9%
Proteomics Core Facility	6.8%	78.9%
Interdisciplinary Center for Plasma Mass Spectrometry (ICPMS)	6.5%	77.8%
Metabolomics Core	6.5%	44.4%
Analytical Lab	6.1%	88.2%
DNA Technologies Core Facility*	6.1%	58.8%
Mouse Biology Program (MBP)	6.1%	70.6%

* The questionnaire did not distinguish between DNA sequencing facilities in CBS, CA&ES, SOM, and the Genome Center. Therefore these numbers should be considered in aggregate.

Faculty's Overall Satisfaction Ratings of the Core Facilities		
	N	%
High	387	50.0%
Above average	198	25.6%
Average	100	12.9%
Low	45	5.8%
None	6	0.8%
No response	38	4.9%
Total	**774**	**100.0%**

Faculty's Overall Criticalness Ratings of the Core Facilities		
	N	%
Essential for UCD	641	82.8%
Helpful, not essential	59	7.6%
Could get service elsewhere	24	3.1%
No response	50	6.5%
Total	**774**	**100.0%**

Faculty's Major Obstacles in Making Most Effective Use of Core Facilities[1]		
	N	%
Prohibitive cost	37	21.3%
Core facility budget model	25	14.4%
Long wait-time	23	13.2%
Administrative red tape	22	12.6%
Campus budget model	21	12.1%
Lack of expertise	11	6.3%
Historical frustrations (recent past)	10	5.7%
Lack of products/services	9	5.2%
Lack of responsiveness	9	5.2%
Lack of quality control	4	2.3%
Historical frustrations (distant past)	3	1.7%
Total	**174**	**100.0%**

b. Core Director Needs & Recommendations

Although success was defined in a variety of ways depending on the field of the Core, three criteria were common. The facility: (1) performs or facilitates high quality and cutting edge resource-related research, (2) supports a variety of research programs, and (3) provides services that are unique to this geographical area.

[1] All faculty survey answers in the lower digit range (except the historical frustrations) can be interpreted as being based on insufficient staffing, which adds to 24.7%. Hence, at least a quarter of the obstacles for faculty appear to be rooted in insufficient staffing of facilities, which can be addressed by appropriate financial support for the professionals that manage and run Cores. Recommendations addressing this apparent issue are contained in other sections of this report.

Nearly all directors responded that the top challenges to the success of their Core are keeping costs low and acquiring funding, obtaining and maintaining modern and current equipment, and hiring and retaining expert staff with limited funding. Other common challenges are promotion and marketing of Cores, the need for more space, and maintaining rapid turn-around time with limited funding and staff.

Based on the challenges they face, the Core directors recommended increasing financial support that would allow facilities to (1) hire new employees or bring back positions that were previously cut, and (2) maintain and replace equipment. Directors would also like to decentralize the contract procedures, moving towards a more efficient process where authority can be delegated to each Core. Finally, over 30% of Cores work with more customers outside of UCD than they do within the institution. Directors of these Cores would like to see changes in the billing system that would allow those clients more flexibility in payment options, such as using credit cards (capacity currently available but would need to be expanded).

c. Benchmark report summary. Below and attached are tables summarizing information from the Association for Biomolecular Resource Facilities Core Administrators Network – Coordinating Committee (ABRF CAN-CC) survey. The following summaries were created by filtering raw data for institutions that were "Academic," "Academic Medical," or "University" (total 147 responses) and only used data from these entity types to calculate the tables. The survey reached universities including Stanford University, University of Illinois - Chicago, UC Berkeley, Northwestern University, Ohio State University, and Pennsylvania State University.

Who do the cores at your organization report to?		
	N	%
Center Director or Department Chair	55	37%
VP or Dean of Research	80	54%
VP for Finance	5	3%
Internal committee (faculty or other organizational leaders)	30	20%
Other	29	20%

What is the general business model for cores at your organization?		
	N	%
Fully subsidized – no user fees are charged	3	2%
Partially subsidized – user fees recover some costs	85	58%
No subsidy – user fees recover all costs	8	5%
Combination	37	25%
Not Sure	14	10%

What are the sources of funding for research core facilities at your organization?		
	N	%
Federal	117	80%
State	86	59%
Industry	40	27%
Private Foundation	53	36%
Professional Society	11	7%
Unsure	12	8%
Other	25	17%

Approximately how many core facilities are there at your organization?		
	N	%
1–10	34	23%
11–20	43	29%
21–40	31	21%
41–60	13	9%
61–100	11	7%
Unsure	11	7%
Blank	4	3%

V. Business Infrastructure/Systems (The Backbone)

Faculty, Core Directors, and institutional leadership all identified a common challenge related to Cores at UC Davis: That, despite individual webpages and e-mail campaigns, the communication and knowledge of what equipment, services and expertise were available to move research and strategic initiatives forward was difficult and often inadequate.

The equipment inventory on campus changes rapidly. This report itself suffers from this situation. It will likely be out of date as soon as it is released due to the dynamic nature of Cores. Every time a grant is received or a department, college, or campus initiative is launched or a new faculty member with new resource needs arrives at UC Davis, the list of assets changes with them. Because of this dynamic, it is not feasible to compile a stand-alone inventory and do it again every few months in order to ensure that it is current and therefore useful. Lists become outdated very quickly. While the Capital Asset Management System ("CAMS") in DaFiS captures equipment inventories, it does not provide information as to which pieces of equipment are in research Cores nor is it easily searchable by campus faculty or available to external potential customers.

While conducting interviews with other institutions that have undergone similar Core reviews in the past, a clear theme emerged: Failure to develop business processes and systems that allow for easy updating in an obligatory centralized manner results in never-ending reviews simply to inventory Cores. Vanderbilt's representative suggested that in hindsight, building their system that captures recharge activities when rates are proposed and then building their public marketing face off of this mandatory system was the single most important investment they made. It provides the means for leadership and faculty to know in real-time what resources are available and makes it easy for both internal and external customers to find the resources they need. Their leadership has access to reports from the system as they make strategic investments either centrally or within departmental units to avoid redundancy in resources and to better align campus investments with campus goals. There is no one right way to accomplish this. Vanderbilt is one example where a business transactional solution became the strategic solution. Rate creation, ordering, billing, invoicing and equipment inventory all happen within their CORE system that ties to their financial system. In this manner, inventory is updated daily because it has become a part of their institutional business processes.

However, Washington University, St. Louis uses a less technology-focused approach. A web-based platform built in SharePoint captures Core information and allowed for the customer and market visibility and ability to search for Cores electronically. Unfortunately, the back-end business process to keep the site updated was highly manual – individuals within Central administration worked with College appointed personnel to get the Cores within each discipline updated at least every six months for the central website. A user-friendly form was built to make it easier for Core Directors to keep their information updated. Universities such as UCSF are exploring the Vanderbilt code to see if they wanted to adopt this methodology.

The Core Committee identified the need for a system "Backbone" to facilitate the ongoing strategic and day-to-day business needs of Cores as an item of primary importance. Several entities across campus have created independent stand-alone shadow systems to handle their Core tracking, billing and ordering needs resulting in redundant and inefficient uses of IT resources. Therefore, the Core Committee recommends a campus-wide enterprise solution. The committee explored multiple options including utilization of programs developed by other universities, such as I-Eagle from Harvard and the Vanderbilt solution. Fortunately, the Mouse Biology Program under Kent Lloyd's direction had already identified these business needs and teamed up with an external vendor to develop the Core Services Billing System ("CSBS") billing/invoicing module that supports the order lifecycle including estimate, order, order amendments, billing, aging, and email communications. The system will interface with external systems to leverage existing data, reduce manual entry and increase data integrity. The CSBS is built on the Kuali framework allowing communication with the Kuali Financial System ("KFS")

and Kuali Rice. It was vetted with various departmental personnel outside the MBP and designed with their suggestions and needs in mind. The MBP demonstrated this module to the Core committee and the committee recommended that the campus invest resources to build on this module into a campus-wide Core Facility management system. The initial module launched in November 2013 and at the conclusion of testing, will be integrated with KFS Phase 3: Purchasing/Accounts Payable/Capital Asset Management, and eventually, Accounts Receivables. While requirements for the new campus-wide system still need to be defined, the committee recommends the system be further developed to allow:

a. Submission of Core equipment and service budget information so that it is accessible for the purpose of creating recharge rates including calculation of any institutional subsidies associated with those rates.
b. An easy methodology to submit and update information about Core resources that do not have recharge rates.
c. A centralized, searchable web-based platform for customers to find UC Davis resources by name of facility, location of facilities and keyword search functionality.
d. Ability to obtain quotes, orders, accept contract terms and pay for invoices online (including payment by credit card and a Core Credits coupon program).
e. Ability to feed links to ordering information on individual Core Facility websites redirecting customers to the CORE system while still allowing individualized web-based marketing by the Core Directors.
f. Reporting functionality to identify resources, bundle resources for proposal development and to allow leadership to make strategic resource decisions with up-to-date information regarding Core usage, trends and technological strengths and weaknesses.
g. A Laboratory Information Management System (“LIMS”) that allows for barcoding and tracking of samples and materials.
h. This standardized system should be made available to all cores on campus, large and small.

While it is difficult to provide an estimate of the investment necessary to build-out this system until all requirements are identified in more detail, a rough initial estimate suggests we would need a minimum of two IT developers and approximately 18 months for the build. Thus, the committee suggests an initial investment commitment of $250,000 to $300,000 but the actual cost could change after all requirements are fully identified and assessed for feasibility and effort necessary to launch a functional integrated system. Resources should be provided to accommodate the specialized needs of individual cores to encourage widespread adoption of

this standardized format. After launch, the system would require ongoing maintenance support on a permanent basis.

VI. Policy & Business Process Recommendations

a. **Central review and approval of recharge rates**. The policy governing the establishment, approval, operation and review of recharge activities is found in PPM Chapter 340, Section 25. A UC Davis website managed by the Budget and Institutional Analysis office contains information and authority guidance documents as well as PDF and Excel forms that departments utilize when proposing or modifying rates (http://budget.ucdavis.edu/rates/). In spite of this information, a recurring theme from Core managers and faculty directors was the need to streamline the process and to make it more responsive, more coordinated, and less onerous. In fact, some Committee members felt that the recharge rate setting process was broken and impossible to navigate or create appropriate or reasonable rates to cover Core costs. Also, there remains confusion among different stakeholders about when rates can be locally versus centrally approved by BIA. The committee noted that the policy and BIA allow for more flexibility than is widely perceived. This likely speaks to the need for better communication between Core managers and directors and business analysts across the university in these matters. (http://budget.ucdavis.edu/rates/documents/Office-with-final-approval.pdf).

   The threshold for Cores at UC Davis to be required to gain approvals for recharge rates by the campus BIA Recharge Group is $50,000.00 in annual Federal revenue. Cores generating greater than $200,000 annually in federal recharges must seek approval from BIA's Federal Recharge Group. Institutions across the nation have different thresholds for central approvals based on their tolerance for risk and institutional culture ranging from $5,000.00 to $250,000.00. $50,000.00 seems a reasonable threshold for UC Davis.

b. **Allowable surplus and deficits.** Campus policy allows for a three year timeframe to determine a break-even value for recharge rates. However, the management section of the UC Davis guidance documents, subsection D states: "Recharge activities must operate on a break-even basis. Therefore, units must make every effort to ensure that a recharge activity does not generate a year-end deficit or surplus in excess of 8.3% (equivalent to one month out of a year) of the annual revenue and income generated by the activity. If the activity is subject to

seasonal fluctuations, then a calendar year or other twelve-month period may be used to evaluate the surplus or deficit."

The federal regulations governing deficits and surpluses of recharge activities for universities uses the term "significant" deficit or surplus when requiring an adjustment of rates on an annual basis. Thus, different universities have implemented different interpretations of what "significant" means based on their tolerance for risk. Levels range from the one month risk tolerance as at UC Davis to 25% of annual costs. Recharge rates for Cores, especially in their initial years can fluctuate widely as customer base and technologies change over time; thus, it is beneficial to provide as much flexibility to research cores as possible within current regulations to allow for market and customer fluctuations. The committee identified other pricing complexities that further complicate the recharge rate setting process. On one hand, cores are supposed to keep their profit under a certain amount. On the other hand, cores are supposed to charge market rates so as to not unfairly compete with industry. These two requirements cannot always be reconciled. Yet another factor is that cores cannot depreciate equipment that was purchased on federal funds, the primary way that most equipment is obtained. So, a severe limit in profit plus a prohibition against charging depreciation for most core equipment means that facilities are always scrambling for funds to keep equipment up to date. These conflicting costing issues create significant complexity and financial constraints that make it difficult to operate sustainably. Therefore*, the committee recommends that* the threshold *be* increased to *16.6% (2 months of operational costs) for annual deficit or surplus calculations and the* trigger *to* adjust *rates* if outside this threshold. This is consistent with another set of OMB regulations (A-87) that govern state and local government recharge rates which defines "significant" as 2 months of operating costs. The committee requests that the BIA implement this modification in guidance and training documents for core research facilities immediately.

c. **Consolidation related to deficit and surplus flexibility**. *The Core Committee also explored consolidation of administration management of multiple cores into one facility to provide more flexibility for deployment of resources* (for example, in lieu of central or college subsidies of rates for certain recharge activities, if one technology is creating a surplus while another is creating a deficit and both activities are located/managed in the same Core – could one support the other so long as within the 3 year timeframe both activities reach the break-even

threshold). After consulting with recharge experts outside and at UC Davis, the general opinion is that this might be possible in unique circumstances where Federal funding is not involved in the equipment purchase and/or recharge activities. In theory, it is possible even when Federal funding is involved, but it would present high levels of administrative oversight in order to accomplish this in a compliant manner under current regulations. Despite these restrictions, there are other reasons and purposes for consolidation of certain research core activities as described in the discussion in another section of this report.

d. **Development of an efficient contract approval process for recharges to external entities.** A major issue of concern raised by core facilities that engage in activities recharged to external entities is the time and effort involved in contract negotiations. The Contracting Services Unit, which reports to AFS through Materiel Management, is responsible for the creation, negotiation and signature authority of these types of service agreements. This situation is not practical and is dysfunctional. Contracting Services is overwhelmed and cannot handle the workload in a timely manner; contracts for even routine activities can take months to get approved. Despite protracted discussions by some cores, little progress has been made to resolve this situation. Cores that engage in external recharge activities are in a competitive research environment that requires fast turnaround times and responsiveness to business needs of research customers.

   In order to streamline contracting processes, the committee recommends that UC Davis adopt standardized templates for routine activities- that allow Core Managers to complete agreements so long as no modifications are made to the Contracting Services' approved templates. Contracting Services has already facilitated a decentralized contract template approach for some Cores on campus that allows Center Directors to initiate agreements locally (but still require Contracting Services review and sign-off) so long as the approved contract template is utilized unchanged for the types of services anticipated. The committee recommends that this approach be extended to remove Contracting Services from routine approvals and adopted for other Cores. Once the online ordering tool is available as part of the system "Backbone" discussed earlier, an online agreement with a non-negotiable, clickable "Accept terms" option would be the most conducive solution to allow for streamlined acceptance of agreement terms and conditions by external entities.

VII. Structure for informed decision making on strategic investments Strategic Infrastructure Approach

After review and discussion of several different approaches to the management and administration of cores practiced at other universities, the Core Committee evaluated four alternative approaches for establishing a governance structure engaged in the management and administration of centralized cores at UC Davis. Each of the four approaches to varying extent addresses issues related to the responsibility for discussing needs, prioritization, and refinement of cores, the authority for making administrative, organizational, financial, and other resource-related (e.g., allocation of space) decisions, and the accountability to faculty and administration for the use of campus resources as well as transparency and faculty buy-in to difficult decisions that need to be made.

Approach #1, "*Status quo*". This approach uses the existing strategy by which a faculty member petitions for support for financial and/or other types of support for equipment, instrumentation, laboratory operations, technical staff, administration, etc. from the Academic Coordinating Council of Deans (ACCD). The faculty member petitioner is encouraged but not always required to seek approval of their proposal first through their School or College Dean's Office ("Lead Dean"). The petitioner typically submits a written request and often makes a presentation at an upcoming meeting of the ACCD, which then deliberates and decides on the value of the proposal to the campus community. For those proposals granted approval, the ACCD negotiates a funding plan among the represented Schools and Colleges, and with the Provost. The "Lead Dean" or their designate, such as the petitioner, is charged with executing the plan and reporting back to ACCD and/or the Provost's Office on how campus funds were spent, such as through multi-year program reviews.

This governance structure for assessing, approving, and reporting is familiar to the entire campus community as it is currently the only centralized process now in place for consideration of campus support for funding proposals for cores, instrumentation, etc. However, the current process for decision-making is often less than fully-informed, is not made by active researchers, and is not readily amenable to coordination or assessment of proposals in context with the campus as a whole; it is not conducted under any budgetary guidance other than a "first-come, first-served" basis. Therefore, for these and other reasons described below the Core Committee does not recommend continuing with this approach.

Approach #2, "*Consensus*". This approach uses the proposed new Research Core Governing Council ("RCGC") chaired by a faculty member appointed to serve a rotating 3 to 5 year term. The members of the RCGC would include chairs of expert subcommittees representing faculty interests and administrative representatives with the authority to allocate resources (e.g., appointed by ACCD) as well as a delegate from the Provost's Office. Administrative support for RCGC activities would come from the Office of Research. The RCGC would review and assess proposals from faculty for Core support (e.g., instrumentation, technical staff, etc.) and be authorized to make funding decisions by consensus.

The most significant benefit of this approach is that decision-making would be informed by discussions early-on in the process by both scientific and administrative stakeholders, so as to facilitate coordination of requests from across campus. However, this process lacks clear lines of accountability for utilization and spending of campus funds. Therefore, the Core Committee believes that despite clear advantages over the "Status Quo" approach, practical concerns regarding the time necessary to build consensus towards a decision and the difficulty associated with accountability might make this approach challenging.

Approach #3, "*Leader plus Advisory*". This approach is a modification of the "Consensus" approach described above. In this modification, the RCGC chair, after deliberations and discussions of individual proposals, would be responsible for drafting and presenting final recommendations to the relevant campus authority (OVCR, Provost, other?) and have final decision-making authority to implement the support plan recommended by the relevant authority. The RCGC would be advisory to the chair.

This approach resolves the challenges of timeliness and accountability inherent in the "Consensus" process described above. However, faculty members of the RCGC are less likely to be enthusiastic or fully invested in the process because they would see their advisory roles as lacking sufficient authority in the process and having diminished effectiveness. Also, the information is channeled through a single individual who cannot be an expert in all areas and the decision is made by non-researchers. Because the success of central coordination and planning is predicated on broad campus acceptance of the governance process, the Core Committee is not enthusiastic about this alternative.

Approach #4, "*Balanced*". This approach is a combinatorial refinement of the "Consensus" and "Leader plus Advisory" approaches described above. In this approach, the RCGC chair would be given decision-making authority for spending campus resources in support of

proposals deliberated by the RCGC. The RCGC chair would be held accountable for those decisions, requiring regular outcomes assessment by the RCGC of those cores and labs receiving campus resources. The chair would rotate every three to five years and would be selected by the RCGC but report to the Office of the Vice Chancellor for Research. The committee must stress the importance of avoiding the perception of "special" or "conflicted" interests on the part of the RCGC chair.

In addition to all of the advantages of the "Consensus" and "Advisory" approaches described above, the "Balanced" approach would ensure that responsibility and authority for assessing and supporting cores occur in the context of a clear line of reporting to ensure personal accountability by the RCGC chair for use of campus resources. Because the RCGC will include many of the members of the ACCD or their delegates, it will provide informed decisions from a combination of active researchers and administrators with fiscal responsibility. In the Core Committee's opinion, this approach will provide an equitable, informed, and visionary process for governance of the management and administration of campus cores and allocation of resources to support equipment needs across campus. Further, this approach is likely to earn campus-wide stakeholder acceptance moving forward.

The committee recognizes that some major equipment requests will be beyond the usual purview of the RCGC. Under these circumstances, Chair will serve to negotiate with the relevant campus authorities and utilize the RCGC and expert committees in an advisory capacity to provide information on the strategic importance of the request.

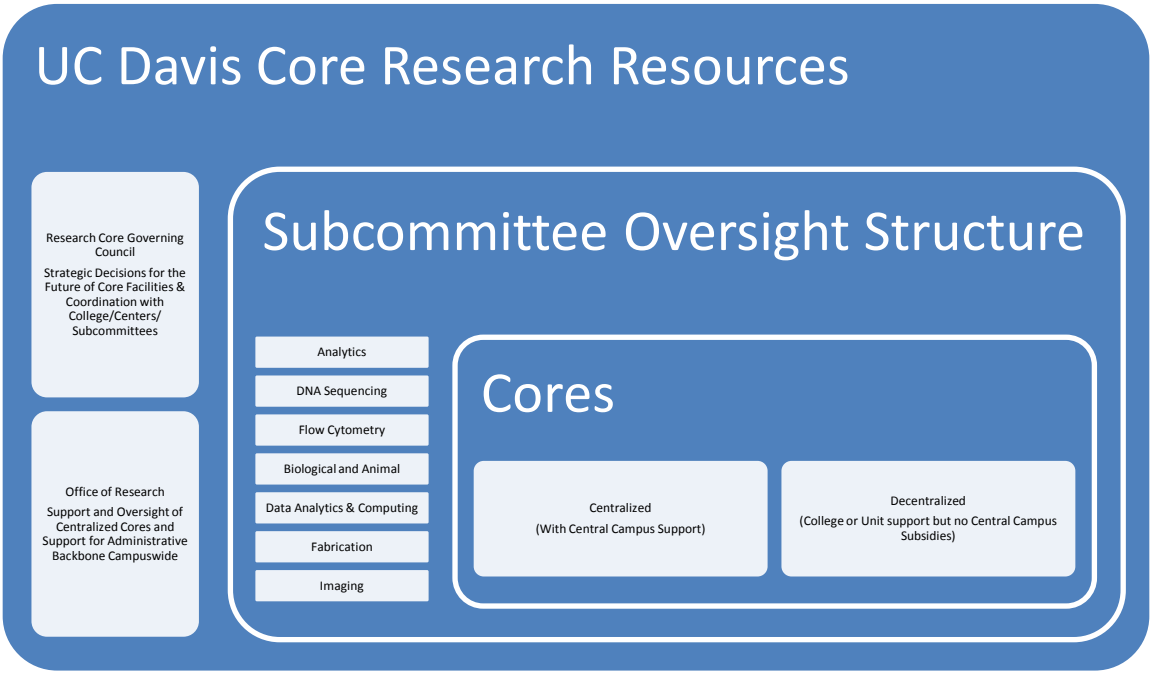
The resultant proposed structure for informed decision making is diagramed below and comprises of a Research Core Governing Council ("RCGC") informed by expert sub-committees focused on specific research areas and technologies. The proposed expert sub-committees are:

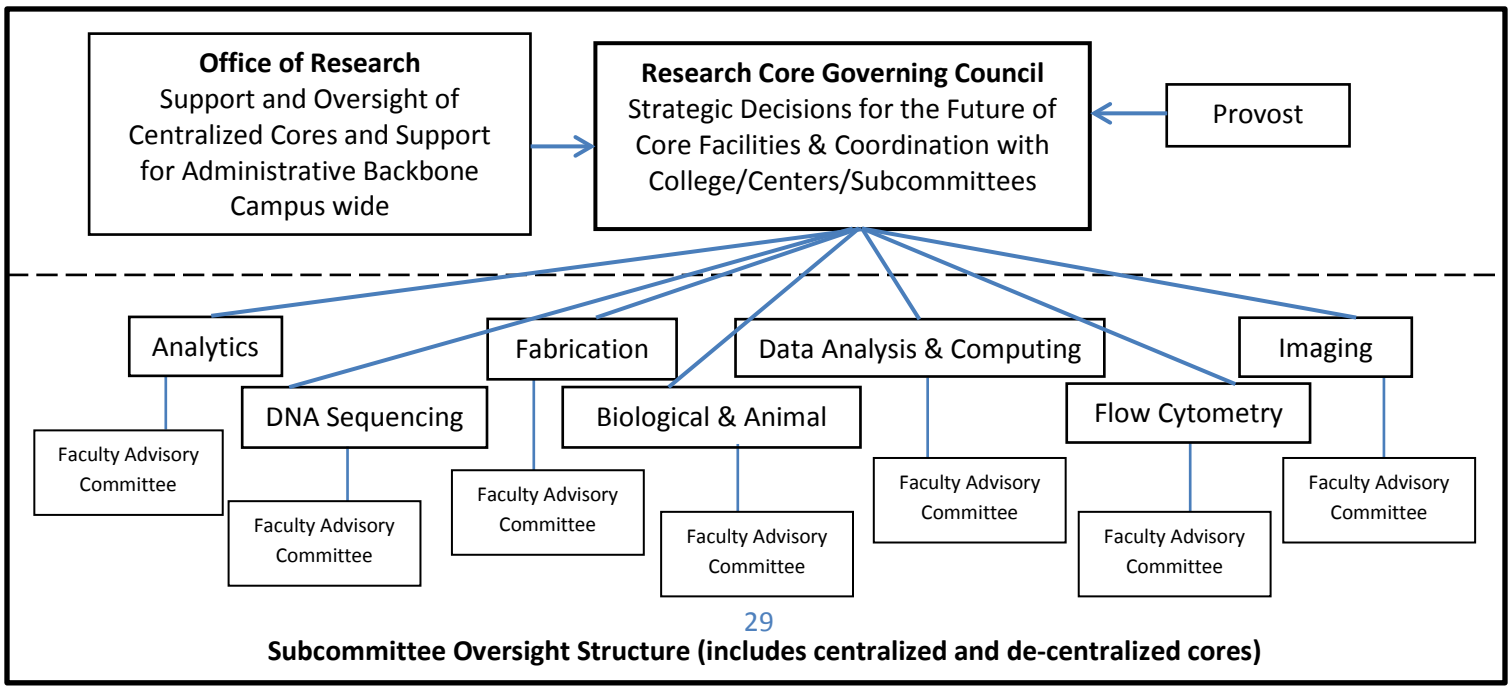
- Analytics
- Biological and animal resources
- Data analytics and computing
- DNA sequencing, genotyping, and expression analysis
- Fabrication
- Flow cytometry
- Imaging

This organizational structure allows for inputs from faculty-driven objectives as well as institution-wide investment strategies. It also enables the administration to obtain faculty-

based advisory recommendations to assist with resource allocation decision making. The model also allows for the continued organic, local growth of key technologies while identifying and reducing potentially duplicative investments. It also allows for flexible accommodation of Cores if they evolve from small local instances to campus-wide interdisciplinary solutions and for ongoing management of Cores for sustained growth of UC Davis' research goals. The committee adopted the term "Sustainagile" to summarize the business model recommended.

The diagram below provides a picture of the suggested business structure:





Subcommittee Oversight Structure (includes centralized and de-centralized cores)

The Core Committee recommends that the Research Core Governing Council ("RCGC") be chartered and chaired by a faculty member (to serve a rotating 3 year term) with the Office of Research providing administrative support and authority to carry out the decisions of the Council. The RCGC should include the chairs of each of the expert subcommittees. It should also include the Vice Chancellor for Research or his delegate as well as representation from faculty and college units with the authority to allocate resources and/or to determine Core reporting lines, strategic plans and structures within their representative colleges or departments; these will most likely be the Associate Deans for Research. It is recommended that a member of the Provost's office also serve on this council to coordinate Core and equipment-related decisions on start-up packages for new faculty and to address budget/resource concerns.

The RCGC decision making will be informed by reviews and reports produced by scientifically themed expert subcommittees. The RCGC would have the authority to create, dissolve and appoint expert subcommittees and their members as necessary to allow UC Davis to respond to scientific trends, technologies and strategic research initiatives as they arise. The themes are likely to change over time. Each subcommittee should be made up of key faculty stakeholders and advisors as well as Core facility representatives who have expertise in each thematic area.

An analyst level administrator is recommended to assist in preparing reports, agendas, facilitating the Core system build and implementing decisions of the RCGC. The committee does not recommend a Director level position for this support due to cost and the possibility of a campus perception of a Director with more authority than the faculty-led RCGC. The Office of the Vice Chancellor for Research would then be empowered to implement the recommendations of the RCGC within the parameters of resources available for research core initiatives from the OCVR, the Provost, and the Deans.

The expert subcommittee chairs should provide annual reports to the RCGC on the state of their thematic areas. These reports should include information about what is new, what might need to be expanded, sunsetted or be combined, and what threats or opportunities are on the horizon. Each Research Core should have an in-depth review by their expert committee at least every five years and the report should be provided to the RCGC. Of course, each Core should have its own faculty advisory group that meets more regularly.

The RCGC would determine which Core should be designated as centrally-supported campus-wide cores with subsidies available from Central Campus. Core Facilities identified as unique to a specific college or department would be expected to be fully self-supporting or be subsidized by their Dean or Department Chair. A reconciliation process should still occur annually to ensure any decentralized subsidization will not cause a decentralized core to compete against a

central core.[2] One example of the primary criteria used to determine central vs. non-central core facilities is at University of Pennsylvania that simply defines central core facilities as: *"Cores [that] provide services and technologies that cannot be readily reproduced in individual laboratories in an efficient, cost-effective manner. Each of the Cores provides useful and appropriate services to Penn investigators and their collaborators at other institutions, with an emphasis on new and emerging technologies and specialty services."* A reconciliation process should occur annually to ensure any decentralized subsidization will not cause a decentralized core to compete against a central core.

It is necessary to distinguish between different types of support and the Committee recommends that support requests allow for only one category, multiple categories or all categories as first requested by a Core Director, and then provided with support through recommendations of the RCGC. Support can fall within three areas:

1) Administrative support for the Core: Managing business operations, handling core finances, IT support and oversight for recharge rate setting processes.
2) Equipment acquisition and replacement. This activity is often (but not always) related to cost-share requests on grant proposals that is run through the ACCD. The committee's recommendation is that grant cost-share requests continue to be handled by the ACCD but with input/recommendation from the RCGC when acquisition or replacements will involve Core activities. The RCGC should make recommendations on key investments for future equipment and Core Facilities based on information from the expert subcommittees and benchmarking activities with other regional and national resources and trends.
3) Ongoing financial maintenance and technician/director support of Cores. This is the area where the "central" or "decentral" Core discussion has the most impact.

For example, using the categories above, a Core could apply for centralized administrative support but remain decentralized within a college for other support and activities. Alternatively, a Core may require maintenance and technician salary support but would prefer handling its

[2] Note: There was considerable discussion on whether only central cores should receive subsidies or if decentralized cores should also be subsidized from a central source. Some felt strongly that Deans might not have the capacity to provide support to decentralized Cores and that this could lead to disruption of operations in strong but non-interdisciplinary research areas. Others felt that to avoid inconsistent recharge rate setting by similar Cores providing similar services only because one Core had a subsidy and another did not was a prime reason to distinguish between Central support and non-Central support. There was no consensus on the most appropriate manner to apply subsidies, thus, the Core Committee recommends that the RCGC come up with guidance and determinations relative to implementing a more holistic and less redundant method for Core Support than what currently occurs under the auspices of the ACCD.

own administration and finance. The process for allocation of resources should, thus, identify the types and means of support available to Cores and identify the most appropriate resource for handling these needs (central or college/department based and/or voucher support). In any event, any Core using centralized support should be required to submit an annual business report in a format to be determined by the RCGC for the purpose of ongoing evaluation and success of UC Davis Cores and should have a more thorough review at least every five years as suggested earlier in these recommendations.

The RCGC would also be responsible for evaluation of proposals from existing and potentially new cores for funding needs, evaluate equipment needs and address proposals for new cores wishing to be under the administration of the OVCR (a "Central" Core). The RCGC should also provide reviews for on campus pre-proposal reviews of applications for limited submission funding opportunities that are directly related to acquisition expensive pieces of equipment or fabrication and/or opportunities for equipment acquisition that require significant institutional cost-sharing.

Comprehensive centers, such as the Cancer Center and the Genome Center, provide a range of services and have distinct missions and funding. These need to be integrated with the decision making process of the RGGC and its expert sub-committees, while at the same time allowing them sufficient independence to fulfill their individual missions.

VIII. Key Challenges, Best Practices and Investment Solutions for Research Cores

a. Challenges for Cores at UC Davis

In General: The primary challenges facing cores that were identified and discussed by the committee include: External and internal competition, lack of resources for replacement of aging equipment or changing technologies, lack of campus coordination (both at Davis and UC-wide) in negotiating better pricing for equipment maintenance and external services from corporate entities, lack of facility resources to co-locate machines in appropriate venues, lack of cohesive information technologies for management, visibility and marketing of resources and financial buffers for Core Facilities as business models, customers, and technologies change and a lack of support for career development options and opportunities for the Core facility professionals - the single most important component determining the success or failure of a core facility. As mentioned earlier, a solution must be implemented to the current system that allows for the

creation of inequitable core subsidies, duplication of resources and redundant costs of maintaining resources.

A major limitation for many local cores is availability of suitable space. For instance, the electron microscopy facilities on campus (especially those in CBS and ENG) are limited by available space suitable for high resolution imaging. One of the objectives of RCGC must be to lobby for appropriate lab space for centralized operations, especially when unique environmental conditions are required (e.g. low vibration, low acoustics, electro-magnetic fields, etc.)

b. Develop a Strategic Core Investment Fund. There is a pent-up demand for investment in Core facilities, particularly for equipment replacement and upgrades. The University charges a Non-University differential ("NUD") on externally funded recharge activities. A portion of this is provided back to the Core that generated the revenue and can be used for equipment maintenance, upgrades and/or purchase of new technologies.[3] Cores are also allowed to apply a "mark-up" when charging external customers. Mark-up revenue may also be used for this purpose. However, all core directors indicated that the amount of this return is insufficient to support investments in future technologies and/or replacement of aging equipment. A small fund is currently available through the OVCR for situations where equipment failure puts a Core Facility at risk as a type of self-insurance. However, the budget for this program is based on coverage of expenditures as opposed to actual budget allocations and so the availability of this program is uncertain and purposely not advertised as a regular source of funding.

[3] One committee member stated: I would like to see that the campus does charge only a very minimal amount indirect costs to recharge money. In fact, in an ideal world the campus should not charge any indirect costs on recharge money proposed in a grant as the direct funds will be used to maintain campus property. Charging indirects on this amount appears as "double dipping". This aspect makes some proposals significantly less competitive due to the high indirect costs. The committee discussed this view and recognized that charging a NUD does not violate any regulations and that if a NUD is not charged it is likely that there would be insufficient resources to resource Cores in the manner recommended in this report. But the Committee recommended more transparency in how centrally kept NUD resources are used to support the research endeavors of the University.

Cores should include in their business plans the necessity of equipment replacement and how this will be accomplished with the resources available to them. Solutions might include future competitive grant opportunities to leverage these costs, increasing external recharge activities and/or identifying foundational or gift-based options when available. Because federal regulations do not allow for depreciation of equipment purchased with federal funds, recharge rates often do not cover the full cost of equipment replacement. The University can provide additional support by establishing a strategic equipment investment fund for core research facilities; this is highly recommended by the Committee to resolve this challenge for Core facilities.

The Office of Research already manages an equipment cost-share matching program with ICR-based campus-managed funds. Currently, the strategic utilization is handled on an ad hoc basis through the ACCD if the request is interdisciplinary/multidisciplinary with presentations by PIs to the committee on their cost-share request. If the request involves any one college, the appropriate Dean and OVCR negotiate on cost share requests (Note: the OVCR has a cost-share committee to assist in these decisions – due to adoption of the new budget model last year, a subcommittee of the ACCD was asked to develop a methodology to replace the old "Shelton" formula for cost share and to provide a de-minimus criteria for when something should be cost shared at the local vs. the central administration level. There is currently no oversight or coordination between such requests. Therefore the committee recommends that cost share requests that involve support of research equipment, facilities and resources, whether for cores or individual faculty, are reviewed by the expert sub-committees who are the most knowledgeable of Core needs and their review is passed to the RCGR for a recommendation to the ACCD. All requests should be reviewed so as to avoid individual faculty requesting equipment that would be better or already available in an existing Core. Instead of using the current ACCD process of allocating costs across colleges on an ad hoc, project-by-project basis based either on faculty #s in each college or based on faculty usage of equipment/cores, establish a pre-paid contribution by all colleges and research units based on a pro-rata share of each unit's ICR returns (that can be adjusted during annual budget cycles dependent on usage and overall need). This will allow for an "evening" of equipment cost related hills and valleys for Deans and departments especially in the realm of large-scale regional or national center proposals that, when successful, have the potential for dramatic impacts on individual budgets.

c. Negotiate pricing structures more effectively for maintenance and equipment upgrades. The business contracts office has already engaged in a number of strategic negotiations with external vendors who provide maintenance services and equipment to the University in multiple areas. UCOP has also engaged with vendors to create Master Agreements and pricing structures for entities with significant UC wide support. The committee recommends that additional efforts like this continue and that we strategically identify and target additional companies for price restructuring. However, the expert committees should be consulted during the negotiation process to ensure that their knowledge is utilized by Strategic Sourcing to achieve appropriate results.

d. Expand Core facility voucher programs. Although, not a substitute for core subsidies, providing a voucher program can minimize new and/or proliferation of redundant equipment purchases as part of faculty start-up packages. According to one official at Duke University in an NIH workshop report on Core Facilities, their voucher program for specialty core services to promote generation of preliminary data and development of high impact projects is more effective than direct subsidization of Core personnel salary support (http://dpcpsi.nih.gov/orip/documents/final_workshop_report_july09%20(1).pdf). There are several successful programs at UC Davis. For example, the Genome Center provides several pilot programs that have successfully generated preliminary data for grant proposals and includes funds for use of core facilities as part of faculty start-up packages. Also, Dean Hildreth has successfully launched this type of program for Imaging Cores in the College of Biological Sciences. This should be further explored as a potential campus-wide solution. When funds are provided as part of start-up funds for use of existing facilities, there must be an alignment of needs and the Core facilities must exist and have the capacity for the additional workload generated.

e. Provide a core facility "loan" program for equipment replacements or upgrades that can be paid back over time through recharge activities as allowed by federal regulations.

f. Promotion of Core Research Resources. The system "Backbone" will not be sufficient by itself to fully promote visibility of UC Davis Research Core Facilities. Experience at other Universities (Harvard's Catalyst, Vanderbilt's COREs, Washington University's CORE Site and UCSF's website) shows that once released, searchable core facility websites are some of the most frequented

research-related websites on a campus when the data and resources are kept up to date and relevant. Thus, OVCR and the Deans should support additional promotional activities such as an annual Core Facility Expo for faculty users, development of cohesive marketing materials, posters, videos, and presentations for substantial cores and/or bundling of core information for specific sponsor needs. This might entail monthly Core Resource highlights on the Office of Research face page, or use of other social media to identify new capacities or technologies as they arise. Travel support for Core professionals and faculty to provide paper and symposium presentations at professional meetings will further highlight Core facility expertise at UC Davis leading to new grant and contract opportunities and potential customers.

g. Provide support and career path development for Research Core Facility and Resource Professionals. The professionals who manage Core Facilities and provide their technical and scientific expertise and experience are critical to the success of a core. Support is not solely relegated to salary lines. Successful research universities realize that if they fail to attract the best talent in support of Core facilities, they risk falling far behind other institutions. The Committee recommends identifying resources to support professional development for Core technicians and administrators. This would include additional education support in best management practices for Cores, education in new emerging technologies and methodologies, career path-development discussions with HR since many individuals are not in tenure-track faculty positions. One problem identified by the committee is that because many of these individuals are in staff positions, salary scales are determined more by job description than level of expertise or experience. More flexibility is required in salary scales to allow for retention of highly experienced individuals. Promotion of attendance at national and international professional conferences and National Core professional groups through travel funds is also a priority. Many of these types of costs cannot be allocated or absorbed into recharge rates. Some universities (e.g. Northwestern University) include professional development and publication/presentation activities of Core personnel in their metrics for evaluating the Core as a whole. The Office of Research might also serve as a conduit for development of a Core Manager professional group at UC Davis with brown-bags, virtual networking, and maintenance of an internal web platform that allows for sharing of challenges and solutions for Core Resource management.

IX. Metrics and Evaluation Criteria for Core Research Resources

Because of the extreme variety of Research Core Facilities and Resources, one evaluation method and a single set of metrics are not appropriate or feasible for every Core. Also, Research Cores often provide more than one service requiring a variability of metrics for different types of service. With this in mind, the committee discussed different parameters and metrics that can be used by the RCGC to evaluate Core proposals for support and/or centralization. In all of our conversations with other Universities and Core Director peers, it is quite apparent that the expectation that all Cores become self-sustaining through their own recharge activities is an unreasonable expectation for some types of Core activities. Nonetheless, universities continue to invest in these core facilities and services because they address fundamental and strategic needs of their faculty. As we can see from the National Core Survey data provided earlier in this report, only a minority of Cores can be largely self-sustaining and the ability of a campus to determine the extent to which Core Service can be self-sustaining, the better it is able to direct resources to the most strategic opportunities for its faculty. For Cores with business plans that do not indicate a self-sustaining budget model, it is important to provide stability for longer terms than just one year at a time, thus the recommendation in this report for a five year review.

Other Cores will need initial funding for establishment of activities but can become self-sustaining over a longer term. Still other Cores might need bridge funding when a key technology changes or when a market re-direction or competition prevents breaking even in the short term.

Different Universities use different models to accommodate these fluctuations in the need for institutional support. For example, Vanderbilt University invested $100 million to consolidate certain Cores into centralized facilities, upgrade technologies and provide a campus-wide system infrastructure for Core Management. They distinguish between “Central” Cores (usually the Cores that are strategically important to the University as a whole and that require institutional subsidies to remain competitive), versus “Local” Cores that are managed within a College or Department. If management is at the College/Dept. level, the institution expects the Core to be self-sustaining or that any subsidies or equipment acquisition cost share must be borne by the College/Dept. or PI. Institutional cost shared equipment must go in to a Central Core for management/maintenance and resource sharing. Any Core Facility can apply to become a Central Core through an application process. Similarly, Central Cores can “graduate” once they become self-sustaining. At another institution, centralized support of a core facility is made available only after receipt of A Strategic Plan, Business Plan and Report on Past

Performance for existing facilities entertained once a year during their annual budget cycle. Centrally supported cores must provide annual reports (template based) addressing performance related to plans submitted. Some committee members recommended that new facilities wanting to be under OVCR would be required to submit a proposal with specific criteria/metrics and justification. Requests for new Cores should provide at least 2 years' worth of information and justification prior to evaluation by the pertinent expert sub- committee and the RCGC. Having a "peer reviewed" system/committee for funding of new facilities as well as for the funding of new instrumentation would be similar to NSF or NIH competing processes. In the case of OVCR, any new or existing facility would be required to show "proof of principle", much like preliminary data in order to be considered for OVCR support. [4]

Many Universities also conduct annual faculty surveys of cores to collect data related to: customer satisfaction, personnel expertise, responsiveness of staff, training opportunities, timeliness, quality and cost of service, accessibility and ease of scheduling and how they became aware that the resources existed. Surveys would also need to address new technological needs and service gaps.

[4] As mentioned earlier, the subject of central vs. decentral cores was a contentious area of consideration and committee did not reach a consensus on where or how to draw the line on central vs. decentral cores. Additional Core Committee comments related to this discussion:

a) This is a problematic discussion on the establishment of local vs central Cores. If we infer that "local cores" will not be eligible for cost-sharing through OVCR as "cost share must be borne by the College/Dept. or PI". This procedure will prohibit purchasing of critical large-scale equipment for limited user bases at local cores as the budget model does not provide sufficient ICR to support expensive equipment purchasing or development (e.g. custom electron microscopes, STM, MRI, …).
b) Counterpoint: The campus must reserve key resources for the equipment that serve the greatest number of faculty. Thus, Cores that serve only a few limited faculty should not receive the same level of central support that a widely used Core should receive.
c) There is an inherent self-inconsistency here. If you want cores to centralize under some criteria, you can't have a high bar for them to cross. I guess the conflict is between the requirement to centralize vs. the desire to centralize. These two forces need to be reconciled. Whatever reorg happens, it is crucial to keep the directors motivated. They bring in the customers and often get equipment for free/cheap by applying for equipment funds from NIH/NSF/etc. Centralization sometimes leads to distance from the stakeholders – need to be careful to keep the ties and engagement.
d) Similarly, local (small) cores need to prove cost-efficiency before they can become "central cores" and, hence, eligible for central support. It is often the small cores with limited user bases but strong scientific productivity that need financial support the most. The policy in the report will therefore hamper (expensive) scientific progress.

Suggested Metrics and Parameters for Core Research Facilities and Resources:

- Strategic importance to key institutional research goals
- Proportion of internal vs. external recharges
- 15% or more federal recharge activity
- Nature of services, expertise or technologies provided (If a new proposed Core, how are faculty getting the services now? What is the anticipated demand and who might be the major users?)
- Government furnished/purchased equipment (no depreciation in rates and thus not available for future equipment replacement or upgrades)
- Lifespan and dynamic nature of technology (frequent transitions, stable/long term?)
- Cost of maintenance vs. replacement of equipment
- Expertise of Core Directors, technicians and personnel
- Market analyses: Are we single-source or is there external or internal competition (Can we get it cheaper elsewhere with the same level of quality and timeliness?)
- # of samples run and projects serviced
- Amount of downtime/idle time of equipment
- Location and the need (or lack of need) for a Core to be in close proximity of its primary users due to nature of the technologies
- Is this cutting-edge new technology or standard technology that forms a foundation for research?

Suggested Key Metrics:

- # of faculty, students, customers served
- Additional activities/services provided that are not “recharged” to customers
- Breadth of clients served (interdisciplinary or specific to a discipline?)
- Availability to campus researchers (capacity)
- Average $ cost per client
- Average $ subsidy per client
- Wait times for services
- Non-$ recoverable service activities value to institution
- Return on investment:
    - # and value of grants and contracts enabled by core facility usage
    - # of individuals served by training and educational programs for faculty and staff
    - Opportunities for innovation – being at the forefront of new technology creation (prototypes, inventions)

- # of publications and citations attributable to Core usage and support

The committee recognizes that to make a survey and annual reporting strategy successful, we must incentivize participation by Core Directors. They must be able to point to the advantages for them of participation in these endeavors even if they do not receive subsidies from Central Administration and/or Deans. Visibility of their resources, advertisement and acknowledgement of their successes and enhancement of ongoing success that might be generated through bundling of Core resources for larger sponsored activities, easier mechanisms for development of recharge rates and ability to engage in external recharge activities as well as better access to core research personnel development might serve as these incentives.

A. Discussion on consolidation or decentralization of Cores:

The committee discussed the concept of consolidating cores and the principles that should govern decisions about when such consolidation might or might not be feasible. Because Research Cores are so diverse, it was difficult to come up with a single set of criteria for when the RCGC might wish to invest in a consolidation approach. The key principles that would always be relevant are:

1) The financial cost of consolidation does not exceed the financial cost over time of maintaining the status quo.
2) Consolidation into one geographical space should be carefully considered related to whether the nature of the Core activity requires proximity to Core customers.
3) Consolidation will serve a greater purpose than keeping the individual core functions separate.
4) Consolidation would allow for better oversight, management, and support of the Core resources with fewer costs.
5) Consolidation would allow for a larger, more strategic approach that no one local core with single college resources could otherwise provide.
6) A major limitation for many local cores is availability of suitable space especially when unique environmental conditions are required (e.g. low vibration, low acoustics, electro-magnetic fields, etc.

The committee identified three types of consolidation and some of the principles surrounding when each might be warranted:

1) Geographical consolidation vs. geographical disbursement of Core facilities. Cores that require proximity to their client base (e.g. Flow cytometry) will require multiple locations to best serve their customers. Cores that have heavy maintenance requirements without needing close proximity would likely benefit greatly from geographical consolidation (e.g. Biorepositories). An added benefit to these types of consolidations was learned during Hurricane Sandy in New York where being able to identify where key freezers holding tissues and cell lines in rapid fashion became extremely important. Consolidation can reduce technician, maintenance and inventory time and effort.

2) Administrative consolidation: Cores with proximity or equipment requirements that do not allow for geographical co-location or sharing of core expertise centrally may still benefit from a shared service approach for administrative support. Creation of recharge rates, budgets, billing and collection activities and reporting could be consolidated in a more streamlined, efficient manner by well-trained administrators.

3) Technical consolidation with geographical diversity. Cores that have multiple sites might still benefit from a "unit" consolidation allowing technicians and faculty expertise to be managed and coordinated by one entity while still allowing proximity to customers.

X. Inventory of Cores

The Committee initially identified 180 different Core Facilities/Resources with recharge rates that appeared to be providing support for research endeavors. After a more careful review, this number was reduced to the 172 Cores considered in this report. A list of these Cores by scientific area and by area of administrative oversight (College, Unit, Central Administration) is provided as Attachment 4. The committee grouped these Research Cores into thematic categories to facilitate the identification of UC Davis' primary strengths and weaknesses as well as areas where greater efficiencies might be possible. Each category was assigned to a Core committee member who was charged to assess the various cores within their thematic purview and to provide recommendations for the cores in those areas. A separate category was identified which the committee called "Comprehensive Centers". These are Centers that are home to more than one type of thematic Core often within one facility. A summary of the numbers of cores by theme and by UC Davis administrative home is provided below:

Count of Cores and Comprehensive Centers by UCD Administrative Home		
Administrative Home	**# Cores**	**# Comp Centers**
College of Agricultural and Environmental Sciences	21	3
College of Biological Sciences	18	2
College of Engineering	8	1
School of Education	3	1
Information and Educational Technology	4	0
College of Letters and Sciences, Division of Social Sciences	12	3
College of Letters and Sciences, Division of Mathematical and Physical Sciences	19	0
Office of Research	30	5
School of Medicine	29	6
School of Veterinary Medicine	28	1
Total	**172**	**22**

Core Facilities by Theme and Subtype	
Theme	**# Cores**
Analytical Technology	**38**
General	26
Mass Spectrometry	8
Metabolomics	1
Proteomics	3
Biological Resources	**31**
Animal Services	13
Biobanking/Repositories	14
Cells & Tissues	4
Comprehensive	**22**
No subtype	22
Data	**15**
Data Repository	3
Informatics	12
Education	**8**
No subtype	8
Fabrication	**13**
No subtype	13
Flow Cytometry	**4**
No subtype	4
DNA sequencing/Genotyping/Gene Expression	**14**
Expression Analysis	5
Sequencing and genotyping	9
Imaging	**20**
Electron microscopy	3
Large scale Imaging	8
Small scale Imaging	9
Miscellaneous & Specialized Budget	**7**
Research Administrative Services	1
No subtype	6
Total	**172**

XI. Analyses of Research Cores by Scientific Theme

The Committee identified the key areas where UC Davis has extensive Cores. Because the nature of Cores is quite disparate and unique depending on the nature of the Facility or Service provided by a Core, the Committee assigned sub-groups and/or individuals to further investigate the current state of Cores within a scientifically themed area (themes identified in the last section. For brevity of this report, the subcommittee assessments are included herein as Attachment 3.

XII. Other Emergent Areas Deferred to other Committee review processes: Animal Husbandry, Big Data and Biorepositories.

When the committee embarked on this review, it became aware that separate review processes were being simultaneously conducted for Computing and Data Analyses and Health related Biorepositories. Therefore, to avoid redundant work and/or divergent confusing views, the committee voted to defer to these initiatives' recommendations. The Biorepository/biobanking report is attached as Attachment 4. A UC System task force is looking into biobanking from a policy perspective but we also need to assess appropriateness of back-up infrastructure needs. For example: Briggs Hall houses CBS and biology biological materials with no backup power. The emergency plan is to roll freezers to LSA with extension cords. Catastrophic planning is necessary in this area. Separate from the Biobanking initiative, the Core Committee recognized that Seed Bank/Genetic Stores: UC Davis is the world leader in Seed Bank/Genetic Stores, AKA germplasm banking – but it is hard to get resources to support these Core services. We have resources that no one else has in the world but need to ensure they are sustainable.

XIII. Conclusion and Action Items: Top 10 Strategies/Priorities for Future Success

a. **Action Item #1: Build the administrative backbone to keep Core facility information up to date, informative, and accessible to researchers and leadership.** We recommend transforming the platform already developed by the Mouse Biology program (billing/invoicing that tie in to KFS) into a campus-wide Core Facilities Management and Reporting System. The system's phase I launch was completed November of 2013. The Committee recommends providing resources for an IT project that adds a recharge creation module on the front end and a web-based ordering/marketing site where users can find up to date information and easy identification and ordering of UC Davis Core Resources in one web location.
b. **Action Item #2: Establish the Research Core Governing Council and Expert Subcommittees for Strategic Oversight of Core Resources.** Implement the

recommended governance structure and hire an administrator within the Office of Research to support this governance structure. Identify where resources are necessary to allow UC Davis to be competitive for large-scale funding opportunities and emerging areas of scientific excellence for the future. Provide informed coordinated decisions on requests for matching equipment funds and equipment replacement funds.

c. **Action Item #3: Consolidate Cores where possible and appropriate.** Eliminate internal recharge rate inconsistencies between similar cores caused by internally heterogeneous subsidies. Identify and prepare consolidation space for cores without proximity barriers. Sunset non-performing Cores. Create shared administrative resources to manage Core resources where physical consolidation is not possible. Provide ongoing recommendations for co-location/collaboration/centralization or decentralization of Cores using principles herein.
d. **Action Item #4: Establish best practices for strategic Core Facilities** including: Establishment of faculty advisory panels for Core Facilities, Annual Reporting processes and Implementation of five-year reviews of Cores (especially if receiving financial subsidies).
e. **Action Item #5: Identify source of funding for long-term Sustainable Resources** for Cores and Investments identified as Key Strategic/Interdisciplinary and Emerging areas that require campus subsidies, new strategic equipment acquisition , equipment upgrading and/or facility co-location resources.
f. **Action Item #6: Increase Core Flexibility and Support:** Modify Policies as allowable by regulatory environments to provide more financial flexibility to Cores especially in their growth years (e.g. modify threshold for adjusting recharge rates from 8% to 16%) and provide a standardized approach to acceptance of external recharge customers contracts and purchase orders using contract templates and/or administrative online ordering systems that allow for credit card payments**. (Credit Card payments are currently accommodated through the CSBS system)**
g. **Action Item #7: Develop and fund a Core facility voucher program** to avoid purchases of redundant resources as part of faculty start-up packages and to promote core facility usage.
h. **Action Item #8: Adopt a once-a-year call for proposals process** from Core Facilities requests for inclusion in campus managed funds support and/or to request inclusion as a “Centralized” Core. The application should include sufficient detail to allow for evaluation of the metrics recommended in this report.

i. **Action Item #9: Develop a Core Facility Professional Development Program.** Given the high level of importance of expertise related to the success of a Core Research Facility or Service, the University must invest in its Core Professionals. Travel support for participation in professional conferences and National Core Facility organizations, technical training on new equipment, develop sustainable career paths for non-tenured faculty and technical staff and provide additional education programs on best practices in Core Management.

j. **Action Item #10: Promote Core Facilities.** This can be accomplished through a variety of mechanisms including support of an Annual Core Expo, provision of marketing materials, a centrally maintained website that allows users to search for Core Resources by keyword, location, types of service, types of equipment or thematic area and that links to the Core Facilities specific URL's, Papers and Symposium participation at professional conferences, sponsor workshops, etc.

ATTACHMENTS

ATTACHMENT 1 – COPY OF COMMITTEE CHARGE LETTER

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

OFFICE OF RESEARCH

1850 RESEARCH PARK DRIVE, SUITE 300
DAVIS, CALIFORNIA 95618

HARRIS A. LEWIN
VICE CHANCELLOR FOR RESEARCH

TELEPHONE: (530) 754-7764
FAX: (530) 754-7873

Date November 10, 2011

ADDRESSEE
Address

RE: Developing Recommendations Concerning Research Cores Administration

Dear Colleagues:

Evaluating and implementing timely recommendations concerning cost- effective best practices for the improved administration of UC Davis research "cores "will be crucially important for our campus to achieve its ambitious goals. I have decided to appoint this committee to provide me and campus leadership at large with perspectives and suggestions that can guide me in revising our current structures and procedures for research cores. The committee's efforts should be directed at conducting a detailed analysis of our current campus situation concerning cores based on proper metrics concerning their scope, value, costs, relevance for research excellence etc. The committee will be expected to provide a realistic analysis of the current cost and financing models (e.g., for buildings, technology, administration, maintenance and compliance issues where appropriate), and also prepare sound recommendations for new criteria being the basis for having certain cores be centrally administered cores versus cores being maintained by our colleges/ schools. I have asked Cindy Kiel, EAVC to chair this committee effort.

The committee's report must include a detailed survey of our research cores campus-wide, providing information about the following questions:

1. What scientific efforts does the core support, and are these efforts intrinsically linked to strategic campus priorities?

2. What is the "physical make-up" of the core? Does it require the campus to maintain specialized buildings, space, technology, imaging equipment or otherwise expensive infrastructure?

3. What is the user base for the core? How many users have taken advantage of the core over the past three years at what level of usage, and representing which colleges/school?

4. Which unit(s) on campus has (have) served as the administrative home for the core?

5. What have the costs been for the core, paid for by either internal UC Davis funds or extramural funds, and what items have been paid for (building, space, renovation, maintenance, technical and administrative staff etc.)

6. If applicable, what types of core costs have been paid for via a re-charge mechanism, and what fraction of overall core costs has been recovered by this mechanism?

Based on this detailed survey and analysis of our research core inventory, the committee's more challenging task will be the development of a set of sound recommendations concerning the future of core administration.

Clearly, recommendations should be based on a reasoning that assigns highest priority to a core's broader scientific relevance, it's being administered by the programmatically most appropriate "home" (department, college/school, central campus), and a financially sustainable model. More specifically, the committee's recommendations should address issues related to these types of questions:

(a) DEFINITIONS. What is a good definition of "core" for UC Davis? What is a good definition of "facility" at UC Davis? How can one properly define the core/facility components of existing major research centers and institutes, and in what ways would it be plausible and administratively be desirable to separate the core/facility component from the rest of the overarching Center/institute that hosts it?
(b) LOCAL VS. CENTRAL CORES. What criteria should be considered when determining whether a core is a local core - i.e., a core that should be administered within a college/school - or a central core - i.e., a core that should be administered centrally? Is the core's user base alone sufficient to answer this question, or should also factors be considered as well?
(c) FINANCIAL MODELS. Based on some overarching principles, and financial considerations concerning a core's user base and overall cost, what financial models should be considered for cores administered at the local (college/school) and the central level?
(d) BUSINESS AND TECHNOLOGY SOLUTIONS. What infrastructures computing and/or technology required are recommended to maintain visibility and viably of research core facilities in the future?

These are just some of the most important an obvious issues to be reflected addressed by this committee. The list of issues and questions raised here should not be viewed as absolutely binding. It is expected that committee members will address other relevant aspects as appropriate.

The committee's report should be submitted to my office by end of summer, 2012.

The task to be performed by the committee is relevant and difficult. I have no doubt that the committee will successfully devise convincing and forward- looking recommendations. These

recommendations will allow our campus to ensure its research excellence, which to a large degree relies on best-possible core administration.

I thank all committee members in advance for their service.

Sincerely,

Harris A. Lewin, Ph.D.
Vice Chancellor for Research

/mlys

Attachment

ATTACHMENT 2 – COPY OF FACULTY AND CORE DIRECTOR SURVEYS

Core Directors Survey

Please provide the following (if you do not have this data readily available, please return without answering specific questions):

A. SHARED RESOURCE (CORE FACILITY) NAME
B. SUMMARY DESCRIPTION (100 words max.) Can include mission, goals, products/services provided, unique aspects, constituents served, etc.)
C. ANNUAL OPERATING BUDGET (2011-12)
    a. Amount from all sources of income (recharge, school/campus subsidy, etc.)
    b. Amount of all expense categories (personnel, supplies, equipment, travel, etc.)
    c. Amount of all expense categories (personnel, supplies, equipment, travel, etc.)
    d. If expenses exceed income, indicate as "deficit" and comment how you reconcile difference
D. TOTAL # OF FTE
    a. # of administrative staff
    b. # of technical staff
    c. # of students
    d. # of other (please define) (Open ended response)
E. TOTAL # OF CLIENTS/CUSTOMERS SERVED OVER LAST 12 MONTHS
    a. Total # of UCD clients/customers
    b. Total # of non-UCD clients/customers
F. TOTAL # OF PRODUCTS/SERVICES PROVIDED OVER LAST 12 MONTHS

What do you see as the greatest successes of your core? (Open ended response)

What are your top 3 or 5 priorities or challenges for ensuring the future success of your core? (Open ended response)

What improvements might UCD make to support the management of your core? (Open ended response)

What resources that you don't have now do you need in the future? (Open ended response)

Any additional comments or input you would like to provide. (Open ended response)

Faculty Survey

What is your overall level of satisfaction with the breadth and depth of shared resources (core facilities) available at UC Davis? (Open ended response)

Please identify up to five Shared Resources at UC Davis that you have used during the last 12 months.

A. Name
B. Satisfaction (High; Above-average; Average; Low; None)
C. Criticalness (Essential for UCD; Helpful, not essential; Could get service elsewhere)
D. Recharge Rate (High but appropriate; Okay; Very good value; Way too high; Too low for service provided)
E. Other (please specify) (Open ended response)

Please identify core services you need or anticipate needing for your research that are currently unavailable at UC Davis. (Open ended response)

What are the major obstacles to your ability to make the most effective use of shared resources available at UC Davis? (Administrative red tape; Campus budget model; Core facilities budget model; Historical frustrations (distant past); Historical frustrations (recent past); Lack of experience; Lack of products/services; Lack of quality control; Lack of responsiveness; Long wait-time; Prohibitive cost)

A. Comments or Other (Open ended response)

Any additional comments or input you would like to provide. (Open ended response)

ATTACHMENT 3 – SUBCOMMITEE REPORTS OF CORE "THEMES" AT UC DAVIS

A. Analytical Technology Laboratories and Core (Prepared by Julie Leary)

Background

There are many laboratories on campus that can come under the umbrella of "Analytical Facilities". (Table 1) One or a combination of departments on campus supports most of these laboratories. Some of the facilities are supported through a campus recharge system, while others have a combination of independent funding, recharge and or industrial support. While some laboratories would welcome financial support from the OVCR, others are quite happy with their current arrangements.

Current Facilities and Status

The current Campus Mass Spectrometry Facilities, CMSF, http://www.cmsf.ucdavis.edu/ , provides mass spectrometry analysis support to the entire Davis campus through 3 separately located laboratories (Hutchison, Briggs and Chemistry). Analysis is provided for small and large biomolecules, proteins, carbohydrates, organic and inorganic synthetic molecules. The facility is partially supported through the OVCR, partially through recharges and partially through grants, contracts and gifts.

ICPMS, the interdisciplinary center for plasma mass spectrometry http://www.icpms.ucdavis.edu, performs "precise and accurate determinations of inorganic trace element and isotope abundances in geological, biological, agricultural, nuclear, environmental and engineering materials". This facility is also partially supported thought the OVCR, recharges and outside contracts and grants.

The Chemistry Glycoscience Core is a small group of Chemistry department faculty with private funding for performing mass spectrometry carbohydrate analysis. There is no web site for this facility and it appears to be supported specifically through a gift from Agilent Corporation.

Other mass spectrometry facilities on campus include the Genome Center Metabolomics and Proteomics Cores. These facilities also provide small molecule and biomolecule as well as protein analysis and are funded through a recharge mechanism as well as through Genome Center funding and a large award from NIH to support the West Coast Metabolomics Center.

There are a number of "Clinical Laboratories" (CNPRC) that fall within the School of Medicine purview. These include Clinical Chemistry, Clinical Endocrinology, Infections Diseases, and CAES. These are all funded through the Medical School.

All facilities on campus defined as providing “Analytical Technology” can be found below in Table 1. Additionally, the COR smartsite resource page has all the specific contact information regarding any of the pertinent facilities.

Table 1

Mass Spectrometry
Campus Mass Spectrometry Facility
GC Proteomics Core Facility
GC Metabolomics Core Facility
Center for Accelerator Mass Spectrometry
Interdisciplinary Center for Plasma Mass Spec (ICPMS)
Stable Isotope Facility
Chemistry Glycoscience Core

General
Electron Microprobe Laboratory
Air Quality Research Center
Amino Acid Analysis Lab
Small Molecular X-ray Crystallography Laboratory
Nuclear Magnetic Resonance Facility
CAES Analytical Lab
Aquatic Toxicology Lab
Clinical Chemistry Laboratories
Clinical Endocrinology Lab
CalEPR Center
Clinical and Molecular Pharmacology Service
Dairy Food Safety Lab
Materials Research laboratory
Milk Quality Lab
Nanomaterials in the Environment, Agriculture, and Technology (NEAT)
Oxidative Stress Diagnostic Lab
Paleomagnetism Laboratory
Pathology Research Labs and Services
Photosynthesis and Redox Systems Energy Center
Veterinary Drug Residue Laboratory
CNPRC Reproductive Endocrine Core Laboratory
CNRPC Respiratory Immunology
CNPRC Stress Endocrine Core Laboratory
CNPRC Clinical Laboratory
CNPRC Infectious Diseases Immunology Core Laboratories
CNPRC Pathogen Detection Laboratory

B. **Flow Cytometry Laboratories and Cores (Prepared by Bridget McLaughlin)**

Overview of demand for flow cytometry at UC Davis

Flow cytometry has been and will continue to be a necessary and powerful cellular analysis tool, affording the separation of desired subpopulations, multi-parameter cell phenotyping and functional analysis on a per cell basis. The applications of flow cytometry to cellular research are numerous, including DNA measurement for cell cycle, probes of metabolic state, cell signaling pathway analysis, multicolor detection of up to 20 intracellular and surface markers and more. Flow cytometry typically relies on converting multiple, separate fluorescent signals to a proportional electronic current as cells flow past multiple illumination sources. Individual cells are constrained by fluidic or acoustic means to ensure intense, precise enumeration of multiple readouts per cell at rates exceeding 25,000 cells per second. **The ever-increasing demand for high-content flow cytometry is driven by the need and desire to measure up to 20 individual cell surface and cytoplasmic readouts per cell with precision at rapid rates.** With flow cytometry, it is possible to analyze millions of cells in minutes, defining phenotypic and functional populations of cells from rare tissues. **It is the ability to determine so much from each cell and measure millions of cells so quickly that is especially attractive to researchers in every college and center at UC Davis.** The demand for separative (cell sorting) and analytic (non-sorting) cytometry has increased steadily over the last 25 years, leading to the development of flow cytometry "nodes" across campus outside of the main shared flow cytometry research cores. **The immediate needs, challenges and opportunities for realignment of flow cytometry resources at UCD are:**

1) **Replace the outdated "MoFlo" cell sorter in the main flow cytometry core on Davis campus.** A high-speed multi-laser cell sorter with appropriate biohazard engineering controls is needed to replace the unreliable, outmoded 15 year old cell sorter that currently exists in this location.
2) **Centralize the management or relocate select cell sorters that are under-utilized**. This report has identified cell sorters that are operated outside of the shared cytometry cores. These cell sorters are under-utilized and are expensive to maintain, it would be cost-effective to relocate these cytometers to core locations that can provide instrument oversight, maintenance and user training. Specifically, BD Aria II cell sorters are easier to operate and can be managed by the core to provide lower cost cell sorting services to complement staff-assisted cell sorting.
3) **Increase staff support in central cytometry core locations: provide partial support for staff salaries to expand the staff at the cytometry cores in Davis and Sacramento.** Customer service is the cornerstone of a successful core laboratory but suffers when staff are overcommitted and under supported. Currently only 2 full-time staff manage and operate 3 locations with 10 cytometers, a tissue cytometer and a quantitive PCR genomic

analyzer. The core needs more staff to properly operate equipment, oversee maintenance, train users, assist with data analysis, manage data for each machine, and develop assays for novel applications, while marketing core services and keeping current on new techniques.

4) **Partially subsidize rates for flow cytometry equipment usage.** Departmental and SOM support for the shared flow cytometry core labs has diminished and now the cytometry cores are 100% self-supporting, a situation that has driven up recharge rates. High instrument hourly rates deter many investigators from using core equipment and encourage the use of cell sorters outside the core that are subsidized by other Programs, Institutes or Centers. These sorters and cytometers are often cheaper or free to use, but caveat emptor, they are also operated by untrained investigators and are poorly maintained. Requests for funds to maintain these instruments outside the core should be evaluated for consistency with core management policies and practices.
5) **Purchase two low-cost, streamlined BioRad S3 cell sorters for self-operated cell sorting.** The S3 is ideal for routine sorting applications, such as for cells that co-express green and red fluorescent proteins, aldefluor^{+} green stem cells, viable single color cell cycle sorting and other high-throughput applications. The S3 is easy to operate and cheaper to maintain, allowing independent use by trained investigators 24/7 at lower cost under the general supervision of core personnel. Most importantly, this type of sorter reduces the cost of sorting for the occasional user or startup investigator and frees staff to operate complex instrumentation for advanced applications. Simply put**, an S3 sorter is a "loss-leader" that brings investigators to the core** and deters use of other low-cost equipment outside the core.
6) **Invest in cutting edge technology.** The Cytof mass cytometer is capable of measuring up to 40 simultaneous markers per cell using metal tags to differentiate each signal. The Dodecagon Fortessa takes advantage of advances in traditional fluorescent tag chemistries with advanced photodetectors to allow the measurement of up to 30 simultaneous markers per cell.

Overview of Flow Cytometry Resources at UC Davis

UC Davis Flow Cytometry Shared Resource Laboratories

The **UC Davis Flow Cytometry Shared Resource** (**UCD FCSR**), known formerly as the "UC Davis Opticore" or "Optical Biology Shared Resource" is **the primary flow cytometry core laboratory at UC Davis,** providing flow cytometry instrumentation, training and education to investigators in Davis and Sacramento. Established 18 years ago in Davis with a single-laser 3-color cytometer, the core has steadily expanded to meet the increased need for cell sorting and cytometry services on

both campuses. Dr. Barbara Shacklett, Professor, Department of Medical Microbiology, is the Scientific Director of the core. Bridget McLaughlin M.S. is the Technical Director of the core, overseeing staff and the day-to-day operations and management of the core. Contact information is provided below:

- **Scientific Director: Barbara Shacklett, Ph.D., Professor, blshacklett@ucdavis.edu**
- **Technical Director: Bridget McLaughlin, M.S., bmclaughlin@ucdavis.edu**
- **Manager: Jonathan Van Dyke, B.S., jonathan.vandyke@ucdmc.ucdavis.edu**

Web links to UCD FCSR resources:

- https://ccresources.ucdmc.ucdavis.edu
- http://www.ucdmc.ucdavis.edu/pathology/research/research_labs/flow_cytometry/index.html

Overview of the management and services provided by the UCD FCSR:

- Administered by the Department of Pathology and Laboratory Medicine, UCDMC.
- Three full service locations on Davis campus and at the UCDMC
- Self-supporting, recharge based shared flow cytometry lab, annual operating budget ~$350,000.
- UC Davis Comprehensive Cancer Center Program Grant provides partial financial support (about 1/5th of annual operating budget).
- Full menu of services, including:
    1. 16 color cell sorting
    2. 20 color cytometric analysis
    3. consultation on experimental design and troubleshooting
    4. assistance with data analysis
    5. education and training in theoretical and practical flow cytometry

Laboratory locations and equipment:

The UC Davis Flow Cytometry Shared Resource serves investigators at three locations offering access to flow cytometry equipment and technical expertise to UC Davis investigators and occasionally to off-campus companies and institutions. Laboratory locations with a specific equipment inventory are detailed below:

Davis Campus:

3425 Tupper Hall, (530) 752 -7205

1. Beckman Coulter MoFlo cell sorter: 3 laser, 11 color

2. BD LSRII analytic flow cytometer: 3 laser, 17 color
3. BD FACScan analytic flow cytometer: 2 laser, 5 color
4. Compucyte Laser Scanning Tissue/Culture analytic cytometer
5. Fluidigm BioMark Real Time PCR for Gene Expression and Genotyping

Sacramento Campus:

Suites 1670/1681 Institute for Regenerative Cures (Stem Cell Building), 2921 Stockton Blvd, Sacramento, (916) 703-9307

1. BD InFlux cell sorter: 5 laser, 16 color
2. BD Fortessa analytic flow cytometer: 5 laser, 20 color
3. Stratedigm S1000EX analytic flow cytometer: 4 laser, 12 color

Research III Satellite Facility, room 3154:

1. BD FACScan analytic flow cytometer: one laser, 3 color

Data analysis tools offered by the UCD FCSR:

The **UCD FCSR provides comprehensive cytometry services**, including operator assisted cell sorting, cell cloning, experiment planning, troubleshooting, data analysis and assistance with manuscript preparation. The core administers an UCD-wide site license for FlowJo (TreeStar, Inc., Ashland OR) analytic software, the leading flow cytometry data analysis and presentation software package. Any investigator can enroll and use the UCD administered FlowJo program, regardless of whether they use core equipment. **With over 100 UCD subscribers**, this program successfully provides cutting edge data analysis tools at reasonable rates. Semi-annual training seminars in FlowJo are provided in person by TreeStar technical staff as part of the subscription agreement with the core.

Education and training:

Proper application of flow cytometry techniques to ensure measurement fidelity requires a basic knowledge of the physics of fluorescence, fluid dynamics, and electronics. **The UCD FCSR is the only campus resource that offers comprehensive training courses in flow cytometry theory best practices to help investigators generate good quality, well-controlled data.** A week-long summer course in Flow Cytometry is offered in conjunction with the UC Davis Biotechnology Program. Taught by core personnel and vendor partners, this course enrolls over 30 students annually, mixing lectures on flow cytometry theory, best practices and new techniques with afternoon laboratory sessions designed to illustrate specific cytometry assays and instrument operation. The Biotechnology Program course focuses on core equipment and personnel, with additional instrumentation and instruction during the laboratory sessions provided by selected cytometry vendor partners. Beyond the summer course, a condensed single-day lecture-only course is offered in the winter to meet the needs and time constraints of UCD clinicians, PI's and post-doctoral researchers.

Other Flow Cytometry Resources at UC Davis

California National Primate Research Center "Flow Cytometry Core Laboratory"
http://www.cnprc.ucdavis.edu/research/arc.aspx

Manager: Abagail Spinner, aspinner@ucdavis.edu, 530 752-5123

This is a multi-service flow cytometry core laboratory, **generally restricted to use by members of the CNPRC and CCM,** since the location is somewhat isolated and security restrictions prohibit casual use of this facility. The CNPRC core is located 2 miles from the UCD FCSR laboratory in Tupper Hall. The CNPRC flow cytometry core recaptures some operating costs under a recharge-for-use structure. Use of the CNPRC flow cytometry core is generally limited to investigators within the CNPRC or CCM, **although some PI's from other Programs, Centers or Schools use the cytometry equipment located within this core, likely because it is subsidized by CNPRC and CCM program grants and costs less to use than the main UCD FCSR recharge-supported core.** Despite the inconvenience of the CNPRC core's location, the recent arrival of a 20-color analyzer at the CCM has drawn some investigators to use the CCM's cytometer, reducing the user base of the UCD FCSR.

Equipment includes one cell sorter and two analytic cytometers:

1. BD FACScalibur analytic flow cytometer, 2 lasers, primarily for clinical assays
2. BD Fortessa analytic flow cytometer, 4 or 5 lasers, for multi-parameter, high resolution flow cytometry, typically research cell staining panels
3. BD FACS Aria cell sorter, 3 laser, in a BSL2 + environment/separate lab room.

Department of Pathology and Laboratory Medicine Clinical Flow Cytometry and Immunology Service Laboratory, UCDMC

Managed by the Department of Pathology and Laboratory Medicine. **Clinical flow cytometry testing lab**, operating 7 days per week, 9-5.

http://www.ucdmc.ucdavis.edu/pathology/services/clinical/hematopathology/flowcytometry_immunology.html

This is a **clinical service lab** that offers clinical assays on two multiparameter analytic flow cytometers. **No cell sorting equipment or services are available from this core**. This lab operates on departmental or insurance billing for recharging diagnostic patient sample testing for clinicians.

Equipment offered:

1. Beckman Coulter FC500 analytic flow cytometer: 2 laser
2. Beckman Coulter Gallios analytic flow cytometer: 3 or 4 laser (?), allows more advanced leukemia diagnostic staining panels that incorporate 6+ stains

---

"Becton Dickinson Cytometry Laboratory and Training Facility"

Manager: Michael Paddy, Ph.D., Project Scientist, Department of Molecular and Cellular Biology, 1241 C Life Sciences, Davis, CA 95616, 530 754 6584, cell 530 848 8282.

Website: http://microscopy.mcb.ucdavis.edu/Imaging_Facility_iWeb/Imaging_Facility_Home.html

This is not an operating flow cytometry core. This is an imaging and microscopy core that inherited an underutilized analytic flow cytometer (Becton Dickinson, FACScalibur, 2 laser, 4 color) that was donated 13 years ago from the manufacturer to MCB. For a time, the FACScalibur was operated as a "Flow Cytometry Laboratory and Training Facility" and the cytometer was available to a select group of trained users "free of charge." At the time, this cytometer offered direct competition with the recharge supported UCD FCSR. However, since the FACSCalibur was not under a maintenance contract, it eventually fell into disrepair and usage declined. Michael Paddy's imaging core inherited it and for a time perhaps maintained it, but now his website clearly states that the **"cytometer is no longer available for recharge use and that users who need flow cytometry services should contact UC Davis Flow Cytometry Shared Resource."** This cytometer is still in operation in the Life Sciences Building, but likely only for investigators in the Department of Molecular and Cellular Biology. While it makes geographical sense to provide access to a 4 color cytometer in a central, satellite location on Davis campus, **the ongoing maintenance of this equipment would likely be more practical under the management of the UCD FCSR**, who can provide training, web-based scheduling, cost-effective maintenance contract negotiation and access to trained staff.

Centralization and Consolidation of Flow Cytometry Resources at UC Davis

Recommendations for Centralized Management of Geographically Separate Flow Cytometry Cores (Bridget McLaughlin, Technical Director, UCD FCSR)

UC Davis should adopt a nodal approach to the establishment and centralized maintenance of shared flow cytometry cores to provide local access to flow cytometry equipment and trained staff in Davis and Sacramento. The concept of "consolidation of equipment resources" does not suit

flow cytometry because of the need to protect sample vitality and integrity prior to immediate analysis. In contrast to technologies that utilize isolated proteins or nucleic acids, flow cytometers process live, intact cells, often obtained from precious human, animal and plant samples. Vital cells must be treated gently to ensure success and post-sort viability when sorting cells for downstream applications such as tissue culture, expansion and transfer to live animals. In non-sorting applications involving analysis of fixed cells, the probes used to detect cellular structures are labile; their degradation adding unwanted artifacts and ambiguity to post-acquisition data interpretation. For these reasons it is necessary to maintain separate cell sorting and analysis facilities in Davis and at the UCDMC in Sacramento. To meet the needs of investigators on both campuses, several cell sorting "nodes" have evolved over the past two decades to provide cell sorting and analytic flow cytometry services. **The evolution of the flow cytometry nodes described below indicates the growing need for campus-wide flow cytometry services and identifies opportunities for management centralization to standardize services and effectively control operational costs of dispersed cytometry laboratory locations.**

1. The UCD FCSR received the first cell sorter on campus, a multiparameter Cytomation "MoFlo" at UCD from the NIH Shared Instrumentation Grant Program in 1998. In 2000, the MoFlo was upgraded in collaboration with Dr. Nicole Baumgarth to become the **nation's first** 3-laser, 10-color cell sorter. During 15 years of reliable operation, the MoFlo's flexible optical and electronic design kept abreast of cytometry trends and was used by hundreds of investigators at UCD. **Today, the MoFlo is in immediate need of replacement to continue, reliable, safe and cutting edge cell sorting at the UCD FCSR lab in Davis.**
2. A second sorter was acquired in 2003 by the CNPRC (BD Aria II) and is operated under the direction of CCM and CNPRC faculty as an internal sorting resource for investigators in those centers; this sorter is still in operation today and serves about 20 investigators and their collaborators.
3. A third cell sorter, **BD inFlux**, was purchased by the **Stem Cell Program** and was placed into the **UCD FCSR as a shared resource for UCDMC investigators**. The arrival of the BD inFlux provided the seed for expansion of the UCD FCSR on the UCDMC campus; this facility now houses 2 additional analytic cytometers and managed by a single full UCD FCSR time staff member. The BD inFlux is a 5 laser, 16 color, 5 nozzle research cell sorter that provides flexible, aseptic cell sorting to multiple groups at the UCDMC.
4. A fourth cell sorter was purchased in 2009 as part of the Stem Cell Program's Good Manufacturing Practices stem cell laboratory in the Institute for Regenerative Cures in Sacramento. This sorter is housed in the GMP facility within the IRC. By intention, this sorter is reserved for human transplantation cell sorting, although protocols for transplantation applications with this Aria II are not federally approved. The sorter is housed in a removable biosafety cabinet. This sorter has never been utilized and has been

parked in shut down for 4 years. All currently available cell sorters expose samples to room air contaminants requiring rigorous testing and validation to receive FDA approval for clinical use in transplantation trials. Manufacturers like Miltenyi are developing novel cell sorters that use disposable components to ensure sterility and eliminate sample carryover. These designs will be cheaper and will likely supersede the use of this Aria II as a clinical cell sorter. This sorter could eventually be relocated and used as a shared instrument within the cytometry core at the IRC.

5. In 2010, a fourth sorter (BD Aria II) was purchased by Shriners Hospital of Northern California, presumably to meet the cell sorting needs of Shriners researchers and UC Davis faculty with dual appointments at Shriners. This Aria II competes directly with the UCD cytometry core.
6. At the same time a fifth sorter (BD Aria II) was "donated" by the manufacturer to the Center for Biophotonics, Science and Technology. This sorter was originally intended to be used in a specific collaboration analyzing microparticles and gold nanoparticles, but is now utilized as a cell analysis resource within the CBST. This Aria II competes directly with the UCD cytometry core.

All five of these sorters require trained staff to operate. **Two of these sorters, in Shriners and CBST, compete directly with the UCD FCSR core in that they provide cell sorting services at little or no charge and thus erode the revenue base of the core.** The Aria II sorter at **Shriners** is operated and maintained by Shriners staff, but **select UCD investigators who have high need for cell sorting services take advantage of the no-cost cell sorting through strategic collaborative arrangements**. The Aria II **sorter at the CBST** is not maintained by full time staff or operated under a maintenance contract with the manufacturer, **a situation that leads to shortened instrument longevity and worse, poor experimental results**. This sorter is located only a few hundred yards from the UCD FCSR inFlux cell sorting core located in the Institute for Regenerative Cures. **If this underutilized and under-supervised Aria II cell sorter could be relocated to the UCD FCSR core nearby at the IRC, it would be maintained by recharge revenue with highly trained staff to ensure proper and widespread use of this valuable resource.** Further, the Aria II sorter housed in the CBST could be self-operated by a select group of UCD investigators who now independently use the Aria II in Shriners, at a less costly "self-operated" rate, **encouraging use of core resources rather than those at Shriners**.

Beyond separative flow cytometry, there is a great demand for multi-color analytic cytometry at UC Davis. Several 3-5 laser cytometers are available in Davis and Sacramento. Investigators want the analytic flow cytometer as close as possible and are inconvenienced by having to drive long distances to access cytometry facilities. **This is why analytic non-sorting cytometers are now present in individual labs and Centers, the core simply isn't in close enough proximity to be**

convenient and new, lower cost analyzers are within the budget of individual investigators. Investigators now can purchase small analytic cytometers for <$50,000, these benchtop cytometers are cropping up in individual labs on campus, especially CIRM funded labs. It is tough to compete with these small, inexpensive systems and often impossible to discourage their purchase, even though these low cost analyzers often don't offer the advanced measurement capabilities of the core instrumentation and are an unanticipated maintenance burden to individual labs and departments. One way to provide more convenience and protect the recharge base for the flow cytometry core is to address the competition from privately owned cytometers by providing lower cost cell sorting services in the core. The availability of low cost, self-serve cell sorter will attract more users to the core. Investigators at both locations would benefit from the availability of a small, uncomplicated cell sorter for routine sorting that would be offered for unassisted use at low cost, covering routine sorting needs cheaply (these sorters cost ~$150,000). When users become familiar with the technical expertise and training offered by core personnel, they often prefer core services. **Education and outreach are important intangible benefits provided by the core that individual investigators often overlook when seeking to purchase a cytometer for their personal use.**

A current inventory of flow cytometers at UC Davis:

Name of Resource	Location	Cell Sorter	Analytic Cytometer
UC Davis Flow Cytometry Shared Resource	Davis	MoFlo 4 laser	FACScan 2 laser LSRII 3 laser Laser Scanning Cytometer 3 laser Fluidigm Biomark qPCR
California National Primate Research Center (CNPRC)	Davis	Aria II 3 laser	FACScalibur 2 laser
Center for Comparative Medicine (CCM)	Davis		Fortessa 5 laser
Genome and Biomedical Sciences Facility (GBSF)	Davis		FACScan single laser (Simon)
Veterinary Medicine	Davis		FACScan single laser (Moore) FC 500 2 laser (VM 3A)
Chemistry	Davis		Attune 2 laser
California Institute for Regenerative Medicine (CIRM)	Davis		Guava 2 laser (Isseroff)
Molecular and Cellular Biology	Davis		FACScalibur 2 laser Canto II 3 laser

UC Davis Flow Cytometry Shared Resource	Sacramento	inFlux 5 laser	Fortessa 5 laser Stratedigm 4 laser FACScan 1 laser
Stem Cell Program	Sacramento		FC 500 2 laser (Nolta)
GMP clinical testing lab	Sacramento		FACScalibur 2 laser
GMP manufacturing lab	Sacramento	Aria II 2 laser (Bauer)	
CBST	Sacramento	Aria II 2 laser (Liu)	
MIND Institute	Sacramento		LSRII 3 laser
Shriners Hospital of Northern California	Sacramento	Aria II 3 laser (Pleasure)	Cyan 3 laser
Pathology Clinical Testing Lab	Sacramento		FC 500 2 laser Gallios 3 laser

Future critical needs for Flow Cytometry at UC Davis:

1) **The primary shared resource cell sorter on Davis campus is 15 years old, outdated, unreliable and in immediate need of replacement. The campus should support the purchase of a 4 laser Astrios cell sorter ($598,000) with advanced biohazard and aseptic controls for high speed multiparameter cell sorting. Many applications require the use of multiple lasers simultaneously or large nozzles under low pressure; the Astrios offers the flexibility to provide state-of-the-art cell sorting capability to meet the needs of a wide range of applications. This sorter is housed in a Class II biosafety cabinet, has state of the art electronics and can process up to 100,000 cells per second and sort in 6 directions, each with individual sort logic and decisions. No other sorter offers these features.**
2) Investigators in Davis and at the UCDMC would benefit from the availability of a simple, 4 color cell sorter with fixed, stable architecture for simple, routine self-operated cell sorting at significantly lower rates than the staff operated cell sorters. Within the past 2 years, a stable, reliable 4 color, 6 parameter fixed-alignment cell sorter has been developed and is available at a cost of $150,000, a breakthrough in cost effective cell sorter design for simple applications. This sorter is designed to be easy to operate and since the maintenance contract is ~10% of the purchase price, it is less expensive to maintain over time, cost savings that are passed on to investigators as a lower recharge rate. The availability of a fixed-architecture sorter at each of the core lab locations in Davis and Sacramento would keep cell sorting within the budget of the average investigator who requires precise, efficient and gentle cell sorting for routine applications.

3) Invest in cutting edge cytometry equipment. One new interesting technology that will be needed in the near future to keep UC Davis current and at the cutting edge of single cell analysis is the CyTOF mass cytometer. This system affords the precise identification of 30-50 individual cell surface and intracytoplasmic markers per cell with virtually no crosstalk between each readout. Unlike fluorescence based readouts, the CyTOF separates signals based on the atomic mass of distinct transitional metals, affording precise correlation of each metal's mass with the labeled antigen and providing quantification of the amount of signal per cell, i.e. more mass = more robust cellular antigen expression. For precious samples, the ability to power-phenotype without the ambiguity introduced by competing fluorescence emissions is a revolutionary development that is sweeping the flow cytometry community. While mass cytometers will not replace traditional fluorescence based cytometers and cannot sort live cells (the mass cytometer incinerates the cells and their associated metal tags at 7000 degrees kelvin, forming ion clouds), it is a critical technology to offer to current and new faculty who will urgently want to take advantage of this powerful advance in cellular analysis. The only CyTOF cytometer available for shared use in Northern California is located within the Stanford University Shared FACS Facility. The UC Davis Flow Cytometry Shared Resource core lab maintains close collaborative ties with Stanford's FACS Facility, ensuring that UC Davis researchers will be able to use Stanford's CyTOF system at inter-campus rates.

C. **Biological Resources Laboratories and Cores (Prepared by Kent Lloyd)**

Biological Shared Resources: Biological Shared Resources consist of 3 subcategories of resources providing technologies, equipment, services, and expert consultation on the application, preservation, and storage* of live animals, tissues, and cells for research. (*does *NOT* include vivaria or husbandry, welfare, and veterinary care services typical of a vivarium)

Category 1: Biobanking and Repository Resources. This subcategory includes a range of Biological Shared Resources that provides physical storage and maintenance of biological specimens for research and, in some cases, technologies, services, and consultation to facilitate the processing, preservation, archiving, maintenance, and dissemination of biological specimens.

Name of Resource	Brief description	Comments
Mouse Biology Program (MBP)	Mutant mouse research core labs	Also Cat 2, 3, Education
Anthropology Museum	Prehistoric human specimens	Also Education
PGF Botanical Conservatory	Greenhouse plants	Also Education
Foundation Plant Services	premium foundation-level virus & disease-tested plant materials for California nurseries	
Foundation Seed Program	Maintain and distribute certified seed cultivars	
Herbarium/Center for Plant Diversity	Plant museum	
Specimen Repository Service	procurement, preparation, and preservation of malignant, benign, and normal human specimens	
Natural Reserve System	Reserve of state's natural ecosystems	Core??

Category 2: Whole Organism Use Resources. This subcategory includes a range of Biological Shared Resources that provide specific and unique technologies, services, facilities, and expertise that facilitate the derivation, manipulation, and use of live plants and animals for research.

Name of Resource	Brief description	Comments
Mouse Biology Program (MBP)	Mouse research	Also Cat 1, 3, Education
CNPRC Inhalation Exposure Core	Exposure to toxins/chemicals	Also Cat 3
CNPRC Behavior & Training service Core	Trains nh-primates	
CNPRC Behavioral/Biobehavioral	Assess primate behavior	

Core		
PGF Controlled Environment Facility	Controlled plant growth chambers	
PGF Research Greenhouses	greenhouses for plant research	
PGF Plant Bio Greenhouse (Sci Lab Bldg)	greenhouses for plant research	
Contained Research Facility	laboratory, greenhouse, and growth chamber space for invasive plants	
Plant Transformation Facility	plant transformation, plant cell biology services	Also Cat 3
Russell Ranch Sustainable Agriculture Facility	impacts of farming systems and inputs on agricultural sustainability	
Bodega Marine Laboratory	Study environmental problems in coastal ecosystems	Also Education
Equine Athletic Performance Lab	Assess equine sports performance	
Experimental Animal Surgical Suite	VetMed: Animal surgery	
Large animal survival surgery Core	SOM: Animal surgery	
VMTRC	Dairy resources	

Category 3: Cells and Tissues Resources. This subcategory includes a range of Biological Shared Resources that provide specific and unique technologies, services, facilities, and expertise that facilitate the culture, processing, and analysis of plant and animal cells and tissues for research.

Name of Resource	Brief description	Comments
Mouse Biology Program (MBP)	Mouse research	Also Cat 2, 3, Education
CNPRC Inhalation Exposure Core	Exposure to toxins/chemicals	Also Cat 2
Mutant Mouse Pathology Lab (MMPL)	Anatomic pathology lab services	
Biosafety Level 3 Lab	CCM BSL3 cell culture lab	
Institute for Regenerative Cures	Multiple stem cell core labs	
Translational Human Embryonic Stem Cell Shared Research Facility [core?]	Human stem cell labs	
Veterinary Public Health Lab	Animal pathogen testing lab	
J. D. Wheat Veterinary Orthopedic Research Lab	Equine bone and cartilage research	
Comparative Pathology Lab (CPL)	Clinical pathology lab services	
Plant Transformation Facility	plant transformation, plant cell biology services	Also Cat 2
Feline Nutrition and Pet Care Center	Additional information provided in	

	Miscellaneous Core Facilities section of this report	

Did not include:

Name of Resource	Brief description	Comments
Drosophila Kitchen	Drosophila	None
Animal Facilities-ANS Dept	Vivaria facilities	Not list here
Young Hall Vivarium	Vivaria facilities	Not list here
Animal Facilities-ANS Dept	Vivaria facilities	Not list here

D. **UC-Davis Imaging Cores (Prepared by Jawdat Al-Bassam)**

This category includes core facilities that utilize imaging strategies and approaches across vast resolution scales from near atomic to a large scale imaging of organisms and objects. These facilities are staffed and equipped to determine organization, structure, and shape of living and non-living materials by using light, electron, and nuclear imaging and microscopy.

Three sub-categories are based on overall imaging approaches. Categories are divided based on scale and type of imaging approaches utilizes:

- **Electron microscopy facilities**: Expertise and facilities to generate images at atomic and molecular scales of molecules, cell, and materials using electron microscopes:
- Molecular Cell Biology Electron Microscopy Imaging Facility (CBS, MCB)
- Electron Microscopy Core Imaging Facility (SOM, Pathology)
- Material Sciences Electron Microscopy Facility (COE, CE&MS)

Small-scale imaging facilities: Expertise and facilities to image cellular, ultra-cellular, tissue organization using light microscopes. Included are facilities that generate images of objects and materials at moderate ultra-structural scales.

- MCB Light Microscopy Imaging Facility (CBS, MCB)
- Cellular and Molecular Imaging Core (SOVM, Center for Health and the Environment)

- **Computational imaging core (CVM, California National Primate Research Center)-cross listed**
- Image Processing Laboratory (COE, Chemical Engineering and Materials Science)
- Keck Imaging Center (CBS, Center for Neuroscience)
- Microscopy and Computer Imaging Laboratory (CVM, Anatomy, Physiology and Cell Biology)
- Keck Spectral Imaging Facility (COA, NEAT)
- Center for Biophotonics (SOM, CBST)
- Center for Visual Sciences (SOM, Ophthalmology)

- **Large-Scale imaging facilities:** Expertise and facilities to image organization of tissues, whole organisms using nuclear magnetic and ultra-sonic approaches. Includes are facilities that image objects and materials at large scales.

- McClellan Nuclear Research Center (MPS, Physics)
- Imaging Research Center (SOM)
- **Computational Imaging Core (CVM, California National Primate Research Center)-cross listed**
- Transcranial Magnetic Stimulation (DSS, Center for Mind and Brain): correct
- Keck Center for Active Visualization in Earth Sciences (KeckCave: MPS, Geology): correct
- Center for Molecular and Genomic Imaging (COE, Biomedical Engineering): correct

- Center for Imaging Sciences (SOM, Cancer Center)
- **Urinary Stone analysis laboratory (CVM)-moved from small scale**
- Ophthalmic Diagnostic Laboratory (SOM, Eye Center)

Recommendations for UC-Davis Imaging Cores:

Introduction:

Imaging methodology is critical for analytical and diagnostic strategies in modern sciences, engineering and medicine. Imaging approaches are critical to keep various parts of the UC-Davis campus on the cutting edge of many areas of research and professional training. Thus, investment and improvement of facilities in these areas are necessary and must be considered a priority for UC-Davis OVCR.

Imaging-focused Core facilities that utilize imaging strategies and approaches across vast resolution scales from near atomic to a large-scale imaging of organisms and objects. These facilities are staffed and equipped to determine organization, structure, and shape of living and non-living materials by using light, electron, and nuclear imaging and microscopy.

General recommendation:

Imaging methodologies are advancing at a rapid pace. Although faculty recruitment has continued to add faculty with excellent expertise in the latest imaging advances, the equipment necessary to carry out imaging and the cost will always be an area of improvement.

Across the University of California, campuses have invested extensively in rebuilding and advance imaging facility infrastructure. As an example, in my field of expertise, UC-San Francisco, UC-Berkeley and UC-Los Angeles have become leaders in molecular imaging with electron microscopy due to a series of investments coupled with faculty and personnel hires to enhance access of the faculty to these facilities.

The general recommendation for imaging technologies will be that UC-Davis OVCR must continue to invest heavily in maintaining and updating imaging facilities with cutting edge equipment. This is a critical recruitment tool for faculty to work and students to train at UC-Davis. Below are specific recommendations for the UC-Davis imaging facilities cores:

1) A relevant and expert faculty advisory group must determine the next strategic steps that each of these facilities must undertake. These expert faculty groups should be invested in these facilities as a part of their research funding programs, or through attracting additional faculty

interest to drive new research programs towards imaging approaches. Each imaging facility faculty advisory committee should make recommendations to OVCR and colleges to repair and upgrade imaging equipment. An example is described below.

2) Centralization of core facilities is not the best course of action. Many facilities for imaging are best located in the same physical space as the user base and must remain small. Large scale imagining systems are required for new technologies where UC-Davis OVCR must develop a relationship with neighboring UC-campuses. Similar large scale efforts were developed between UC-Berkeley and UC-San Francisco that have become successful ventures for shared imaging facilities. Examples include shared UC-Beamlines at Advanced light source and QB3 facilities.
3) Each facility should invest in expert staff identified by faculty advisory board that has the sole responsibility of training and helping students and research staff with these cutting edge technologies. These expert staff members are critical and necessary for effective scientific operation of UC-Davis facilities. OVCR should identify these expert staff and help UC-Davis to retain them. Two mechanisms can support these expert staff: Income generated from the facilities themselves that can support staff salary, or the staff must be supported by additional support from OVCR or individual colleges.
4) UC-Davis colleges and OVCR should backstop and facilitate imaging facilities to support service, maintenance as well as recruitment activities. OVCR should develop request system for each of the colleges to determine which facilities are most essential to support. Peer-Review processes should be developed at the college and OVCR levels to help identify facilities that are in need of support.
5) UC-Davis OVCR must promote and identify faculty who can apply for equipment and national facility funding programs to improve core facilities. Colleges should stimulate new research faculty interest programs, an example is the CBS voucher program, provided by Dean James Hildreth, to promote MCB-electron microscopy facility usage by research programs.

Imaging Core Facilities at UC-Davis

The following recommendations for each of the facilities cores are based on current information available online and/or personal committee members' knowledge about each of these facility cores.

Three categories of imaging core facilities, based on scale:

A) Electron microscopy facilities: Expertise and Facilities to generate images at atomic and molecular scales of molecules, cell, and materials using electron microscopes:

Molecular Cell Biology Electron Microscopy Imaging Facility (CBS, MCB)

This is a newly renovated facility that is focused on three-dimensional molecular and cellular electron microscopy imaging methods. The facility is supported by recharge based on

research activities that supports the service and maintenance of equipment. A faculty advisory committee with research programs that require electron microscopy supports the needs of the facility and provides direction for the staff and the facility. One expert staff member supports the training and data collection activities carried out at the Electron Microscopy Facility that the faculty advisory committee recruited specifically for the role. CBS provides support voucher programs to help activate new faculty research programs.

https://www.mcb.ucdavis.edu/cryoem/

Diagnostic and Research Electron Microscopy Facility (SOM, Pathology)
A recharge facility supports clinical and basic science electron microscopy needs at the UC-Davis Health System, with a focus on tissue and cell sectioning based electron microscopy methods that are suited for the clinical applications. The facility is fully recharge supported and includes three-staff members whose services are charged on an hourly rate. No clear advisory committee is described for this facility

http://www.ucdmc.ucdavis.edu/pathology/research/research_labs/electron_microscopy/

Materials Science Electron Microscopy Facility (COE, CE&MS)

This facility supports the needs of material sciences, and engineering needs for electron microscopy. The research methods and sample preparation methods, training and imaging approaches are very different from those of biological electron microscopy facilities described above. This facility includes some staff support and advisory structure but the details are not clear. This facility is funded by recharge rates. Electron microscopy equipment upgrades maybe required based on discussion with engineering faculty.

http://chms.engineering.ucdavis.edu/icem/

B) Small-scale Imaging Facilities: Expertise and facilities to image cellular, ultra-cellular, tissue organization using light microscopes. Included are facilities that generate images of objects and materials at moderate ultra-structural scales.

MCB Light Microscopy Imaging Facility (CBS, MCB)

The MCB Light Microscopy Imaging Facility houses cutting edge light microscopes. Includes excellent staff support. The facility is supported by recharge rates on hourly basis for both equipment and staff time. The facility is led by faculty committee, who has helped to write equipment grants to facilitate new equipment purchases. This is has resulted in improving usage and increasing the capabilities of the facility.

http://microscopy.mcb.ucdavis.edu/Imaging_Facility_iWeb/Imaging_Facility_Home.html

Cellular and Molecular Imaging Core (CVM, Center for Health and environment)
This facility supports histology light microscopy needs for the UC-Davis Health System. The facility handles samples based on recharge basis for both staff and equipment usage time. The facility includes on staff person and is supported by a one faculty person.

http://cellimagingcore.ucdavis.edu/

Computational Imaging Core (CVM, California National Primate Research Center)-cross listed
This is a full service facility that supports cellular, organismal imaging, and digital image analysis for the California National Primate Research Center (CNPRC). The facility is supported on a recharge basis as a part of the CNPRC research activities. No advisory structure or staff support is described.

http://cic.primate.ucdavis.edu/cichome.html

Image Processing Laboratory (COE, Chemical Engineering and Materials Science)
No information found online

Keck Imaging Center (CBS, Center for Neuroscience)

This facility supports light microscopes with similar capabilities to those at the MCB-light microscopy facility with a focus on neuroscience-based application and research programs at the Center for Neuroscience. The center is recharge based and is supported by two faculty members.

http://kic.ucdavis.edu/index.html

Microscopy and Computer Imaging Lab (CVM)

This is a recharge based light microscopy, printing service, and film developing facility supporting the Anatomy, Physiology and Cell Biology Department at UC-Davis. IT includes both light microscopy and poster printing capabilities. There is a single staff person supporting this facility and no clear advising structure.

http://www.vetmed.ucdavis.edu/apc/services/index.cfm

Keck Spectral Imaging Facility (COA, NEAT)

This is a material imaging facility supporting the Nano-materials in the Environment, Agriculture and Technology (NEAT). The facility is a on a recharge basis and supports light microscopes as well as atomic imaging equipment such as an electron microscope or laser Raman microscopes. One faculty member advises this facility.

http://neat.ucdavis.edu/pages/affiliate/ccoafm_main.htm

Center for Biophotonics (SOM, CBST)

This is a full service research center and facility at the UC-Davis health system that includes a range of microscopes. The center is housed at UC-Davis and has partnerships with many other institutions. The center is led by faculty committee from the departments of Neurosurgery, Pathology, and Biochemistry and Molecular Medicine. It houses full research staff and faculty research programs. The center is funded by recharge and through grant support from NSF. The Biophotonics Center faculty and staff carry out extensive teaching and training including undergraduate summer programs.

http://cbst.ucdavis.edu/

Center for Visual Sciences (SOM, Ophthalmology)

This is an ophthalmology supporting core service center for the UC-Davis Health System. The center is a part of a National Eye Institute grant focused on imaging ocular and retinal conditions or defects associated with image formation. There is a faculty advisory committee but no clear description of equipment or expert staff.

http://cvs.ucdavis.edu/research/

C) Large-Scale Imaging Facilities: Expertise and facilities to image organization of tissues, whole organisms using nuclear magnetic and ultra-sonic approaches. Includes are facilities that image objects and materials at large scales.

McClellan Nuclear Research Center (MPS, Physics)

This is a nuclear physics study and imaging center supporting the Physics Department. The focus of this center is imaging sub-atomic particles in geological and soil samples to determine elemental content. The center is recharge based but the rates are not described. The center advisory faculty or support staff structures are not described.

http://mnrc.ucdavis.edu/

Imaging Research Center (SOM)

This is a full service recharge-based medical imaging center that supports hospitals and research activities at the UC-Davis Health System. The center includes patient magnetic resonance Imaging (MRI) systems for patient diagnostics. The center includes a full system of trained expert staff support, as well as medical faculty members of the Radiology and Psychiatry Departments at the SOM. The faculty advisory structure is not described.

http://ucdirc.ucdavis.edu/index.php

Computational Imaging Core (CVM, California National Primate Research Center)-cross listed

See above

Transcranial Magnetic Stimulation (DSS, Center for Mind and Brain): This is a center supporting activities for Center for Mind and Brain focused on visual and auditory stimulation using a combination of computational approaches and MRI methodology. Neither recharge basis nor advisory structure is clearly described.

http://mindbrain.ucdavis.edu/people/jeremy/facilities/transcranial-magnetic-stimulation-tms/

Keck Center for Active Visualization in Earth Sciences (KeckCave: MPS, Geology)

This is an educational visualization laboratory focused on geological earth studies and training using virtual reality tools. The center is equipped with extensive virtual reality and computing systems. The Keck Foundation and NSF funding provide support for the KeckCave.

Center for Molecular and Genomic Imaging (COE, Biomedical Engineering):

This is a full service recharge-based biomedical engineering imaging center focused on imaging whole animals using ultrasound, CT and MRI approaches. A faculty advisory committee supports the center. The center includes trained imaging staff who train and assistant with research activities at the center.

http://imaging.bme.ucdavis.edu/overview-2/about-us/

Center for Imaging Sciences (SOM, Cancer Center)

This is a part of the imaging research center described above

Urinary Stone Analysis Laboratory (CVM)

This laboratory provides clinical and chemical analysis of urinary stones produced by animals to determine composition and helps to devise treatments. The laboratory is supported by recharge support from CVM activities.

http://www.vetmed.ucdavis.edu/usal/

Ophthalmic Diagnostic Laboratory (SOM, Eye Center)

This is a laboratory for the eye center (SOM) to test patients at the UC-Davis Health System through large-scale imaging, histology and clinical analyses on tissue samples. This unit is supported through recharge activities at the Eye Center.

http://www.ucdmc.ucdavis.edu/eyecenter/specialities/pathology.html

E. **DNA Sequencing, Genotyping and Expression Analysis Laboratories and Cores (Prepared by Richard Michelmore)**

Background

There have been several cores providing DNA sequencing, genotyping, and expression analysis services to diverse clientele across campus since the early 1990's. For the most part, they have coordinated their efforts and have served the campus well. There has been little duplication of effort.

These cores have had to transition from being providers of expensive, specialized technologies to purveyors of increasingly inexpensive and widely available services. DNA sequencing is becoming a commodity that has an expanding number of uses. A variety of platforms are available for cheap genotyping, including sequencing, although flexibility is sometimes challenging. Microarrays are being replaced by RNAseq for expression analysis. These technologies have and will in the future change rapidly. The life span of sequencing and genotyping technologies is currently approximately two to three years. Further major disruptive advances are anticipated in the near future. A major challenge for all cores is to stay technically current.

Generating sequence, genotype, or expression data is no longer a constraint. Preparation of material for analysis and the utilization of the unprecedented amounts of data being generated are now the rate limiting steps.

Current Status at UC Davis

The current sequencing and genotyping cores include two Sanger-based facilities, one in CBS (http://dnaseq.ucdavis.edu/) and the other in CA&ES (https://cgf.ucdavis.edu/). These have been complementary as the former provides low throughput sequencing for clone confirmation, while the latter provides medium scale sequencing for larger numbers of clones. Both are experiencing greatly reduced business due to the changes in technology. Sanger sequencing is also provided by commercial entities such as Davis Sequencing (http://www.davissequencing.com/) and Quintara Bio (http://www.quintarabio.com/) in the Bay Area that offer lower prices. However, some faculty continue to use the CBS facility due to quality of service and convenience. The CBS facility plans to continue for the foreseeable future. The CA&ES facility plans to close at the end of 2013.

The DNA Technologies and Expression Analysis Cores (http://dnatech.genomecenter.ucdavis.edu http://genomecenter.ucdavis.edu/expression_analysis) provide state-of-the art next-gen sequencing and genotyping services, based on Illumina (Hiseq2500 and Miseq) short-read and

PacBio long-read sequencing technologies. They also provide Illumina array-based genotyping and expression analysis. In addition, they increasingly emphasize semi-automated high throughput library preparation. They also provide training courses for sample preparation and data analysis.

The Genomics Shared Resource (GSR) in SOM provides both genotyping (Affymetrix & Agilent chips) and sequencing (Illumina GAII) services from a wide range of clinical samples (http://www.ucdmc.ucdavis.edu/CANCER/research/sharedresources/ger.html). The GSR is the Cancer Center's genomics core and an integral part of their NCI Cancer Center Support Grant, from which it receives direct funding. They have recently acquired an Illumina Miseq to become a provider of CLIA-certified clinical genomics services as well as plan to be one of the major nodes for the UC-wide Clinical Genomics Super Shared Resources.

The Veterinary Genetics Laboratory (VGL; http://www.vgl.ucdavis.edu/) offers STR and SNP genotyping services (ABI3730, Mass Array, Pyrosequencing) to a specific, animal-centric clientele that is Forensics' accredited. Much of this clientele is off-campus.

The Lucy Whittier Molecular Core Facility in Veterinary Medicine offers genotyping and expression analysis services based on quantitative PCR and TaqMan chemistry (http://www.ucdmc.ucdavis.edu/medmicro/taqman.html). Expression analysis is also available from the Microarray Facility in the MMI Department of SOM (Affymetrix arrays and qPCR; http://www.ucdmc.ucdavis.edu/medmicro/microarray.html).

The BGI@UC Davis was established to handle large scale genomics projects and circumvent the need for major investment by UCD in more Illumina sequencing machines that may have a limited life span. This facility is currently in the ramp-up phase and the details of the relationship are still being worked out. The recent purchase of Complete Genomics by BGI introduces additional uncertainty as to how this relationship will develop. However, it has great potential for generating and analyzing vast amounts of data. The BGI@UC Davis has recently moved into permanent space with three Illumina Hiseq 2500s and five Hiseq 2000s. They do not currently provide CLIA sequencing.

Future projections

- Sequencing machines will become cheaper, easier to operate, and increasingly efficient. DNA sequencing will become a routine commodity available from a variety of bench top machines as well as from larger machines capable of producing vast amounts of data.
- Genotyping will increasingly done by sequencing either of whole genomes, or reduced components of the genome, such as the exome, panels of specific genes, or random reduced representations rather than by utilizing specific SNP assays. However, for some applications, specific SNP assays will remain the favored approach because of the larger number of samples that can be analyzed and the much simpler downstream data analysis.

- RNA-seq is becoming the standard method for expression analysis and microarrays are obsolete.
- Experienced, high volume users and departments will purchase and operate their own benchtop machines for routine DNA sequencing and genotyping.
- DNA sequencing will be used as a digital read-out for evaluating experiments rather than for just generating actual DNA sequence.
- DNA sequencing and genotyping will become an integral component of many types of studies.
- Medical studies and the health system will require a genetic component. For the latter, sequencing will need to be CLIA compliant.
- DNA sequencing and genotyping by a variety of academic, government, and private entities will generate unprecedented amounts of DNA. This will generate major opportunities and challenges to acquire, curate, protect, analyze, and distribute.

Overview of needs

Sample preparation.

As the cost of sequencing has declined and the throughput of the sequencing machines has increased, the generation of sequence data *per se* is becoming no longer to be the bottleneck. Preparation of libraries to sequence has become rate limiting. Inexpensive, automated workflows for DNA and RNA extraction and routine preparation of large numbers of libraries are required as well as the ability to prepare specialist libraries such as large fragment and native DNA libraries for epigenetic analysis.

Large scale projects.

It is now possible to sequence huge numbers of individuals (GWAS), progeny (GBS), samples (RNAseq), etc. Large projects require the use of substantial amounts of equipment and infrastructure. It is beyond the scope, remit, and resources of a campus core facility to conduct large studies. Such projects should be out-sourced. Core facilities need to be scaled to handle medium and small scale projects.

Medium and small scale projects for occasional users and neophytes.

Many labs that will need DNA sequencing will not have the experience or resources to generate and analyze the sequence they need. Such capabilities should be provided by service cores. The cores can also provide components of large projects that are outsourced.

CLIA sequencing

Medicine interventions are increasingly going to be informed by genetic information. Therefore the SOM will require rapid, reliable CLIA-grade sequencing, either locally within the system or outsourced.

Clone confirmation by Sanger sequencing

Sanger sequencing currently remains the best way to verify the sequence of individual molecular constructs. Therefore, campus researchers need either local or commercial access to this with short turnaround times.

Genotyping by sequencing.

It is becoming increasingly cost effective to genotype individuals by either whole genome, exome, or reduced representation sequencing.

DNA sequence as a read-out especially for expression analysis

DNA sequencing will increasingly be used as a digital readout for experiments, especially RNAseq. The experimental space and potential number of samples is vast.

Data analysis and integration

The above will generate unprecedented amounts of data that will need to be acquired, curated, analyzed, integrated with other heterogeneous datasets, and distributed. The core and campus need the infrastructure to address this.

Options and Recommendations Going Forward

Large-scale projects should be outsourced to BGI/Complete Genomics, Illumina, or another provider. Cores should have the capacity to assist or manage all scales of projects depending on the expertise of the researcher.

High-volume users and departments will purchase and deploy their own (semi-) automated library preparation workflows and bench top sequencers for routine DNA sequencing. However, when appropriate, the possibility for coordination with the GC core should be explored to ensure that resources are not wasted on poorly operated machines and inadequate ability to handle the data. An option is for high volume users to sponsor a machine in the GC; they gain priority for sequencing, thus guaranteeing immediate access to a functional, well-maintained machine and adequate data analysis infrastructure.

Sequencing and genotyping should remain consolidated in a single core in the Genome Center to support medium-scale and occasional users based on current technology (e.g. Illumina 2500 and multiple Miseqs) as well as state-of-the-art and specialized sequencing technologies (e.g. PacBio and Nanopore). This core should also provide routine (semi-) automated library preparation as well as specialized library preparation (e.g. from single cells or for epigenetic analysis). It should provide standard and specialized bioinformatics support for data analysis. It should continue to provide training in library preparation and data analysis.

A parallel facility for routine sequencing and genotyping should continue to be supported and developed further within SOM on the Sacramento campus. Specialized DNA sequencing technologies (e.g. PacBio) should be provided to SOM faculty by the Genome Center.

SOM should also develop or have access to efficient CLIA sequencing either on-site in Sacramento or close by to ensure fast turn-around time of sequence data to allow health delivery decisions in a timely manner. This should be scaled to be able to address the needs of the Health System.

The VGL should continue to operate as a self-supporting specialized unit that addresses their animal clientele; however, it should be coordinated with other entities to ensure that it utilizes the latest technologies.

It is not clear how the need for Sanger sequencing should be addressed: continued operation of the CBS facility, consolidation with the GC core, or outsourced to commercial providers. This will likely be resolved over the next couple of years in response to demand.

The campus should develop and support the infrastructure to handle the vast amounts of data that will be generated by both occasional and high-volume users. This will require the handling of data from the service cores, the individual high volume researchers/departments, and outside data generators.

Facility	Services	Platforms	Sample prep	Data analysis	# staff	Recharge revenue	Portion covered	# groups	% campus
CBS Sequencing	Sanger sequencing	2 ABI 3730	Yes Biomek	Limited	3	$332,500	~85%	??	90%
	Fragment analysis	1 ABI 3130							
CGF CA&ES	Sanger sequencing	1 ABI3730	Yes	Limited	1				
	Fragment analysis								
Genome Center	Illumina sequencing	1 Hiseq 2500	Yes Intergenx	Extensive	6	$1,604,289	90%	124	75%
	Illumina SNP analysis	3 Miseq	Calipher						Other UC 15
	Long read sequencing	1 Pacbio RS	Fluidigm						
		1 iScan	Blue pippin						
		(2 GAII)							
GSR SOM	Illumina sequencing	2 GAII	Yes	Some	7?	$389,000	71%	20 - 25	95%
		Affy Genechip							
VGL	Sanger sequencing	2 ABI 3730	Yes	Yes	35	$150,000	4%	13 campus	4%
	STR & SNP genotyping	1 Mass array							
		1 Pyrosequencer							
Microarray MMI	Expression analysis	Affy Genechip	No	No	1				
BGI@UC Davis	Illumina sequencing	3 - 20 Hiseq	No	In future?	2+				

Not covered in this report because not utilizing DNA/RNA based analyses:

Center for Biomarker Discovery in Dept. Pathology, SOM (Luminex-based).

Equine Infectious Disease Lab.

Marine Ecosystem Health Diagnostic and Surveillance Lab.

F. **Fabrication Laboratories and Cores (Prepared by Martha Krebs)**

This group of facilities can be divided into two categories: 1) traditional "shops" which provide instructional, design and fabrication services for machining, electronics, and glass-making; and 2) specialized facilities that may or may not belong in this category or even be considered as a core facility. This will be discussed below.

Traditional Shops. The facilities in this category are in the School of Engineering, the College of Biological Science and the Departments of Physics and Chemistry.

Engineering Fabrication Laboratory	College of Engineering
Biological and Agricultural Engineering Shop	College of Engineering
MCB Electronics Shop	College of Biological Sciences
Physics Electronics Shop	Department of Physics
Physics IT Shop	Department of Physics
Physics Machine Shop	Department of Physics
Chemistry Machine Shop	Department of Chemistry
Chemistry Electronics Shop	Department of Chemistry
Glass Shop	Department of Chemistry
Crocker Machine Shop	OVCR
Note: many fabrication shops (BME, theater, etc.) were not identified as CORES in the recharge lists used to begin the Committee's inventory. This emphasizes the need for a Backbone system that can accurately account for these types of facilities and provide visibility and marketing for the Cores	

With the exception of the Engineering Fabrication Laboratory and the Physics Machine Shop, these facilities provide support on a recharge basis to research carried out in the related Schools and Departments, to other Davis researchers and to outside entities. The Physics Machine Shop dedicates 1200sf of its 3500sf to student machines and projects. The remainder of activity is funded on a recharge basis. The Engineering Fabrication Laboratory is primarily instructional space for undergraduate and graduate students to learn the use of state-of-the-art machine tools, including computer numerical control capability. There is some open lab time and there is a 3-D printer in the lab managed by undergraduates. There is no formal recharge for non-instructional use of the lab. The principle challenge in these facilities is to maintain functionality of existing machines and replacement of out-of-date equipment. The Glass Shop in Chemistry is used broadly on the campus. The three technicians in the MCB Electronics Shop provide electronics, electrical, instrumentation, moving and light construction services. It is also important to comment on the availability of the specialized knowledge of the technical staff in these facilities especially for design activities with both faculty and students.

Specialized Fabrication Facilities. These facilities provide highly specialized capabilities. They are listed in the table and will be described below.

Good Management Practices (GMP) Laboratory	School of Medicine, Sacramento Campus
Food Science and Technology Pilot Plant	College of Agricultural and Environmental Science
Northern California Nanotechnology Center	College of Engineering
Intelligent Manufacturing Systems & Mechatronics Laboratory*	College of Engineering

*College of Engineering staff notes that this facility is Professor Yamazaki's personal laboratory. It has not been available to external users, has no recharge rate, and so may not qualify as a Core Facility.

Good Practices Management Laboratory. Established at the UC Davis Medical School by the California Institute for Regenerative Medicine, this Laboratory was established to support research scientists throughout California. It provides a multi-use, clean room facility, with high flexibility and versatility, for the production of clinical grade therapeutics consistent with FDA requirements. It offers switchable manufacturing room pressurization, providing a strictly controlled environment for cellular manufacturing, as well as the ideal setting for producing gene therapy vectors. Additionally, it features the first clinical grade fluorescent activated cell sorter in a true biosafety cabinet, and the first GMP-grade Hot Cell chamber for the manufacture of novel, clinical grade positron emission tomography reagents. This facility focuses on stem cell related processes and products, has a recharge mechanism.

Food Science and Technology Pilot Plant. This facility supports the teaching, research and extension missions of the Department of Food Science and Technology. It contains production scale equipment for the full range of food processing from peeling, drying, cooking, preservation, all to the FDA requirements for Good Management Practices. Much of this equipment has been provided by industrial donors. The facility has established recharge rates for sponsor-supported faculty research and provides the facility on a fee-for-use basis to assist companies and individuals with production and testing of product formulations provided by the client. The facility is also used for continuing education and training education that provides additional support for the facility. This outside support is critical to maintain the technical staff for the facility.

Northern California Nanotechnology Center. This is a class 100 clean room facility with equipment for the deposition of materials, lithography, etching, and inspection for micro- and nanosystem research and characterization. The Center provides classes for UC Davis faculty and students as well external users. The facility was established in 2004 and has required acquisition of updated instrumentation. Developing relationships with corporate partners is crucial to acquiring new instrumentation at the current standard. Maintaining the specialized environment and instrumentation of the Center also requires significant operating costs as well as trained staff. The

College of Engineering has been seeking to expand external use of the facility in order to underwrite these costs.

*Intelligent Manufacturing Systems & Mechatronics Laboratory***.** The Intelligent Manufacturing Systems (IMS) laboratories of Professor Kazuo Yamazaki of the Department of Mechanical and Aerospace Engineering consists of two major research laboratories, one devoted to conventional machining and the other to non-conventional machining and nano-machining operations. These are strictly research laboratories and are not available as recharge units or campus core facilities. Both of these are machine tool research laboratories and are equipped with state of the art equipment valued at more than $4 million. They are by far the best-equipped research laboratories in the area of machine tools among any universities in the US. The IMS Laboratory supports research in Mechatronics, Microprocess Control of Machines, CNC Machine Tool Design and Control, 3-D Coordinate Measurement and Probing, CAD/CAM, Sculptured Surface Machining, Plastic Injection Molding, Powder Sintering, and Network Based Manufacturing. The laboratory provides research and instructional services for Professor Yamazaki and his research partners including the firm Mori Seiki. The laboratory facilities include several multi-axis, CNC machine tools, provided by Mori Seiki. The relationship with Mori Seiki is important for COE.

G. **Educational Outreach and Evaluation Cores (Prepared by Cindy Kiel)**

The initial Research Core Resources identified through the recharge rate inventory review produced an initial list of potential cores in the Education, Outreach and Evaluation category. Many of the recharge related programs are specific to particular research grants or funding programs and did not fully meet the definition of a Core facility in support of the Research Mission for UC Davis. This is an area where services may exist free of recharge rates and thus, it is a prime example of why a better identification mechanism for these resources is necessary.

Many sponsoring agencies require the inclusion of an evaluation plan for research projects. Other times, researchers may benefit from evaluation of their proposed activities even when not required by a sponsoring agency. Outreach services can help faculty reach out to K-12 constituents and other educational venues to enhance broader impacts of their research programs. Below are the resources that have been identified by the Office of Research that can aid in these endeavors. It is not a comprehensive list due to not yet having a Core facility system that routinely captures these types of resources in a routine or systematic manner.

The Distance Learning Program is a UC Davis College of Engineering Masters and Doctoral Degree program currently available only to Lawrence Livermore National Laboratory and Sandia National Laboratories employees. Jan Neff is the Program Coordinator in the College of Engineering.

The International Agriculture Programs Core in the College of Agriculture http://ip.ucdavis.edu/ facilitates the exchange of information and learning between UC Davis and the global community in the areas of agriculture and the environment. Specifically, on a recharge basis, it can assist in development of materials (posters, videos, PowerPoint, etc.) for international audiences in the agriculture arena.

The Shared Human Electrophysiology Lab (Teaching Lab) housed in the Center for Mind and Brain http://mindbrain.ucdavis.edu/facilities offers teaching lab and conference space with recharge rates.

Center for Cooperative Research and Extension Services for Schools (CRESS)
http://education.ucdavis.edu/overview/center-education-and-evaluation-services CRESS has established recharge rates for some of their activities. According to the College of Education website, the CRESS Center "pursues collaborative research, based on the understanding that critical knowledge is generated at the nexus of theory and practice. We provide evaluation services to university faculty as well as regional education and community-based agencies conducting research or providing programs with an education connection. We also provide small incentive grants for faculty to collaborate with school practitioners on research of mutual interest, and publish findings from our action research projects." Within CRESS is the Center for Education and Evaluation

Services (CEES) which is a full-service program evaluation center. Their web information states that "We approach our work with all clients as a partnership, working collaboratively to identify the best methods for evaluating program processes, outcomes and impact. Our services range from consultation and advising to complete program evaluations, including study design, data analysis, and report preparation. CEES addresses education-related issues in a variety of fields. Our projects include impact evaluations for large state-wide education initiatives for the Department of Education, external evaluations for university-based projects funded by federal agencies, and impact studies for non-profits. We have evaluated many teacher professional development projects, after school initiatives, and interdisciplinary collaborations."

Center for Community School Partnerships Services: The Center for Community School Partnerships Services (CCSPS) in the College of Education does not appear to have recharge rates established through UC Davis, but, according to their website, provides the following services: http://education.ucdavis.edu/ccsp-services "CCSP has over twelve years of experience in providing consultation and technical assistance for local, regional, and statewide groups. Our training workshops and materials are based on extensive field research and examination of the working practices in communities throughout California. CCSP provides direct technical assistance and training in the areas common to the community-school model; academic enrichment, collaborative leadership and governance, youth development, school-based health care, parent leadership development, field-research, and program evaluation. Consulting and technical assistance services can take any or all of several different forms: on-site or over the phone consultation, on-going communication through e-mail or written documentation, or small work-group. Technical assistance typically results in an action plan for your community-school collaborative and may be augmented with appropriate tools, presentations, and other working-documents."

Clinical and Translational Science Center (CTSC) Evaluation Program
http://www.ucdmc.ucdavis.edu/ctsc/area/evaluation/ The CTSC Evaluation Program in the School of Medicine "leads the comprehensive effort to evaluate the overall impact of the Clinical and Translational Science Center and its program areas. The evaluation team also provides ongoing consultation and oversight for all CTSC Training Programs, including the CTSC T32, MCRTP, K12 and CTSC-affiliated programs, such as BIRWCH and HHMI. In addition, the Evaluation Program provides evaluation services for several programs in the Schools of Health, including the Betty Irene Moore School of Nursing, School of Medicine PRIME Programs for medical students, and the Western Center for Agricultural Health and Safety. The Program's areas of expertise include:

- Program evaluation design using qualitative and quantitative methods
- Process evaluation for program improvement using focus groups, interviews and surveys
- Outcomes analysis for program objectives and success
- Logic models for program planning and grant development

- Social network analysis and data visualizations

Center for Program Evaluation and Research http://tobaccoeval.ucdavis.edu/ The Center for Program Evaluation and Research at UC Davis offers consulting and training in evaluation of social service and disease prevention programs. It also serves as the state-wide evaluation technical assistance provider for California's tobacco control programs, where it is known as the Tobacco Control Evaluation Center (TCEC). TCEC provides individual technical assistance, training, and evaluation-related resources while striving to build the evaluation capacity of local programs. The evaluation specialists and consultants at The Center for Program Evaluation and Research are highly trained and experienced evaluators who strive to contribute to the building of strong and healthy communities through evaluation and research.

UC Davis Extension Center for Human Services http://humanservices.ucdavis.edu/Academy/InThisSection/Consultation.aspx?unit=ACADEMY#eval The Northern California Training Academy's research team located within the UC Davis Extension offers the northern region expertise and experience in research, grants and evaluation. The team possesses extensive experience working with nonprofit, community-based, policy/advocacy, governmental, nongovernmental and private sector stakeholders conducting innovative research and evaluation projects. They provide a coordinated approach for data collection and use to foster data-driven decision making for programs and services that strive to support children and families. Their team works to customize a research or evaluation design that ensures counties obtain and understand the data, analysis and implications to make informed decisions and engage in continuous improvement. The provide services in project design, strategies and technical aspects of data collection, interpretation of findings and implementation of findings into practice.

The research funding landscape is becoming more and more demanding of researchers on outcomes and evaluation of the impact of funded research. The Data Act, the Executive Order for Public Access, StarMetrics and the new RPPR initiatives of the federal funding agencies are only a small list of the national initiatives attempting to collect data, measure outcomes and impacts of science and scholarly activities. Thus, the need for faculty to have access to expertise in project design that builds evaluation of qualitative and quantitative outcomes will become more important in the future. Currently, there are pockets of expertise in colleges and centers but there are no comprehensive central-based core resources allocated to this type of research support. Investment in this area might prove a critical path for the University in the future.

H. **Miscellaneous Laboratories and Cores (Prepared by Bridget McLaughlin)**

Vet Med Central Service and Vet Med Biological Media Services

Central Services:

This is a recharge based self-supporting School of Veterinary Medicine laboratory reagent and supply shop operated out of Haring Hall, Davis main campus. They offer laboratory supplies, office supplies, and surgical supplies to investigators in all Centers, Schools, and Departments in Davis and at the UCDMC in Sacramento. They offer daily delivery of all the supplies they sell. This is a campus wide supply resource.

Information from the School of Veterinary Medicine Strategic Plan:

Central Services

The Central Services unit is a self-supporting activity, which provides a centralized receiving and dispensing service and maintains a readily available inventory of supplies in support of the instruction, research, and administrative programs of the School and other campus users. The unit emphasizes high quality customer service, a diverse product line, an effective cost-to-price structure to benefit the end user, a daily free delivery service, and advice on product quality/usage for specific research purposes.

The VM Biological Media Services

http://www.vmbms.ucdavis.edu/index.lasso

VM Biological Media Services offers a whole host of services to the campus. They are affiliated with Vet Med Central Services and are located directly upstairs in Haring Hall. This recharge based self-supporting unit media supply shop offers:

1. **S**ource for routine media needs and supplies.
2. **C**ustom media made to your specifications.
3. **F**ree on campus delivery
4. **S**upply center for Gibco/Invitrogen enzymes and tissue culture media.

Information from the School of Veterinary Medicine Strategic Plan:

Biological Media Service

The Biological Media Service is a centralized service to provide efficient and economical provision of biological media and clean sterile supplies in support of the teaching and research activities of the School, the campus, other major universities and colleges, and practicing veterinarians on a national and international level. The service also provides assistance to end users on the proper handling and disposal of media products to comply with government regulations. The service is a self-supporting unit.

More information on VM Biological Media Service's website:

> VMBMS is an international provider of a wide range of culture media with over 2000 formulations available. We have served the UCD School of Veterinary Medicine since 1951, providing researchers, classrooms and diagnostic laboratories with media, supplies and glassware services.
>
> While VMBMS has grown to a state of the art laboratory, we remain committed to our original mission to serve and assist our University customers and colleagues. We are available for custom media preparation and will work with you to achieve media made to your specifications. We continuously seek to improve our line of products and strive to provide our customers with the best tools in diagnostic procedures.
>
> VMBMS offers the reliability that you have come to expect from us throughout the years as well as the ability to provide you with the newest formulations that research has to offer. We have enjoyed our many years of service to the School of Veterinary Medicine as well as to the campus at large and remain dedicated to the principle of excellence in media production and development.

Institute for Governmental Affairs: Society, Economics, Politics and Public Policy

http://www.iga.ucdavis.edu/Research

This program offers programs in Public Policy and Journalism, and seems to chiefly facilitate internships between UC Davis graduate students and appropriate government and other institutions involved in legislation, lobbying and other political activities.

Please contact Associate Director A.G. Block at (916) 445-7300 or email him at agblock@ucdavis.edu.

More information from their website:

> The Institute of Governmental Affairs (IGA) supports social science research, graduate student training, public affairs programming, and outreach activities at UC Davis. IGA

houses a number of formal research programs and enjoys the participation of faculty from a number of departments across the campus. IGA also serves as a campus home for scholars visiting from around the world.

Are you a legislative office, government agency, department or commission, or an association, nonprofit or business involved in public policy or politics? And would you be able to provide valuable experience for would-be interns? We'd love to have your support and give UC Center scholar interns a chance to experience what you have to offer!

Western Center for Agricultural Health and Safety

College of Agriculture and Environmental Science, #187 on our Excel sheet

http://agcenter.ucdavis.edu/AgDoc/about.php

Director: Mark Schenker

This does not seem to be a "core" resource per se, rather a collaborative network of researchers/resources to study farm worker health and safety.

The Western Center for Agricultural Health and Safety was established in 1990 through a cooperative agreement with the National Institute for Occupational Safety & Health (NIOSH). The center is one of nine agricultural health and safety centers established in the United States by the Centers for Disease Control for the purpose of protecting and improving the health and safety of the nation's farmers, farmworkers, and consumers. California is the leading agricultural state in the country, consuming and exporting a range and multitude of products. Together with the other Western states, California is also home to a number of types of farm, from family businesses to corporate megadairies, all of which employ family members, farmworkers and laborers from many countries and cultures.

Director Dr. Marc Schenker heads up an interdisciplinary team of investigators who collaborate on scientific studies of the challenging aspects of agriculture affecting health and safety. Current areas of research and outreach include:

• Musculoskeletal Injury and Ergonomics • Neurotoxicity and Pesticides • Respiratory Diseases • Industrial Hygiene and Exposure Assessment • Socioeconomic Impacts on Health Behaviors • Environmental Risk Assessment • Evaluation and Biostatistics • Costs and Financial Effects of Adverse Health Outcomes

The Center has benefited from its affiliation with the UC Davis Medical School and the Department

of Public Health Sciences. Drawing on the resources of the University, the Center fosters the communication of ideas through a quarterly newsletter, monthly seminars and periodic conferences and presentations.

The Western Center for Agricultural Health and Safety is a comprehensive, multidisciplinary program dedicated to the understanding and prevention of illness and injury in Western agriculture. The Center is located at the University of California, Davis, with collocated Schools of Medicine and Veterinary Medicine, and a land grant College of Agriculture and Environmental Sciences. It benefits from collaborations with the Division of Agriculture and Natural Resources, various state agencies stakeholders and NGOs. The state capitol in Sacramento, 12 miles from Davis, is home to the state Departments of Health Services, Food and Agriculture, and Environmental Protection. This large, diverse, multidisciplinary expertise provides a wealth of resources and experience to the Center, and access to populations and contacts in the field.

Institute for Regenerative Cures/Stem Cell Program Cores

In general, the Stem Cell Program cores do not seem to be self-supporting, but recoup some operating and staff costs through recharge services offered on a collaborative basis. The following cores range from a large facility, e.g. the GMP facility, to staff expertise services (Karyotyping, Teratoma core, Vector core, iPSC core) to individual pieces of equipment that are available for recharge use to other investigators upon appointment. To my knowledge, no web-based calendar is in use to track, facilitate or monitor the usage of these resources.

- GMP facility: provide cell culture and small molecule development under GMP conditions
  - Cell sorting equipment:
  - BD FACS AriaII cell sorter: 2 laser, 6 color, restricted use, only for GMP grade cell sorting for human transplantation studies and trials. 3 years old, never has been operated/idle ….awaiting appropriate trials to move forward with actual regular use. Status: pending, not truly available for recharge use except in the future for clinical trials….
- Karyotyping core: Catherine Nacey, provides service for recharge
- Immune deficient mouse/Teratoma core, Jeannine McGee, manager, Stem Cell Program: Recharge based services: test derived cells, iPSC etc. in immune deficient mice over 2-3 months for teratoma formation.
- Vector core: lentiviral/retroviral: Karen Pepper, manager, mostly internal to Stem cell group?
- Induced Pluiropotent Stem Cell Core: provides staff expertise and cell culture and characterization services for new collaborators.
- Translational Human Embryonic Stem Cell Research Facility: essentially, the stem cell program 1A

- Microscopy core: Keyence BZ-II 9000 fluorescent microscope, recharge $21.00/hr, contact Kari Pollock
- Videomicroscopy core: BioStation IM time lapse imaging microscope for long term sterile video monitoring
- Animal Optical Imaging (Simon cherry, Steve Rendig, Doug Rowland, CMGI???)
- PET lab: Julie Sutcliffe, PI
- Immune monitoring core: Richard Pollard, David Asmuth, Xiao-Dong Li (not really a functioning, recharge driven core)
- Imaging core, Director: David Pleasure, M.D., manager, Athena Soulika

Located in Shriners Hospital, microscopy and FACS (their cell sorter, a BD FACS Aria II, is used by UC Davis investigators at no charge provided they collaborate with Shriners researchers. The availability of "free of charge" sorting has had a strong, negative impact on the usage of the inFlux cell sorter operated by the UCD Shared Flow Cytometry Resource.

Feline Nutrition and Pet Care Center

Supervisor: Debbie Bee, dlbee@ucdavis.edu

This is a recharge-based unit within the School of Veterinary Medicine providing "specific pathogen free" (SPF) cats and kittens for research studies, provided that appropriate animal care IACUC protocols are in place.

Information from the School of Veterinary Medicine's Plan:

Feline Nutrition and Pet Care Center

The Feline Nutrition and Pet Care Center was developed around a specific pathogen-free cat colony, which supports studies on nutrition, physiology, genetic and medical research, and as animal models for humans. The Center offers graduate students, residents, and post-DVM students training in clinical nutrition. Future research studies will specifically focus manganese deficiency and requirements, obesity and energetics and adaptation of cats to various dietary concentrations of protein.

Other info from an investigator who has used this resource:

"You can request blood samples from SPF cats and kittens to run assays but you must have an approved IACUC protocol for such requests. You could double check regarding this issue with Debbie Bee (dlbee@ucdavis.edu) who supervises and handles the cats in this colony for sure. Blood draws will result in a fee for service charge but this is a great resource. If you are looking for animals for an experimental study, they sell their SPF cats as well- we usually bought all of our research cats from this colony for all of our FIV vaccine studies. The costs of these cats were slightly lower than other commercial SPF vendors such Liberty Labs (or were, not sure of the

comparison now), and typically the Nutrition colony kittens were much better socialized and easier to work with, compared to Liberty cats that tended to be more on the "feral" side of behavior and difficult to work with. Debbie Bee can also provide you with information regarding animal costs (the older the SPF cat, the more expensive)."

I. Considerations for Existing Central Core Facilities

This purpose of this section is to provide a small example of strategic resource needs that begin to inform leadership of how small or large the financial investment should be in order to keep UC Davis research supported for the future. This section is not designed to be a comprehensive list of potential strategic investments for Core Facilities nor does this section suggest that these requests have been evaluated by or are recommended by the Core Committee. Please refer to the subcommittee reports within this attachment for additional investment suggestions included in particular scientific themed areas. Although subcommittee leaders for this report were informally asked to identify scientifically themed areas for investment, (and some of the subcommittee reports herein include this information for that scientifically themed area), there was no formal request to develop a campus-wide list. The committee recommends that a comprehensive survey or needs or a proposal process be conducted across campus after again updating the Core inventory in order to more fully ascertain the full investment amount most conducive to campus needs. Again, the committee does not recommend or endorse the Central Core investments identified below for necessity or redundancy. Rather, this is provided solely as an indication of the pent-up need for investment in Cores on our campus and to allow campus leadership an idea of what level of investment might be necessary to continue to have competitive and sustainable Cores for the future. All of these identified resource needs should be further evaluated by the RCGC and campus leadership.

CORE FACILITES REPORT REQUEST FOR INVESTMENT
RESEARCH FACILITIES

CAMPUS MASS SPECTROMETRY FACILTIES

- **Software upgrade for Orbitrap XL Mass Spectrometer $15,000**
  Investment Impact Factor: High

  The Orbitrap was purchased in 2007 for $504,000 with funds from an NIH Instrumentation Grant written by the CMSF. It is the only open-access high resolution mass spectrometer available on this campus and, as such, is very popular, running 350-400 samples per month. However, its acquisition software runs on Windows XP, which will no longer be officially supported by Microsoft on April 8th, 2014. We will, thus, be forced to disconnect this popular instrument from the campus network and it will become more vulnerable to any viruses and malware because Microsoft will no longer provide patches to the operating system.

* CMSF is not the only facility with an Orbitrap on rates. Oliver Fiehn has one too.

Many other instruments on campus face this same problem of sunsetting XP, including other cores administered by Crocker.

- **Replacement of outdated MALDI TOF/TOF $550,000**
  Investment Impact Factor: Very High

The CMSF currently manages the AB Sciex 4700 MALDI TOF/TOF mass spectrometer. This instrument was purchased in 2003 with campus funds for $539,000 and has proven to be the most popular workhorse open-access mass spectrometer. It has already run >90,000 samples for UC Davis investigators because it can analyze a wide variety of molecules and is relatively easy to operate. However, as it is now >10 years old, it's capabilities have been completely superseded by modern instrumentation, thus denying UC Davis investigators access to cutting edge technology. Needless to say, it is well past its expected lifetime of 7 years (UCOP Equipment Useful Life Index), and the instrument software is now no longer officially supported by the vendor and is stuck on Windows XP (see above concerns). The hardware is also becoming more difficult to repair and locate.

The CMSF would be greatly improved by purchasing a new MALDI TOF/TOF, preferably the UltraFlextreme by Bruker, which greatly expands upon the current AB Sciex 4700's capabilities. The UltraFlextreme is already being used as an open-access instrument at other major research universities as Bruker currently makes the best MALDI TOF instrumentation. Moreover, the new MALDIs now offer two new, cutting edge capabilities which would become available to UCD investigators: 1) MALDI Imaging and 2) Microbial Identification, aka, Biotyping.

1) MALDI Imaging is analogous to light microscopy of tissue sections, however, in this case the chemical mass signatures of important biomolecules such as signaling peptides or lipids can be directly measured and cytolocalized in tissue sections. This capability would be extremely useful to many UCD Investigators and would be highly complementary to many of the imaging projects ongoing at this campus such as at the CMGI in Biomedical Engineering (BME). Indeed, 2 of the current users of the existing 4700 MALDI TOF are Drs. Sutcliffe and Ferrara in BME and this exciting new capability would help propel their research to the forefront of imaging science. Please see Figures 1 & 2 below and this Nature Methods paper: http://www.nature.com/nmeth/journal/v4/n10/full/nmeth1094.html

2) Microbial Identification. Another exciting new capability of new MALDI TOFs is the ability to do rapid identification of microorganisms. Currently, microbial identification takes several days as microbes must first be plated out on petri dishes and grown before traditional IDs can take place. Biotyping on the new MALDIs makes use of their exquisite sensitivity, is available now as a kit and allows IDs to be done in as little as 30 minutes! This capability will completely change the fields of microbiology and food science (yeasts) and is even being used in clinical & hospital settings. This capability would be an excellent service for the CMSF to provide on both an open-access and fee-per sample basis. Please see http://maldibiotyper.com/home.html for more details.

CORE FACILITES REPORT REQUEST FOR INVESTMENT
RESEARCH FACILITIES COOP2 Facilities

CONTROLLED ENVIRONMENT FACILITY (CECF)

- Retrofit of controllers for CEF-B in years 2014/15 (Requested in our 2012/13 annual report) **$250,000.**
- Installation of a plant robot phenotyping facility. **$1,000,000**
- Planning money for the development of the detailed Architects & Engineers workup for the much needed CEF expansion **$$Unknown**
- Reinstatement of the salary for Dennis Lewis (Annual Salary = **$85,442 + benefits @ 48.3%**).

CORE FACILITES REPORT REQUEST FOR INVESTMENT
RESEARCH FACILITIES COOP2 Facilities

CROCKER NUCLEAR LABORATORIES

76 inch Cyclotron

Maintenance & Reliability:

- Magnetic Trim coils: $300k
- Trim coil power supplies $500k
- Main power supply $300k

- Vacuum Pumps $250k
- Radiation Effects Bragg Chamber $75k
- Digitized Cyclotron Controls $200k
- Electronic test equipment $50k
- 2nd Radiation Effects Beamline $100k
- 6-inch diameter beam $10k
- RF Spectrum Analyzer $30k
- RF Network Analyzer $80k
- RF power Measurement $20k
- Computer system upgrades $120k
- Electronic test equipment $50k

Future 240 MeV Upgrade:

- RF LINAC 240 MeV $20M
- Proton beam medical Gantry $10M
- Heavy Ion Source $5M
- Super Conducting Magnet upgrade 240 MeV $5M

The UC Davis 76 inch cyclotron was designed and built for nuclear physics research and as such has the capability to tune the beam energies continuously from 1 MeV to 70 MeV. This results in very clean heavy ion beams with low energy spreads that are ideal for proton beam cancer treatment and radiation testing. Since the Cyclotron's inception and installation in the early 1960s at UC Davis, it has brought in the funding to build the Crocker Nuclear Laboratory where it is operated. The Cyclotron is currently self-sustaining with its income derived from commercial customers and medical treatments.

In order to reduce the risk of Cyclotron outages due to aging hardware the Cyclotron is requesting funding for maintenance and reliability upgrades. These items will mitigate risk and ensure that the Cyclotron can continue supporting the current operational tempo of cancer treatments and mission critical national defense radiation effects testing. The Air Force and National Reconnaissance Office in conjugation with the Aerospace Corporation and others are considering investing in upgrading the cyclotron facility. This investment would include funding of a Heavy Ion Beam source, a 240 MeV LINAC, and other system upgrades. These upgrades would be made in order to ensure that the cyclotron will remain a national security testing asset well into the future.

The second category on the list are those upgrades which will allow for the cyclotron to have a greatly expanded functionality, educational utility, whole body proton beam treatment, and

advanced radiation effects testing. At this time there is no western regional United States whole body heavy ion beam, proton beam, treatment facility. The UCSF and UC Davis medical centers are both interested in obtaining a whole body heavy ion beam cancer treatment facility. The current commercial off the shelf turnkey cost is approximately $250M. An alternative to this high initial capital investment is to upgrade the existing 70 MeV heavy ion cyclotron to 240 MeV with the addition of a $20M dollar RF Linear Accelerator. This would require an additional $10M for a patient treatment room with a gantry to guide the beam to the patient.

The total cost would be approximately $30M to $50M dollars to upgrade the UC Davis cyclotron as opposed to over $250M to purchase a turnkey system from a third party. A second approach would be to replace the cyclotrons current normal conducting magnetic coils with super conducting coils. This would double the average magnetic field allowing the cyclotron to directly generate 240 MeV protons which are suitable for whole body cancer treatments. The cost would be approximately $5m to $10M dollars. The invested cost could be recouped in approximately 5 to 7 years.

Many academic, community service, and research opportunities would fall out of the above activities. These would enhance the UC Davis brand as a world leader in innovation and technology.

IMPROVE

- We are requesting a Walk-in Environmental Test Chamber (http://www.thermotron.com/product/temperature-humidity/walk-in) We need this chamber to meet the requirements of our existing National Park Service (NPS) contract and to be competitive for new air quality monitoring contracts from the U.S. Environmental Protection Agency (EPA). We are not currently complying with the EPA laboratory conditioning requirements for weighing air pollution sample filters. Our existing contract with the NPS specifies that we meet the EPA requirements, but we in fact do not. We need to invest in an Environment Test Chamber before our contract goes out for re-bid in 2015. In addition, we are preparing to bid on a $4 million/year contract with EPA to perform air quality measurements in urban areas across the United States; we expect the Request for Proposals for this work to come out by the end of 2013. **$100,000**

- We are requesting a second story on the annex (which the building was designed to support). We were criticized in our 5-year review for having inadequate space so an addition to the annex would help to solve that problem. This would also help meet our

space needs if we are awarded the $4M/year EPA contract to perform air quality measurements in urban areas across the United States. **$$Unknown**

CORE FACILITES REPORT REQUEST FOR INVESTMENT
RESEARCH FACILITIES COOP2 Facilities

INTERDISCIPINARY CENTER FOR PLASMA MASS SPECTROMETRY (ICPMS)

- Agilent 7700x quadrupole ICP-MS to replace the decade-old Agilent 7500a that is failing. (Though still operating, the 7500a requires continual maintenance and we will soon be losing vendor support for repairs. Third party maintenance is unlikely since a series of improved successor products dominate the market. A new state-of-the-art Agilent 7700x quadrupole ICP-MS would be a Center workhorse for many years to come.) **$200,000**

ATTACHMENT 4 - LISTS OF CORE FACILITIES BY SCIENTIFIC THEME AND COLLEGE

See attached MS Excel attachment.

ATTACHMENT 5 – Copy of Biorepository Committee Report

Strategic Plan:

Harmonization, Centralization, and Expansion of UCDHS Biobanking

Prepared by

Yu-Jui Yvonne Wan, PhD

Scientific Director of Biorepository for the UCDHS

Ryan Rodriguez

Coordinator for the Biorepository for the UCDHS

May 30, 2013

Abstract –

In order to organize and effectively utilize the University of California, Davis Health System (UCDHS) Biobanking resources to meet the objectives of the Department of Pathology's Strategic Plan as well as the Institution's Mission, we have developed a Biorepository Strategic Plan to create a network of harmonized UCDHS Biorepositories. We propose the creation of an institutional infrastructure to accelerate discoveries in translational and personalized medicine in an effort to identify, prevent, and treat human disease. This Strategic Plan builds upon the existing biobanking infrastructure and services to include the Cancer Center Biorepository, Pathology Services, and Information Management. The proposed Biorepository network provides the UCDHS scientific community with a consolidated, collaborative, and standardized resource for the management and access of biospecimens and associated data. The Network aligns the UCDHS Biobanks with the UCBRAID initiative and enables the UCDHS to achieve its mission of improving lives and transforming healthcare**.** The development of a UCDHS Biorepository Network will be achieved through the implementation of three specific aims; Harmonization of tissue banks, Virtual Centralization, and the Expansion of Biorepository services, which are detailed in the Approach Section.

Introduction –

Clinical and translational research is dependent upon the availability of high quality biospecimens and associated clinical data. However, biorepositories with standardized procedures, informatics requirements, and regulatory compliance are rare. At many US medical centers, the storage of human biospecimens is commonly decentralized and poorly organized. Most of these institutions, the University of California, Davis Health System (UCDHS) included, cannot readily report on the number and type of biospecimens archived. This decentralized system of biospecimen and data management results in inefficient, often redundant, biobanking efforts across the institution that lack standardized methods.

The UCDHS is a comprehensive academic health system that strives to create a healthier world through bold innovation. The UCDHS seeks to develop innovative health care technologies and to foster high-impact research. Advances in clinical and translational research are rapidly changing healthcare. The success of clinical and translational studies is dependent upon access to high quality biospecimens. Through the refinement of biospecimen resources, the UCDHS may develop a robust personalized medicine program. We propose linking the existing Department of Pathology tissue collection, processing, and storage infrastructure within a centralized UCDHS Biorepository Network. This resource will empower the UCDHS to conduct the translational research that will lead to improved lives and the transformation of healthcare.

Approach -

Aim 1 Harmonization of UCDHS Biobanks

UCDHS is positioned to become a leader in personalized medical technologies. Personalized medicine requires therapies that are specific, preventative, and precisely targeted to each patient or each type of disease. The development of personalized medicine programs is dependent upon the discoveries of clinical and translational research performed with high quality annotated human biospecimens. In an effort to accelerate the pace of clinical and translations research, the University of California has initiated the UC Biomedical Acceleration, Integration, and Development (UC BRAID) program. The aim of the UC BRAID Biobanking Working Group is to standardize biobanking practices across the five UC biomedical campuses that include UCD, UCI, UCLA, UCSD, and UCSF. Human tissues, blood, cells, and fluids for clinical and translational research will be available to UCDHS researchers through a local network of harmonized Biorepositories.

Currently, biobanking and biorepository activities within the UCDHS include programmatic biobanks, clinical trials biorepositories, and investigator managed research collections. While the collection and banking of biospecimens are performed within compliance of the Institutional Review Board (IRB), there are few standardized operating procedures (SOPs) in place to ensure that the processes/procedures are performed in a standardized manner. The SOPs in place for

one biobank are not shared with other biobanks. The proposed UCDHS Biobank Network seeks to harmonize biobanking activities through the standardization of sample processing, storage, distribution, and data management practices for UCDHS biobanks. We propose to harmonize the UCDHS biobanks through the implementation of standardized procedures for biospecimen archiving that are founded upon "Best Practices" guidelines established by the five UC Biomedical Centers. Application of these standards will allow U C D H S biobanks to be "UC Recognized", establish eligibility for College of American Pathology (CAP) – Biorepository Accreditation, and permit the implementation of a Universal Informed Consent procedure for the collection of biospecimens. Harmonization of UCDHS biobanks is required to align the local UCDHS biobanks with the University of California wide UC BRAID Integrated Biobanking initiative.

Objective 1.1 – "UC- Recognized" Biobanking Operations

The organization and application of standard protocols for current UCDHS biobanks varies. Biobanks such as the Cancer Center Biorepository are organized with protocols in place that describe policies and procedures, while investigator managed biospecimen collections typically lack documented standardized procedures. We propose to implement standardized procedures for all UCDHS biobanking groups in order to receive UC-Recognized status.

UC-Recognized status will be extended to member UCDHS biobanks that implement standardized, or harmonized, procedures. Adoption of the standardized set of operating procedures, quality measures, and staff training will ensure that each biospecimen collection meets the National Institute of Health (NIH), International Society for Biospecimen and Environmental Research (ISBER), and CAP standards. UC-Recognized biobanks will also meet the ethical operating standards of the IRB. The biobank users will realize the benefits of using the specimens deposited in UC-Recognized biobanks. The primary benefit is assurance of the quality standards for biospecimens, which will increase user confidence in producing high quality scientific data. We propose that participation in multi-campus research will be limited to high quality biospecimens obtained from UC-Recognized biobanks.

The UC BRAID Biobanking Working Group is leading the effort to develop harmonized operational protocols for biospecimen collection, processing, preservation, storage, distribution, and discarding. These harmonized protocols will describe key quality assurance parameters to ensure integrity of the biospecimens collected at the five collaborating UC biomed campuses. UC BRAID Biobanking harmonization efforts at the UCDHS are coordinated through representatives Dr. Yvonne Wan and Ryan Rodriguez. Participation in the UC BRAID Biobanking Working Group requires participation in weekly teleconferences, contribution to the development of SOPs and resources, and coordination of UC BRAID effort with UCDHS biobank practices. Dr. Wan's participation is supported by a NIH grant entitled "Engaging University of California Stakeholders for Biorepository Research" at 2% effort.

Additional resources are required to bring UCDHS biobanks into compliance with the criteria to receive UC-Recognized status. Harmonization of standard procedures across UCDHS biobanks

will require one administrative staff at the Junior Specialist level for 24 months at 50% effort. Working with the Biorepository Coordinator Ryan Rodriguez, this person will be involved in the review of SOPs, Quality Management Practices, and the assessment of environmental monitoring practices for UCDHS biobanks. Upon completion of each review, the Junior Specialist will assist UCDHS biobanks with the implementation of harmonized protocols, quality management, and environmental monitoring practices.

Objective 1.2 – CAP-Biorepository Accreditation of UCDHS Biobanks to Ensure Biospecimen Quality

College of American Pathologist (CAP) – Biorepository accreditation is the established gold standard in laboratory accreditation. The CAP program is designed to drive the adoption of standardized methods through the consistent application of best practices and evidence based standards. UC-Recognized biobanking groups will have the quality management infrastructure in place to facilitate CAP – Biorepository accreditation. Benefits of CAP Accreditation include recognition as a top performer in biorepository operations, assurance of the consistent application of SOPs, and will strengthen collaborations through the distribution of quality biospecimens.

Each biobanking group should be encouraged to apply for CAP Accreditation. Once the application for accreditation has been accepted, CAP will coordinate an onsite inspection of the biorepository. CAP inspectors will conduct a comprehensive audit on the biobank operations utilizing an Evidence of Compliance methodology. The CAP- Biorepository accreditation inspection will assess Quality Management, Information Technology Systems, Informed consent and IRB compliance, and Distribution policies of the biobank. The Quality Management inspection is designed to confirm that the biobank has documented policies and procedures in place for specimen handling, specimen processing, and the usage of instruments and related equipment. Information systems will be evaluated for hardware, software, security, data retrieval, interfaces, and inventory system management. Informed consent and IRB compliance review require access to the biobank policies for sample acquisition and distribution of both biospecimens and associated data. All policies and procedures must be documented in a SOP format that is accepted by the CAP.

Preparation for the initial CAP-Biorepository inspection for each biobank will require significant effort to compile, organize, and re-format all applicable SOPs. SOPs must be drafted for those biobanks at UCDMC that lack standardized procedures. We will also assist those biobanks to implement the necessary standard practices. For example, the Cancer Center Biorepository has SOPs, but there are many quality assurance procedures that are not documented. For each biobank, three consecutive months of historical environmental monitoring data for all biospecimen storage conditions, locations, and equipment must be compiled and formatted for presentation to the CAP inspection team. UCDHS biobanks will be subjected to a comprehensive inspection of up to 143 operational procedures to include; quality management, Information technologies, and policies for informed consent and biospecimen distribution. The Cancer Center

Biorepository will be the first UCDHS biobank to prepare for CAP Accreditation. The current challenge is that we lack of personnel to (1) re-format established protocols into the CAP accepted format, (2) draft missing SOPs for environmental monitoring, training, and data management, and (3) locate and compile historical environmental data.

We need one full time person at the Research Associate level for 24 months to assist the existing biobanks to establish their SOPs and receive CAP accreditation. We also need a half-time junior specialist for two years to assist another three Biobanks (such as the Cancer Center, Alzheimer's and Mind Institute or others) to prepare applications for CAP accreditation.
Currently, CAP Accreditation of the Cancer Center Biorepository has not advanced beyond initial review due to lack of personnel support.

Objective 1.3 – Development and implementation of a Universal Informed Consent (UIC) for biospecimen collection

The lack of a universal informed consent procedure is a significant challenge for the UCDHS. Currently, the Clinical and Translational Science Center lists 10 approved IRB protocols that permit the collection and banking of cancer biospecimens. The disease/program focused Informed Consent practices create competition and redundancy within the UCDHS as well as confusion for patients. Details of the consent procedures vary between protocols to include the type of biospecimens that may be collected and whether or not personal health data may be accessed. Currently, the Program-specific informed consent practices within the Cancer Center provide members of the clinical care research group may directly access the patient medical record. To ensure the protection of patient privacy, the proposed UIC will limit the access of Personal Health Information (PHI) to specified "Honest Brokers" within each biobank/program. Under this framework, investigators will have immediate access to de-identified biospecimens and the associated de-identified clinical data. The Honest Broker will provide additional health information upon request. The implementation of one UIC policy to allow for the future unspecified use of biospecimens is a critical component of the UCDHS biobank harmonization effort.

We propose to develop and implement a single UIC. To facilitate the adoption and implementation of the UIC across the UCDHS, we propose the development of an electronic version of the UIC and the establishment of an electronic consenting process. The UIC will require supplemental resources beyond the consent form to ensure that UCDHS patients understand and are comfortable with the decision to donate specimens for future research. We propose to design and implement a UIC with supplemental information and resource that include (1) a brochure detailing key information for donating specimen; (2) a toll free hotline, also included in the brochure, may be called if a patient has questions or wishes to speak or meet with a well-trained member of the program staff; (3) a webpage, also included in the brochure, designed to educate patients on biobanking and the impact of biospecimens on translational research. The webpage will include a Frequently Asked Questions page and directions for electronic communication resources, such as email and the telephone hotline.

Preliminary work on objective 1.3 was initiated on May 7th in the form of a meeting between Dr. Wan and IRB administrative leaders Ms. Cindy Kiel, Executive Vice Chancellor of Research, and IRB Administrative Director Mr. Daniel Redline to discuss the development of a UIC procedure for the UCDHS. General guidance was provided by the IRB leadership to facilitate the development of the UIC forms and processes. The implementation of UIC will require commitments to staff training and education, patient resources and outreach, and strict governance of the UIC processes. UCDHS staff identified to consent patients will be required to be trained in a uniform manner to ensure that all participating patients are consented in a consistent manner. This training must be documented and performed annually. Supplementary patient information resources must be developed to support the implemented UIC process. Ryan Rodriguez will lead the development of the UIC protocol to include consent procedures and submission of the UIC documents to receive IRB approval. One full time personnel at the Research Associate level is needed for the implementation of the consenting process. This Research Associate will be required to meet with prospective biospecimen donors to discuss donation of tissue and/or fluids. This person will also be involved in the answering of donor questions via the proposed hotline, email, and in person. Initially we request a full time position for two years.

Budget Summary for the Implementation of Aim 1 –

Objective	Title	Calendar Months	Salary Requested	Fringe Benefits	Total
1.1 and 1.2	Junior Specialist	24	70,000	34,650	104,650
1.2	Research Associate	24	120,000	41,280	161,280
1.3	Research Associate	24	120,000	41,280	161,280
				Total	**$427,210**

Aim 2 Centralization –

The loose organization and lack of standardization of the UCDHS biorepositories presents a significant challenge to the ability of the UCDHS to leverage critical biospecimen resources. Figure 1 shows the current UCDHS Biorepository infrastructure. The current decentralize status of UCDHS biorepository assets does not allow for adoption of harmonized processes. The alignment of UCDHS biospecimen resources into an organized network is critical to the future success of the Institution. We propose to organize the individual UCDHS biobanking groups into an affiliated biobanking network called the Human Biospecimen Resource Network (HBRN) (Figure 2). This network will provide the needed common governance structure, standardized informatics framework, and harmonized operational procedures. There are many benefits to a centralized bioinformatics framework that is integrated with a standardized governance structure. One, the chain of custody for biospecimens may be tracked from collection to distribution. Two, centralized governance policies ensure that all biospecimen research at UCDHS and collaborating institutions is conducted in compliance with informed consent and privacy

requirements. Third, sample and data access is enhanced through the shared informatics data repository for all biospecimens. Development and implementation of an integrated data repository is the critical step in the alignment of UCDHS biobanks into an affiliated network of biospecimen resources. Once implemented, the number and type of biospecimens will be known to the clinical and translational research community. The proposed organization of the UCDHS Biorepository infrastructure is summarized in Figure 2.

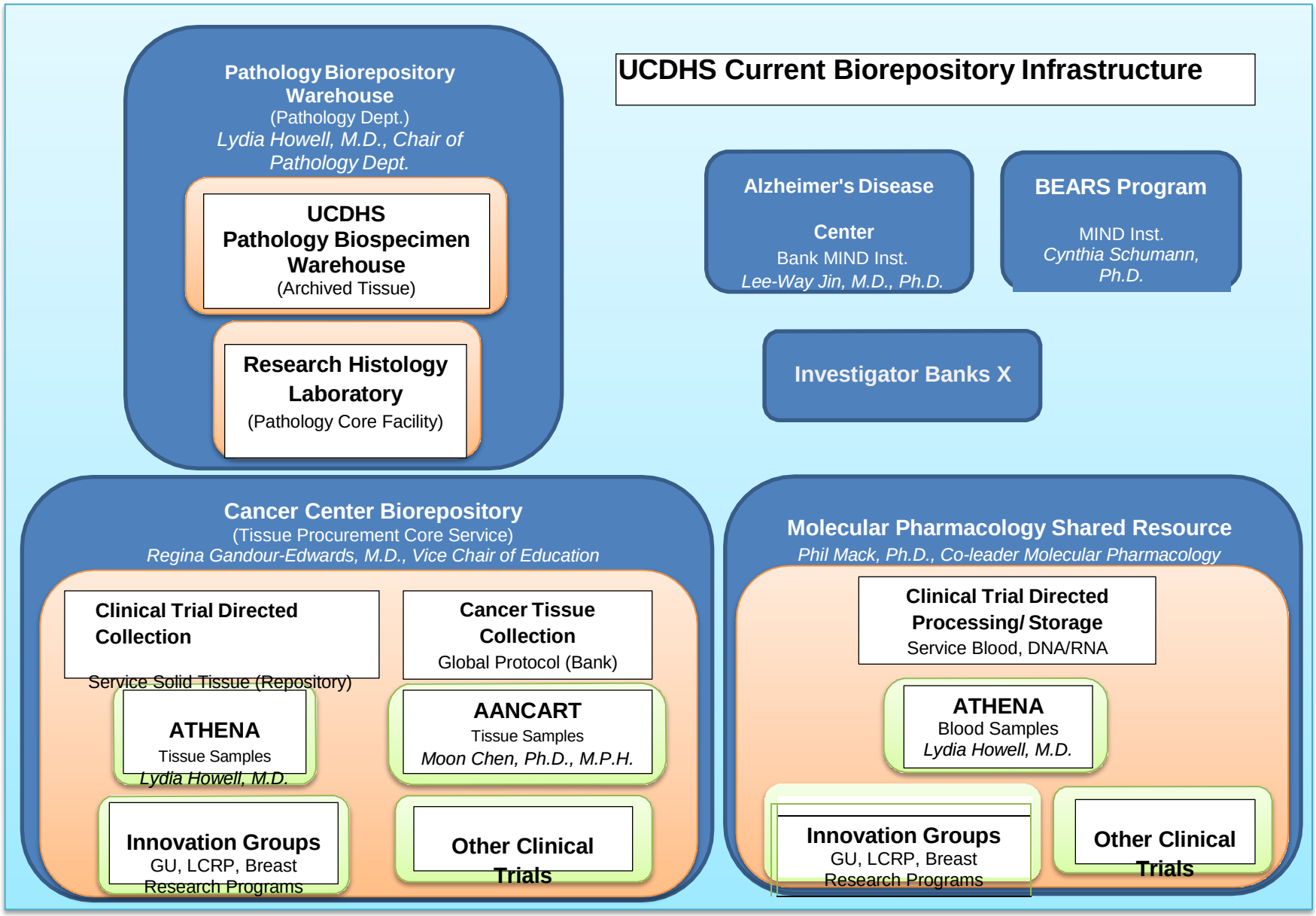


Figure 1. Current Biorepository Infrastructure. Colors are all inclusive. Bubbles within the light blue square represent the UCDHS current biorepository infrastructure. Dark blue bubbles represent independent biobanks within UCDHS. Orange bubbles represent specific functions within each biobank. Green bubbles represent the different projects supported by the specific functions. BEARS is the Brain Endowment for Autism Research Sciences. AANCART is the Asian Network for Cancer Awareness, Research and Training.

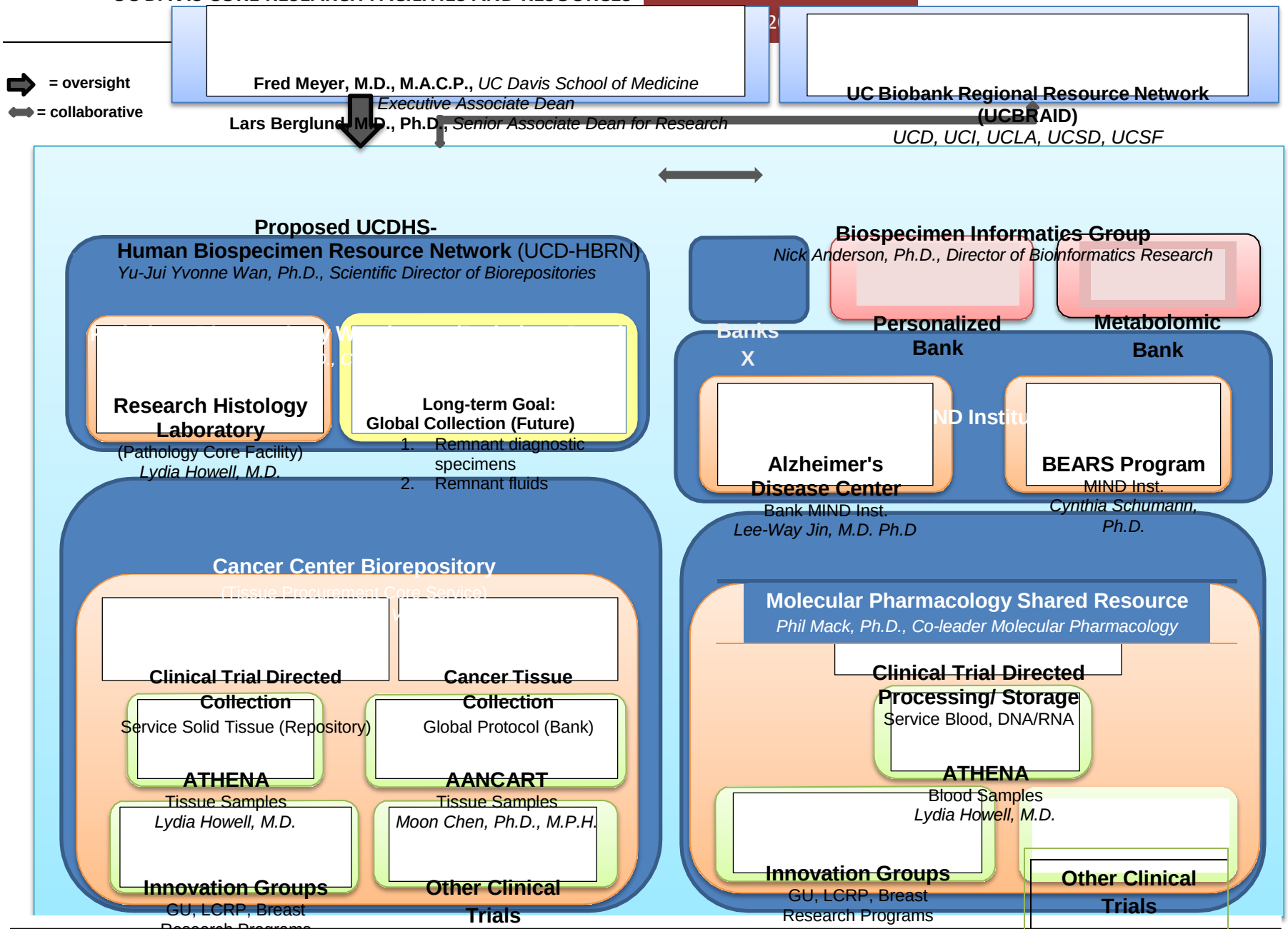


Figure 2. Proposed Biorepository Infrastructure. Colors are all inclusive. Bubbles within the light blue square represent the UCDHS future biorepository infrastructure. Dark blue bubbles represent independent biobanks within UCDHS. Orange bubbles represent specific functions within each biobank. Green bubbles represent the different projects supported by the specific functions. Yellow bubbles represent future biobanking activities. Red bubbles represent proposed Metabolomic and Personalized Medicine biobanks. BEARS is the

Objective 2.1 – Administrative Coordination and Governance of the HBRN Biobanks

The primary function of the HBRN is to facilitate translational research through the development, implementation, and maintenance of uniform biobanking practices. Standardized biobanking practices to be managed by the HBRN will include operational, information management, and governance processes. The HBRN will act as an intermediary for biospecimen requests, UC BRAID coordination, and will develop quality management requirements.

The transition of member biobanks to a quality focused enterprise founded on harmonized practices will require the expertise and support of the HBRN coordination group. UCDHS HBRN member biobanks will require robust quality management programs to maintain both CAP accreditation and UC Recognized status. The HBRN will provide support to network biobanks to guide the effort to obtain and maintain accreditation status. Quality management support will consist of the development of standardized forms, biobank education for investigators, and SOP management. Local HBRN biobanks will be required to operate within the quality requirements established by the UCBRAID Biobanking Working Group. Dr. Wan and Ryan Rodriguez will play a critical role in the coordination and implementation of the required quality management programs for HBRN biobanks.

For many research projects, biospecimens collected in one location are not sufficient to provide enough samples for a study. The development of the resource network can meet the demands of translational research. However, increased data and biospecimen sharing across research networks poses significant regulatory governance challenges. The formation of a centralized governance structure is critical to facilitate high quality and efficient research.

A governing board comprised of key stakeholders representing the research community is required for institutional core resources such as Biorepositories. Governance committees are required to ensure that biospecimens are collected and distributed within the framework of the IRB protocol, local institutional policies, and state law.

The current decentralized state of UCDHS biobanks has resulted in the establishment of multiple governance committees to guide the operations of multiple biobanks. Two governance committees have been formed to oversee the UCDHS HBRN. Each committee is to be composed of UCDHS translational and basic scientists. The functions of those two committees are listed below.

UCDHS Biobank Committee (UBC)

- General oversight of administrative operations:
  - Policy Compliance.
  - Harmonization of UCDHS biobanks with UC BRAID.
  - Forum for community concerns.
  - Coordination of biobanking activities with the UCD IRB.
- General review of banking related activities:
  - Determination of banking focus.

- Ensure compliance with UC-Recognized standards.
- Establish banker to investigator (user) relationship
- Establish data governance policies

Biospecimen Utilization Committee (BUC)

- Scientific review of requests for biospecimens from the UCDHS HBRN banks:
  - Ensure that requesting investigators have experience and expertise to effectively use biospecimens in research.
  - Evaluate intended use to ensure that the usage is scientifically and ethically appropriate.
  - Confirm that use is consistent with applicable policies and regulations.
  - Review plan for data access and sharing.

Formation of both HBRN governance committees was initiated in May 2013. Invitations to serve on the committees were extended to 14 UCDHS scientists with expertise in clinical and translational science. All prospective members have agreed to serve on either the UBC or the BUC. The adoption and implementation of defined and consistent research governance policies for all UCDHS biobanks is critical to the success of future biospecimen research.

Ryan Rodriguez will be tasked with the coordination of meetings, documentation of meeting proceedings, distribution of committee relevant documents, generation education materials, and working with various entities to implement governance policies. No additional personnel is requested for this objective.

Objective 2.2 – Development of the Biospecimen Integrated Data Repository

To realize the promise of personalized medicine, new information systems must be developed that enable data accessibility for clinicians, translational investigators, bioinformaticists, and administrators. Biospecimen data must be readily accessible in a secure yet user-friendly manner through an integrated data repository (IDR). The IDR must support the following biorepository functions for all associated biobanks under the proposed HBRN; (1) retrieval of retrospective information for quality assurance, basic and clinical research, and biospecimen science; (2) biorepository workflow management; (3) biospecimen chain of custody tracking; (4) protection of patient privacy; and (5) interface with external collaborating systems such as UCReX. The development of an integrated data repository is the foundation of the UCDHS harmonization effort.

The lack of visibility and transparency of UCDHS biobanks to the research community is due to the absence of a user friendly consolidated IDR. The lack of available information has limited access to banked biospecimens to members of the research group affiliated with each biobank. The proliferation of redundant investigator maintained biospecimen collections is

also attributed to the absence of an organized Institutional biobanking effort. Currently, the UCDHS is unknowingly supporting the hidden cost of biobanking activities. These hidden costs are in the form of freezers, space, labor, and sub-optimal software. These costs are amplified when samples are not utilized due to suboptimal inventory and tracking systems. Institutional investment in biospecimen data infrastructure will introduce efficiencies to decrease financial burden to investigators, the institution, while improving opportunities for research funding.

The development and implementation of an IDR will require one health information scientist at 100% effort for 24 months. Incoming Director of Bioinformatics Research, Dr. Nick Anderson, has successfully developed integrated data repositories for biobanks and multi-institutional clinical research networks. We already had an initial meeting with Dr. Anderson and will work closely with him to develop and implement the proposed biobanking IDR. The needed bioinformatic software is not requested here assuming the software will be part of the budget established for the Bioinformatic Program.

Budget Summary for the Implementation of Aim 2 –

Objective	Title	Calendar Months	Salary Requested	Fringe Benefit	Total
2.2	Bioinformatic Support at the Research Associate Level	24	130,000	27,430	**$157,430**

Aim 3 Expansions of Tissue Banking and Services provided by the UCDHS HBRN

With approximately 200,000 unique patient encounters each year and 900,000 patient visits, the UCDHS has the opportunity to expand the number and type of biospecimens banked. However, prospective collection of all remnant diagnostic specimens may be cost prohibitive. For example, the collection of a single blood sample processed to serum for the 200,000 unique UCDHS patients will cost ~$1,200,000.00/year in processing, materials, and storage costs. The accumulation of clinically irrelevant biospecimens will occupy valuable storage space. Success of the HBRN will be measured by the number/type of biospecimens distributed and projects supported rather than the number of samples held in storage. Thus, a targeted approach is most reasonable. In addition, a very robust searchable program and supporting database is required for biospecimen banking and usage. Furthermore, in order to use patients' data, banking of remnant specimens requires patient consent. To implement this, electronic consenting has to be in place. Thus, it seems that the UCDHS is not ready to bank all the remnant samples in the immediate future. Organization of the UCDHS biobanking infrastructure will facilitate the rapid establishment of new biobanks. Thus, we propose to establish "Personalized" and "Metabolomics" biobanks using a targeted banking strategy. These two to be established biobanks will use the in-development Universal Informed Consent form, adopt SOPs to obtain UC-Recognized status, and will apply for CAP accreditation. Once established, we will use these two biobanks as UCDHS model biobanks. When mature, the HBRN infrastructure will enable the rapid expansion of biobanking

services for the UCDHS. Future proposals will describe the implementation of expanded biobanking activities to include all biospecimens, fluids, and the derivatives of each. The scale of the biospecimen resource, when fully realized, will enable research on rare and/or minority demographic populations that could not otherwise be conducted. This is the ultimate goal of the HBRN. We anticipate that it will take five years to achieve this long-term goal.

Objective 3.1 – Establishment of a "Metabolomics Biobank"

It is important to align research focus with the type of patients in the UCDHS. Targeted banking will generate translational data for specific projects, which will result in rapid grant application and manuscript submissions. For example, UCDHS performs approximately 250-400 bariatric surgeries per year. Banking specimens from patients before and after surgery allows us to study metabolic syndromes which is an alarming heath issue. All patients that undergo bariatric surgery have a BMI greater than 35. Biospecimens from these patients are ideal for the study of metabolic syndromes and diabetes. In addition, obesity is a risk factor for many types of cancer and cancer risks decrease after bariatric surgery. Thus, the specimens derived from Bariatric patients are ideal to study the association between obesity and cancer formation. Potential specimens to be banked include blood, urine, feces, livers, jejunum, and white adipose tissues prior to or during surgery. After the surgery, it is possible to bank urine, feces, and blood over one year of follow up visits. These samples can be used to identify potential biomarkers for the detection of cancer risks. Many UCDMC researchers are interested in studying obesity, metabolic syndromes, or associated diabetics. The establishment of a Metabolomic biobank will be leveraged in support or collaboration with investigators at the West Coast Metabolomics Core at UC Davis.

Objective 3.2 – Establishment of a "Personalized Biobank"

Rapid advances in health care diagnostics provide affordable access to what were once cost prohibitive diagnostic technologies. Once established, the HBRN infrastructure may be leveraged to support a fee for service Personalized Biobank. The Personalized Biobank is to provide services to bank patients' specimens for future diagnosis or treatment, similar to the practice of biobanking "cord blood". Specimens will be banked for 10 or 20 years for a fixed fee. The sample will only be released upon request by the patients. Patients can also request to have their specimen sequenced or genotyped in order to obtain genomic information. We will work with other Core facilities at UCDMC to conduct such services to include exon sequencing or SNP analysis. As this is a patient sponsored service, it would be optional for the patients to have their genomic data analyzed or further studied by researchers. This effort will align the Personalized Medicine Biobank with the Cancer Center's Goal to develop a biorepository that will contain specimens with known genomic characteristics. Personnel, space, equipment, and supplies are needed to form these two new biobanks. We ask for two years of support to establish the proposed two biobanks. We anticipate that the biobanks will be self-supported by grants and generated income within five years. Dr. Wan and Ryan Rodriguez will be actively involved in the development of a business plan and the pursuit of grant funding opportunities.

Budget Summary for the Implementation of Aim 3 –

Objective	ROLE ON PROJECT	Calendar Months	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
3.1	Junior Specialist	24	70,000	34,650	104,650
3.2	Research Associate	24	120,000	41,280	161,280
3.2	Junior Specialist	24	70,000	34,650	104,650
				Total	**$370,580**

EQUIPMENT (One time request)	**Quantity**	
Minus 80C Freezer	4	50,000
Liquid Nitrogen Storage	1	10,000
Bench top refrigerated centrifuge	1	6,000
BSLII Hood (Thermo Scientific 1.2 MSC-Advantage)	1	15,000
Computers	2	3,000
Equipment maintenance for 2 years		8,000
	Total	**$92,000**
SUPPLIES		
Consumables and Disposals: tips, tubes, labels, surgical tools, sterilizers for two years		36,000
Pipettes (2 sets)		4,000
RNA Later and General Chemicals		10,000
	Total	**$50,000**
	SUBTOTAL	**$512,580**

Personnel:

Dr. Yvonne Wan, Ph.D. will oversee the overall performance and implementation of the Master Plan (Aims 1-3) and be in charge of the newly established Personalized and Metabolomics biobanks. Currently Dr. Wan devotes 20% of her effort as the Scientific Director of the Biorepository for the UCDHS. Additional 15% effort is requested for the new responsibilities.

Two Junior Specialists are requested for the banking, processing, and distribution of samples. They are also responsible for data entry for the two newly established biobanks.

One Research Associate is requested for the development of the business plan for the Personalized Bank, working with the Research Associate under Objective 1.3 to develop, obtain, and implement IRB approval of a Universal Informed Consent. The Research Associate will also develop a Biorepository marketing strategy and work with other Core facilities, such as the Molecular Biology Core within the Pathology Department, to perform DNA sequencing and other SNP assays. The Research Associate will work with two Junior Specialists for all the banking-related activities.

Space:

2,000 square footage of laboratory space is needed to accommodate freezers, laboratory equipment, biosafety hood, and tissue processing procedures.