Advancing Innovation and Convergence In Cancer Research

Jerry S.H. Lee, Ph.D.
Health Sciences Director
Deputy Director, Center for Strategic Scientific Initiatives (CSSI)
Office of the Director, National Cancer Institute (NCI)
National Institutes of Health (NIH)

2015 ASEE Engineering Research Council Annual Meeting
Change and Research Opportunities: Perspectives from NIST, DOE, NGA, and NCI

March 10, 2015
NCI Center for Strategic Scientific Initiatives (FY99 – FY14)

Office of Cancer Genomics
IMAT $7.4M
Office of Tech & Industrial Relations
UIR $3.9M

Center for Strategic Scientific Initiatives Established

Pilot Launch $10.5M
Restructure of NCI-wide SBIR/STTR mechanisms

Pilot Launch $8.7M
Office of Cancer Nanotechnology

Pilot Launch $10.5M

Pilot Launch $11.7M
The Cancer Genome Atlas Program Office

Pilot Launch $13.1M
Office of Cancer Clinical Proteomics Research

Pilot Launch $30M
Office of Physical Sciences Oncology

Pilot Launch $10.5M
Office of Latin American Cancer Program Development

Pilot Launch $20M
Pilot Launch $10M
Pilot Launch $3M

Pilot Launch $30M
Office of Biorepositories & Biospecimen Research

Pilot Launch $10.5M
Office of Biorepositories & Biospecimen Research Management

Pilot Launch $60M

Pilot Launch $15M
Prognostic Questions Project

Pilot Launch $20M

Office of Cancer Genomics

Center for Cancer Genomics Spun Off to Coordinate NCI-wide genomics efforts

SBIR Development Center Spun Off to Coordinate NCI-wide SBIR/STTR awards

Center for Global Health Spun Off to Coordinate NCI-wide international activities

Center for Cancer Genomics Center for Cancer Genomics Branch Spun Off to Coordinate NCI-wide genomics efforts

Physical Sciences in Oncology Network Incorporated into NCI Division of Cancer Biology

Pilot Launch $31.6M

Pilot Launch $25M

Pilot Launch $11M

Biorepositories & Biospecimen Research Branch Spun Off to Coordinate NCI-wide biospecimen efforts

Data from NCI Factbooks (http://obf.cancer.gov/financial/factbook.htm)
What is It?
Tumor, Cancer, and Metastasis

5 year Relative Survival Rates

<table>
<thead>
<tr>
<th>Organ Site</th>
<th>All Stages</th>
<th>Localized</th>
<th>Regional</th>
<th>Distant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prostate</td>
<td>99</td>
<td>&gt;99</td>
<td>&gt;99</td>
<td>28</td>
</tr>
<tr>
<td>Breast</td>
<td>89</td>
<td>99</td>
<td>85</td>
<td>25</td>
</tr>
<tr>
<td>Ovary</td>
<td>45</td>
<td>92</td>
<td>72</td>
<td>27</td>
</tr>
<tr>
<td>Uterine Cervix</td>
<td>68</td>
<td>91</td>
<td>57</td>
<td>16</td>
</tr>
<tr>
<td>Melanoma</td>
<td>91</td>
<td>98</td>
<td>63</td>
<td>16</td>
</tr>
<tr>
<td>Urinary Bladder</td>
<td>77</td>
<td>69</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>Kidney</td>
<td>72</td>
<td>92</td>
<td>65</td>
<td>12</td>
</tr>
<tr>
<td>Colon and rectum</td>
<td>65</td>
<td>90</td>
<td>71</td>
<td>13</td>
</tr>
<tr>
<td>Esophagus</td>
<td>18</td>
<td>40</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Lung and bronchus</td>
<td>17</td>
<td>54</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>Liver</td>
<td>17</td>
<td>30</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Pancreas</td>
<td>7</td>
<td>26</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

“...>90% of deaths are caused by disseminated disease or metastasis...”

Gupta et. al., Cell, 2006 and Siegel et. al. CA Cancer J Clin, Jan/Feb 2015
In the U.S., Cancer Continues to Represent an Enormous Burden

- 576,691 Americans died of cancer in 2011 (589,430 projected for 2015)
- 1,658,370 Americans will be newly diagnosed with cancer in 2015 (projected)
- $157 billion in 2010 for cancer healthcare costs ($173 billion projected in 2020)

Unlike Other Major Disease Killers, Cancer Continues to Take Nearly the Same Toll as it did in 1950

Source for 2015 projected deaths and diagnoses: Siegel et. al, Cancer Statistics, 2015; Source for cost and projections: http://costprojections.cancer.gov
Global Burden: By 2020, Cancer Incidence 16 M/yr (Mortality 10 M/yr)

Source: IACR, WHO
Unprecedented Amount of Scientific Knowledge: Omics

1923
49,024 pubs

2001
54,587 pubs

2005
580,824 pubs

2010

2015

ISI search for articles only in genomics, proteomics, transcriptomics, metabolomics, phenomics, interactomics, glycomics
Is More Knowledge Yielding More Solutions for Patients?

Drug Discovery and Development

- 10 – 15 years at ~ $1.8 billion*
- 2007: 19 NMEs [lowest since 1983]
- 2008: 21 NMEs [29% new-in-class]
- 2009: 24 NMEs [17% new-in-class]

Diagnostic Biomarkers

- Averaging 1.5 FDA approvals per year†
- 1000’s of samples
- Balancing complexity of biology against heterogeneity of patients

Maybe…but can it be more efficient?

Translation Pace: How To Break Out of Current Paradigm?

- Standards and protocols
- Real-time, public release of data
- Large, multi-disciplinary teams
- Pilot-friendly team environment to share failures and successes
- Team members with trans-disciplinary training

The potential to transform cancer drug discovery and diagnostics

Paul et. al, Nature Rev. Drug Discovery, March 2010
National Institutes of Health (NIH): 27 Institutes and Centers

NIH Budget ~ $30.14 Billion (FY14)
- ~81% for extramural support
- ~60,000 grants and contracts

NCI Budget ~ $4.92 Billion (FY14)
- ~75% for extramural support
- ~7,500 grants and contracts
National Institutes of Health (NIH): 27 Institutes and Centers [FY14]

The NIH Extramural Team: Checks & Balances

Ensure fair and unbiased evaluation of the scientific and technical merit of proposed research
- Manages study sections
- Prepares/issues summary statements

Ensure all required business management actions are performed by the grantee and federal government
- Participates in budget negotiations
- Prepares/issues Notice of Awards (NoA)

Does not
- Assemble review committee
- Make awards

http://grants.nih.gov
NIH: Types of Funding Announcements (FOAs)

http://grants.nih.gov/grants/planning_application.htm

![Diagram showing Types of Funding Opportunity Announcements (FOA)]

- Non-specific, investigator-initiated “unsolicited” research
  - May submit any topic within the breadth of the NIH mission.
  - No money set-aside
  - Competition tied mainly to an IC’s overall payline

- Often broadly defined or a reminder of a scientific need
  - Investigator-initiated “unsolicited” research
  - No money set asides (unless PAS)
  - Competition tied mainly to the IC’s overall payline
  - High-priority applications may be funded beyond the payline

- NIH-Requested Research; Well-defined scientific area
  - Specifies funds and targets number of awards
  - Competition depends on number of applicants and dollars set aside

~685 in FY14
NIH Research Portfolio Online Reporting Tools (RePORT)  [FY14]

NIH Research Portfolio Online Reporting Tools (RePORT)  [FY04]

FY04 grants data from http://projectreporter.nih.gov
National Cancer Program: Stakeholders

~$18 B per year

- NCI: $5 B
- Private Industry: $9.2 B
- Fed/State: $3.4 B
- NPO/Foundations: $0.6 B

NCAB Working Group Report, 2010
National Cancer Institute Organization

Director
Harold Varmus, MD

Deputy Director
Douglas Lowy, MD

National Cancer Institute

$4.79B
(FY13)

Office of the Director

CSSI

~$110 M (~3%)

Center for Cancer Research
~$812M (~17%)

Division of Cancer Epidemiology and Genetics

Division of Cancer Treatment and Diagnosis
~$1,166M (~32%)

Division of Cancer Biology
~$726M (~20%)

Division of Cancer Control and Population Sciences
~$398M (~11%)

Division of Cancer Prevention
~$249M (~7%)

Division of Extramural Activities
~$22M (~0.5%)

Conducting – Intramural

Funding – Extramural

NCI 2013 Fact Book: FY13 Budget Breakdown

Fiscal Year 2013 Budget
(Dollars in Thousands)

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contracts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research &amp; Development (R&amp;D)</td>
<td>$616,046</td>
<td>17.1%</td>
</tr>
<tr>
<td>Buildings and Facilities</td>
<td>7,904</td>
<td>0.2%</td>
</tr>
<tr>
<td>Construction Contracts</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Subtotal Contracts</td>
<td>623,950</td>
<td>17.3%</td>
</tr>
<tr>
<td>Grants</td>
<td></td>
<td>82.7%</td>
</tr>
<tr>
<td>Research Project Grants (RPGs)</td>
<td>2,000,161</td>
<td>55.4%</td>
</tr>
<tr>
<td>Cancer Centers/Specialized Centers/SPORES</td>
<td>533,951</td>
<td>14.8%</td>
</tr>
<tr>
<td>NRSA</td>
<td>65,788</td>
<td>1.8%</td>
</tr>
<tr>
<td>Other Research Grants</td>
<td>387,538</td>
<td>10.7%</td>
</tr>
<tr>
<td>Construction Grants</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Subtotal Grants</td>
<td>2,987,438</td>
<td>82.7%</td>
</tr>
<tr>
<td>Total Extramural Funds</td>
<td>3,611,386</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total intramural/RMS</td>
<td>1,177,626</td>
<td></td>
</tr>
<tr>
<td>Total NCI</td>
<td>$4,789,014</td>
<td></td>
</tr>
</tbody>
</table>

Data from NCI FY13 Factbook (http://obf.cancer.gov/financial/factbook.htm)
NCI’s Federally Funded Research and Development Center (FFRDC)

Established in 1972 as one of the nation’s 39 FFRDC’s and the only one devoted exclusively to biomedical research and development.

Facts
As one of Frederick County’s major employers, the contractor Leidos Biomedical Research Inc. employs approximately 1,800 employees.

Economic Impact
In addition to payroll, Leidos Biomedical Research contributes:

- Dollars spent via Leidos Biomedical Research (formerly SAIC-Frederick) purchase orders, Contract Year 2011
  - Frederick County...$16,820,351
  - Maryland............$183,088,783

- Dollars spent via Leidos Biomedical Research (formerly SAIC-Frederick) purchase orders, 9/26/08–8/10/11
  - Frederick County...$35,895,585
  - Maryland............$296,944,980

Physical
- 68 acres deeded to the Department of Health and Human Services (HHS)
- 991,217 net square feet
- 1,654,035 gross square feet
- 113 buildings on site

NCI Funding in FY12 $238,204

http://frederick.cancer.gov/About/Facts.aspx
NCI Center for Strategic Scientific Initiatives (CSSI): Concept Shop

Mission

“...to create and uniquely implement exploratory programs focused on the development and integration of advanced technologies, trans-disciplinary approaches, infrastructures, and standards, to accelerate the creation and broad deployment of data, knowledge, and tools to empower the entire cancer research continuum in better understanding and leveraging knowledge of the cancer biology space for patient benefit...”

*Red dates indicate approval(s) by NCI Board of Scientific Advisors
Support Convergence and Innovation At Many Scales

NCI Alliance for Nanotechnology in Cancer
Phase II

Cancer Target Discovery & Development (CTD²)

Early settlers

Team Explorers

Discoverers/ Pioneers

PHYSICAL SCIENCES in ONCOLOGY

CLINICAL PROTEOMIC TECHNOLOGIES in CANCER

THE CANCER GENOME ATLAS

Provocative Questions Initiative

IMAT

Basic Applied Translational Clinical Commercial/Industry
Center Framework: “What is Water?” - Measurements → Insights

- Measurements
  - Color (clear, yellow, brown)
  - Taste (none, metallic, awful)

- Phase (liquid, gas, solid)
  - Phase change (boil, melt, freeze)

- Quantitative “Data”

<table>
<thead>
<tr>
<th>Saturated steam</th>
<th>Supersaturated steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (kPa)</td>
<td>Temp (°C)</td>
</tr>
<tr>
<td>1</td>
<td>993.3</td>
</tr>
<tr>
<td>2</td>
<td>114.6</td>
</tr>
<tr>
<td>3</td>
<td>132.4</td>
</tr>
<tr>
<td>4</td>
<td>142.9</td>
</tr>
<tr>
<td>5</td>
<td>155.1</td>
</tr>
<tr>
<td>6</td>
<td>159.3</td>
</tr>
<tr>
<td>7</td>
<td>164.2</td>
</tr>
<tr>
<td>8</td>
<td>169.6</td>
</tr>
<tr>
<td>9</td>
<td>174.5</td>
</tr>
<tr>
<td>10</td>
<td>179.2</td>
</tr>
<tr>
<td>11</td>
<td>183.6</td>
</tr>
<tr>
<td>12</td>
<td>187.3</td>
</tr>
<tr>
<td>13</td>
<td>189.5</td>
</tr>
<tr>
<td>14</td>
<td>191.2</td>
</tr>
<tr>
<td>15</td>
<td>192.6</td>
</tr>
<tr>
<td>16</td>
<td>194.0</td>
</tr>
<tr>
<td>17</td>
<td>195.2</td>
</tr>
<tr>
<td>18</td>
<td>196.4</td>
</tr>
<tr>
<td>19</td>
<td>197.3</td>
</tr>
<tr>
<td>20</td>
<td>198.2</td>
</tr>
<tr>
<td>21</td>
<td>199.0</td>
</tr>
<tr>
<td>22</td>
<td>199.7</td>
</tr>
<tr>
<td>23</td>
<td>200.7</td>
</tr>
<tr>
<td>24</td>
<td>201.7</td>
</tr>
<tr>
<td>25</td>
<td>202.3</td>
</tr>
<tr>
<td>26</td>
<td>202.9</td>
</tr>
<tr>
<td>27</td>
<td>203.7</td>
</tr>
<tr>
<td>28</td>
<td>204.3</td>
</tr>
<tr>
<td>29</td>
<td>204.8</td>
</tr>
<tr>
<td>30</td>
<td>205.4</td>
</tr>
</tbody>
</table>

Lots of Quantitative “Data”

But also Lots of disagreements…
Standards and Sharing of Data →
New Insights and Understanding

- Define samples & protocols
- Share collected data

New Parameter
“Pressure”

(Phase Diagram)

New Understanding
- Phase boundaries
- V/L equilibrium
- Triple Point

(Steam Table)

LOTS of Quantitative and Reproducible Data
2003 Launch of the Technology Dashboard of CSSI: IMAT

To support the development, maturation, and dissemination of innovative and/or potentially transformative next-generation technologies

Innovative Technologies for Molecular Analysis of Cancer
- Proof-of-concept technologies/projects encouraged
- Milestone and technology development driven (no biology)

Application of Emerging Technologies for Cancer Research
- Validation and dissemination of platforms
- Demonstration of impact on basic and clinical research

Snapshot of Initial Applications (2003-2004)
First Step(back)- Cancer Genomics: Taking a Page from Engineers

Disease of Genomic Alterations

- Copy number
- Expression (regulation of)
- Regulation of translation
- Mutations
- Epigenome

- Systematic identification of all genomic changes
- Repeat (<500) for individual cancer
- Replicate for as many cancers as possible
- Make it publically available
Many “Thermometers”: Heterogeneity of Platforms

454
Illumina
SOLiD
Helicos
Visigen
PacBio
Ion-Torrent
Oxford Molecular
Complete Genomics
Intelligent Biosystems
LaserGen, Inc.
LaserGen
ZSGenetics
NABsys
Agilent
Febit
Raindance
Helicos
Visigen
PacBio
Ion-Torrent
Oxford Molecular
Complete Genomics
Intelligent Biosystems
LaserGen, Inc.
LaserGen
ZSGenetics
NABsys
Agilent
Febit
Raindance
Unanticipated Innovation: Samples AND Handling Matter!

“We found that specimens obtained late in the week (prolonged specimen handling) are more likely to be ER/PR negative than specimens obtained on other weekdays (regular specimen handling).”

“Garbage In...Garbage Out”

Nkoy et. al., Arch Pathol Lab Med, April 2010

Table 1. Frequency of Specimen Removal by Day of the Week

<table>
<thead>
<tr>
<th>Day</th>
<th>Cases</th>
<th>ER-Negative</th>
<th>PR-Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>16</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Monday</td>
<td>1252</td>
<td>230</td>
<td>325</td>
</tr>
<tr>
<td>Tuesday</td>
<td>1176</td>
<td>248</td>
<td>332</td>
</tr>
<tr>
<td>Wednesday</td>
<td>784</td>
<td>170</td>
<td>212</td>
</tr>
<tr>
<td>Thursday</td>
<td>904</td>
<td>191</td>
<td>259</td>
</tr>
<tr>
<td>Friday</td>
<td>919</td>
<td>216</td>
<td>276</td>
</tr>
<tr>
<td>Saturday</td>
<td>26</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>System</td>
<td>5077</td>
<td>1063</td>
<td>1418</td>
</tr>
</tbody>
</table>

Abbreviations: ER, estrogen receptor; PR, progesterone receptor.
TCGA: Connecting Multiple Standardized Sources, Experiments, and Data Types

Three Cancers- Pilot

glioblastoma multiforme (brain)
squamous carcinoma (lung)
serous cystadenocarcinoma (ovarian)

Multiple data types
- Clinical diagnosis
- Treatment history
- Histologic diagnosis
- Pathologic status
- Tissue anatomic site
- Surgical history
- Gene expression
- Chromosomal copy number
- Loss of heterozygosity
- Methylation patterns
- miRNA expression
- DNA sequence

Biospecimen Core Resource with more than 13 Tissue Source Sites
7 Cancer Genomic Characterization Centers
3 Genome Sequencing Centers
Data Coordinating Center
## Genomic “Steam Table”

### Summer 2011

| Source: UCSC Cancer Genomic Heatmaps (CopyNumber SNP6) [https://genome-cancer.ucsc.edu/] | Compiled by Jerry S.H. Lee, PhD, May 2011 |

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glioblastoma</td>
<td>470</td>
</tr>
<tr>
<td>Head &amp; neck</td>
<td>51</td>
</tr>
<tr>
<td>Lung adenocarcinoma</td>
<td>57</td>
</tr>
<tr>
<td>Lung squamous</td>
<td>159</td>
</tr>
<tr>
<td>Breast carcinoma</td>
<td>180</td>
</tr>
<tr>
<td>Stomach adenocarcinoma</td>
<td>84</td>
</tr>
<tr>
<td>Kidney clear cell carcinoma</td>
<td>260</td>
</tr>
<tr>
<td>Ovarian serous</td>
<td>520</td>
</tr>
<tr>
<td>Colon adenocarcinoma</td>
<td>198</td>
</tr>
<tr>
<td>Rectum adenocarcinoma</td>
<td>74</td>
</tr>
</tbody>
</table>

**Total:** 2053
### Genomic "Steam Table"

**Spring 2013**

<table>
<thead>
<tr>
<th></th>
<th>chr1</th>
<th>chr2</th>
<th>chr3</th>
<th>chr4</th>
<th>chr5</th>
<th>chr6</th>
<th>chr7</th>
<th>chr8</th>
<th>chr9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glioblastoma</strong></td>
<td>563</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Brain lower grade glioma</strong></td>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Head &amp; neck</strong></td>
<td>306</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thyroid carc</strong></td>
<td>401</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lung adeno</strong></td>
<td>356</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lung squamous</strong></td>
<td>343</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Breast carc</strong></td>
<td>866</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stomach adeno</strong></td>
<td>237</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Liver hep. carc</strong></td>
<td>97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kidney pap. cell carc</strong></td>
<td>103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kidney clear cell carc</strong></td>
<td>493</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ovarian serous</strong></td>
<td>559</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Uterine corpus end. carc</strong></td>
<td>492</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cervical carc</strong></td>
<td>102</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bladder carc</strong></td>
<td>135</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prostate adeno</strong></td>
<td>171</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Colon/rectum adeno</strong></td>
<td>575</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total:** 5979

Source: UCSC Cancer Genomic Heatmaps (CopyNumber GISTIC2) [https://genome-cancer.ucsc.edu/]  Compiled by Jerry S.H. Lee, PhD, March 2013
Clinical Proteomic Tumor Analysis Centers (CPTAC Phase II)

- Analyze matched TCGA samples using two approaches
  - Targeting genome to proteome
  - Mapping proteome to genome

- Develop **validated and quantitative** assays and reagents
  - Lessons from Phase I (mock 510K submission)
  - Antibody Characterization Lab

- Distribute raw and analyzed data via public data portal
# Genomic Steam Table

*Source: UCSC Cancer Genomic Heatmaps (CopyNumber GISTIC2) [https://genome-cancer.ucsc.edu/] Compiled by Jerry S.H. Lee, PhD, March 2013*

|                | cnr1 | cnr2 | cnr3 | cnr4 | cnr5 | cnr6 | cnr7 | cnr8 | cnr9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 |
|----------------|------|------|------|------|------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Total:**     |      |      |      |      |      |      |      |      |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

- **Spring 2013**
- **Brain lower grade glioma:** 180
- **Head & neck:** 306
- **Thyroid carc:** 401
- **Lung adeno:** 356
- **Lung squamous:** 343
- **Breast carc:** 866
- **Stomach adeno:** 237
- **Liver hep. carc:** 97
- **Kidney pap. cell carc:** 103
- **Kidney clear cell carc:** 493
- **Ovarian serous:** 559
- **Uterine corpus end. carc:** 492
- **Cervical carc:** 102
- **Bladder carc:** 135
- **Prostate adeno:** 171
- **Colon/rectum adeno:** 575

**Total:** 5979
Colorectal Cancer: Global proteome reveals 2 new subtypes

Transcriptome Subtypes
- MSI/CIMP
- Invasive
- CIN

Proteome Subtypes
- A
- B
- C
- D
- E

Proteogenomic characterization of human colon and rectal cancer

nature July 20, 2014
CPTAC Public Resources: http://proteomics.cancer.gov

32,273 files (6.5 TB)
314 mAbs (~$35)
554 assays

New!
Software Tools

Release Date | Disease | # of Samples | Proteins
9/4/2013 | Colorectal | 95 | ~8,000 proteins
2/20/2014 | Breast | 105 | ~12,000 phospho-proteins
6/16/2014 | Ovarian | 174** | ~10,000 proteins

**32 samples with global, phospho, and glyco-proteomics data
The Cancer Imaging Archive

TCIA Collections

The image data in The Cancer Imaging Archive (TCIA) is organized into purpose-built collections of subjects. The subjects typically have one or several clinical and/or anatomical site (lung, brain, etc.) in common. Each link in the table below contains information concerning the scientific information about how to obtain any supporting non-image data which may be available, and links to view or download the image. This will have reproducibility in scientific research. TCIA supports Digital Object Identifiers (DOIs) which allow users to share subsets of TCIA data in their research manuscript. You can subscribe to our Email List or social media feeds to be notified of new collections and changes.

http://cancerimagingarchive.net
Where Do We Go From Here?

Is it JUST More Data?

Time? (Evolution)
Physical Sciences-Oncology Network (PS-ON): Phase II

**Thematic Areas:** The Physical Dynamics of Cancer  |  Spatial Organization and Cancer

---

**PS-OC PAR – PAR-14-169**
- U54 mechanism up to $1.5M (DC)/year
  - 2-3 Projects/Center
  - Education/Outreach Unit
  - Pilot/Trans-Network Projects
- Competition under **Type 1** (i.e., new Centers)
- 3rd Receipt Date Nov 26, 2015 (LOI Oct 14, 2015)

---

**PS-OP PAR – PAR-15-021**
- U01 mechanism up to $500K (DC)/year
  - 1 Project
  - Trans-Network Projects
  - Pilot Projects **Optional**
- 2nd Receipt Date Nov 26, 2015 (LOI Oct 14, 2015)
PAR-14-285: Innovative Research in Cancer Nanotechnology (IRCN)

- U01 Mechanism up to $450K in Direct Cost per year [5 years total]
- **Milestone-driven** focus on developing further understanding of *nanomaterial interactions with biological systems* and the *mechanisms of nanoparticle delivery* to the *desirable* and *intended cancer targets* *in vivo*
- 2nd Receipt Date April 15, 2015; Total of 6 receipt dates

NOT-CA-14-035: Nanotechnology Research Training Program

- T32 Mechanism
- Support for the development and operation of cancer nanotechnology research training programs to educate graduate students and postdoctoral fellows in the multi-disciplinary field of cancer nanotechnology research
- **Next Receipt Date** May 25, 2015; Standard receipt dates
**Program Objective:**
Challenge the scientific community to creatively think about and answer **important, but non-obvious or understudied**, provocative questions (PQs) in cancer research.

**Phase 1:** PQs solicited through website and workshops (~$21M/yr)
- **FY12**
  - 24 original PQs for R01/R21 apps (56 awards)
- **FY13**
  - 24 new PQs for R01/R21 apps (29 awards)
- **FY14**
  - 24 final PQs for R01/R21 apps (83 awards)

**Phase 2:** PQs solicited and managed by NCI Q-Teams [$20M/yr]
- **FY15**
  - 12 new PQs for R01/R21 apps (Spring 2015)

**PQ13 (2011):** Can tumors be detected when they are two to three orders of magnitude smaller than those currently detected with in vivo imaging modalities?

**PQB4 (2013):** What methods can be devised to characterize the functional state of individual cells within a solid tumor?

---

**Program Director**
emily.greenspan@nih.gov

**Project Manager**
michelle.berny-lang@nih.gov
Innovative Molecular Analysis Technology Program in 2015 [$11M]

100 active projects (478 to date)

Due Dates: 3/17/15, 6/17/15, and 9/22/15

Tony Dickherber
tony.dickherber@nih.gov
Acknowledgements/Thanks to the “Secret Ingredients”
Learn More About Us...

http://cssi.cancer.gov

Jerry S.H. Lee, PhD
jerry.lee@nih.gov
NIH Early Career Reviewer Program

PURPOSE
• Train and educate qualified scientists
• Help emerging researchers advance their careers by exposing them to review experience
• Enrich the existing pool of NIH reviewers

REQUIREMENTS
• ≤ 1 mail-in review
• Faculty appointment or equivalent
• Active independent research program
• Recent publications

Interested in serving as an NIH reviewer?
Send your CV to petersonjt@csr.nih.gov

http://public.csr.nih.gov/ReviewerResources/BecomeARReviewer/ECR/

View the Video!
Inside the NIH Grant Review Process
CSR has produced a video of a mock study section meeting to provide another inside look at how NIH grant applications are reviewed for scientific and technical merit.
View the video via the Web:
http://www.csr.nih.gov/Video/Video.asp