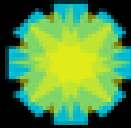


Pathology Informatics 2012: Personalized Medicine



APIII and LabInfoTech Summit present

PATHOLOGY
Informatics 2012

October 9-12, 2012
Chicago, Ill.



The Pathology Informatics Roadmap for Implementing Cancer Personalized Medicine[†]

Michael J. Becich, MD PhD - becich@pitt.edu
Chairman, Department of Biomedical Informatics

<http://www.dbmi.pitt.edu>

University of Pittsburgh School of Medicine

[†] Input from Personalized Medicine and Next Generation Sequencing Task Forces at University of Pittsburgh Cancer Institute (UPCI)

Disclosures of COI for 2012 for MJB

- Corporate Support for API, Strategic Summit and Pathology Informatics 2012
 - 450K projected for 2012 [Cerner, Leica, McKesson, SCC Soft Computer, Sunquest - CAP Today – ASCP, Definiens, LABVANTAGE, PathCentral - Aperio, ARUP, Atlas Medical, Aurora Interactive, Data General, Halfpenny Technologies, Hamamatsu, HistoIndex, Knome, LifePoint Informatics, LigoLab, Milestone, mTuitive, NinePoint Medical, NovoPath, Odin, Orchard Software, Philips, Softek Illuminate, Software Testing Solutions, StarLIMS, Ventana, Voicebrook]
- Corporate Sponsored Research – ZERO (1st time in 15 years!!!)
- Startup/Public Companies (Consulting, Royalties/Licensing, Stock - MJB):
 - De-ID Data Corp – de-identification software (licensing agreement)
<http://www.de-idata.com/>
 - Empire Genomics - Scientific Advisory Board (<http://www.empiregenomics.com>)
 - Omnyx – Joint Venture with UPMC and GE (<http://www.omnyx.com>)
 - iKaryos Diagnostics – Scientific Advisory Board (<http://www.ikaryos.com/>)
 - NinePoint Medical – Scientific Advisory Board (www.ninepointmedical.com)
- Consultancy (honorarium)
 - Cancer Center Consulting – MD Anderson, Karmanos Cancer Center, Moffitt Cancer Center, NFGC, Penn State CC, Roswell, U Buffalo, UMDNJ, U Colorado, VCU
 - CTSA Consulting – Duke, Emory, MCW, Northwestern, UAK, UC Davis, UCLA, U Chicago, U Cincinnati, U IN, U KY, UC Davis, UMich, UMN, UNC, UNM, UWI and Wash U
 - Pathology – GoPath DX (honorarium)

Personalized Medicine Task Force

University of Pittsburgh Cancer Institute effort by MJB and:

- **Adrian Lee, PhD – Genomics of Breast Cancer**
- **Scot Stevens – CIO Cancer Center**
- **Mike Davis – Senior Programmer**
- **Next Generation Sequencing (NGS) Task Force**
 - Rama Gullapalli, MD PhD – Computational Pathology Fellow
 - Jeff Kant, MD PhD – Director of Molecular Diagnostics Lab
 - Ketaki Desai, PhD – Research Associate, DBMI
 - Kicked Off with “Cancer Genomics” Symposium March 2011

Speakers from 2011 UPCI Symposium

Personalized Genomic Medicine Technologies, Training & Clinical Applications

Mark S. Boguski, M.D., Ph.D., F.C.A.P.
Center for Biomedical Informatics, Harvard Medical School
Department of Pathology, BIDMC
March 10, 2011



Beth Israel Deaconess
Medical Center



A teaching hospital of
Harvard Medical School

Personalized Genomic Analyses of Human Cancer

Victor Velculescu, M.D., Ph.D.
Ludwig Center for Cancer Genetics and Therapeutics
Johns Hopkins Kimmel Cancer Center

UPCI Symposium
March 10, 2011



THE
GENOME
INSTITUTE
at Washington University

Recent Advances in the Analysis of Cancer Genomes

Richard K. Wilson, Ph.D.
Washington University
School of Medicine



Structural Rearrangements in Breast Cancer Genomes

Adrian V. Lee, Ph.D.
Visiting Professor,
Dept. Pharmacology and Chemical Biology
Director, Women's Cancer Research Center



University of Pittsburgh
University of Pittsburgh Cancer Institute



Goals for today's discussion

- Identifying role of Path Info and the LIS in implementing cancer personalized medicine
- Implementing an Enterprise Analytic Data Warehouse and the Role of Pathology Informatics
- Next Generation Sequencing and impact on cancer personalized medicine and Pathology
- Making the Case for “Computational Pathologists” – a Partnership Between Pathology and Biomedical Informatics

Introduction

- **How will Pathology Informatics and the LIS impact personalized cancer care?**
- **Key areas of evolution needed in LIS:**
 - Personalized Medicine and the LIS – Will Require the Next Generation of Warehousing of Data, Tissue/Blood and DNA
 - LIS role in “Real” Decision Support
 - No effective EMRs for Cancer Care – “Actionable” Care
 - No integration of disparate data types (outcomes/CER)
 - Molecular Path–Role of Next Generation Sequencing

Two Interdependent Worlds...

**Disease
World**

Pathology Informatics

Bioinformatics & Comp/Sys Bio

This is the realm (and the need for) of "computational pathology"

LIS

**Tissue
Banking**

**Molecular
Pathology**

- Diagnosis
- Histological Subtypes
- Grading
- Staging
- LN Involvement
- Margins
- Localization and Size
- Molecular Markers
- Sequence
- SNPs
- Methylation Status
- Biospecimens Inventory
- Genomic DNA Store
- Disease DNA Store

OMIM
Clinical
Synopsis

Genome

Phenome

Variome

Microbiome

Proteome

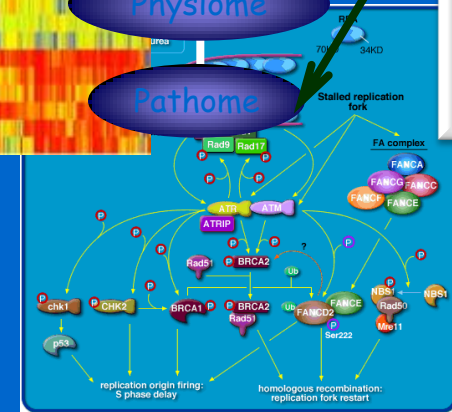
Interactome

Metabolome

Physiome

Pathome

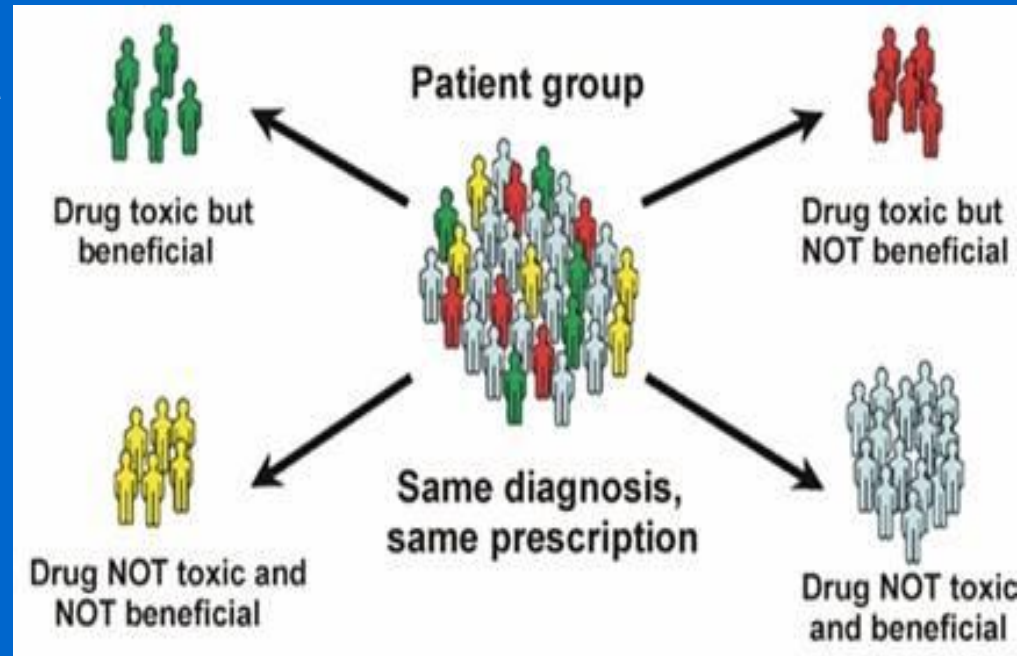
Pharmacogenom



With Some Data Exchange...

Personalized Medicine and Theranostics

- Theranostics is applying the power of pathology to predict therapeutic response
- Determining whether a treatment is working
- Monitoring healthy people to detect early signs of disease
- Producing safer drugs by predicting potential for adverse effects earlier
- Targeting groups of people most likely to benefit from a drug, while keeping its use from those who may be harmed by it
- Producing better medical products
- Ready access to information
- Decreasing health care costs



Modified from: From Schwartz, CAP, 2009

Emerging Developments and Your Future in Pathology

Personalized Medicine Requires Biomedical Informatics Science

• Development of a Analytical Data Warehouse is key!!!

- This will require biomedical informatics expertise in several areas:
 - Expertise in multidimensional **database design and query** (computer science collaboration?)
 - **Natural Language Processing** of text (H&P, Consults, Discharge, etc..)
 - Structured capture of key medical data will require controlled **vocabularies** and implementation of a cancer **ontology** (EVS of NCI?)
 - **De-identification** of text for sharing with researchers (De-ID Data Corp)
 - Implementation of **decision support** algorithms to make genomic data “actionable” (**Bayesian methods/artificial intelligence**)
 - **Human-computer interaction** (usability) studies to ensure user friendly design and query for reduction in practice for clinicians
- This is only for the ADW, for analyzing NGS data you will need significant **bioinformatics*** expertise (faculty, staff and trainees).

Proposed Cancer Personalized Medicine Information Management System

Omics Data

- TCGA
- UPMC
- Other

1. Clinical Data Extraction

2. Enterprise Analytic Data Warehouse

3. Clinical Decision Making

Biobank

Pharmacy dBs

Oncology EMR

Laboratory Information Systems

1. Ontology
2. Harmonization
3. Synoptic reporting
4. Dx/Staging/Response input

Omics Data Bank (ODB)

Clinical Data Center (CDC)

Integration Analysis

Governance\Security\Tracking

Comparative Effectiveness Analysis

- Delivery via:
1. Pathways
 2. Oncology EMR
 3. CRMS



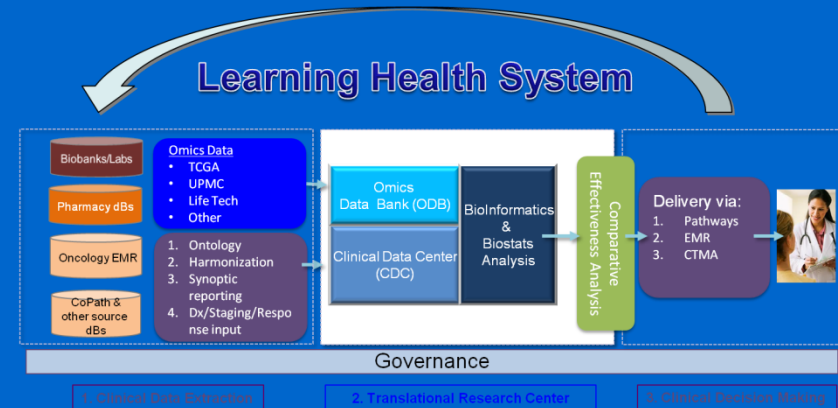
Cancer Center HIT

Vendor Partnership

Cancer Center HIT

Activities Underway for EADW:

- **Harmonization** of data elements from disparate systems into a unified data model & ontology
- **Extraction of standardized clinical data** into a common data warehouse
- **Extraction of standardized “omics” data** into the common data warehouse
- **Integration of clinical and omics data** linking key data elements
- **Comparative effectiveness analysis of genetic testing** as predictors of key clinical outcomes as well as cost effectiveness of possible therapeutic options
- **Ongoing outcomes analysis** to use data from the integrated data warehouse to confirm the predictions made by the clinical decision making or to define more targeted therapies or new studies



Drugs/Genes Linked in Oncology

- **Drugs:** Arsenic Trioxide, Brentuximab, Vedotin, Busulfan, Capecitabine, Cetuximab (2), Crizotinib, Dasatinib, Erlotinib, Fulvestrant, Gefitinib (2), Imatinib (4), Irinotecan, Lapatinib, Mercaptopurine, Nilotinib (2), Panitumumab (2), Rasburicase, Tamoxifen, Thioguanine, Tositumomab, Trastuzumab, Vemurafenib – **Early Inventory = 30 FDA Approved Drugs***
- **Genes:** PML/RARa, CD30, Ph Chromosome, DPD, EGFR, KRAS, ALK, ER receptor, CYP2D6, C-Kit, PDGFR, FIP1L1-PDGFRa, UGT1A1, Her2/neu, TPMT, UGT1A1, KRAS, G6PD, ER receptor, TPMT, CD20 antigen, Her2/neu, BRAF – **Early Inventory = 24 genes**

From Gullapalli et al., 2011 (accepted JPI)

* numbers in parentheses are numbers of genetic polymorphisms affecting the drug

Bioinformatics Team, Molecular Pathology and Librarian in our
Biomedical Informatics PhD Program Curating Drug Candidates for
Public Sharing

New Technologies and Their Impact

- **Next Generation Sequencing (NGS)**
 - Massively parallel sequencing is here and 2nd generation machines (ABI, Illumina, etc...) are being replaced by 3rd generation technology (Ion Torrent, PacBio, etc...)
 - Implications are that an entire human genome can be done in a laboratory in about a day to a month for about \$10K (depending on application)
 - Goal with new technology is hours to days and about \$1K!!!

Analyzing Cancer Genomes

Cancer genomes contains a lot of genetic damage.

- Many of the mutations in cancer are incidental.
- Initial mutation disrupts the normal DNA repair/replication processes.
- Corruption spreads through the rest of the genome.

Today: Find the “driver” mutations amongst the thousands of “passengers.”

- Identifying the driver mutations will give us new targets for therapies.

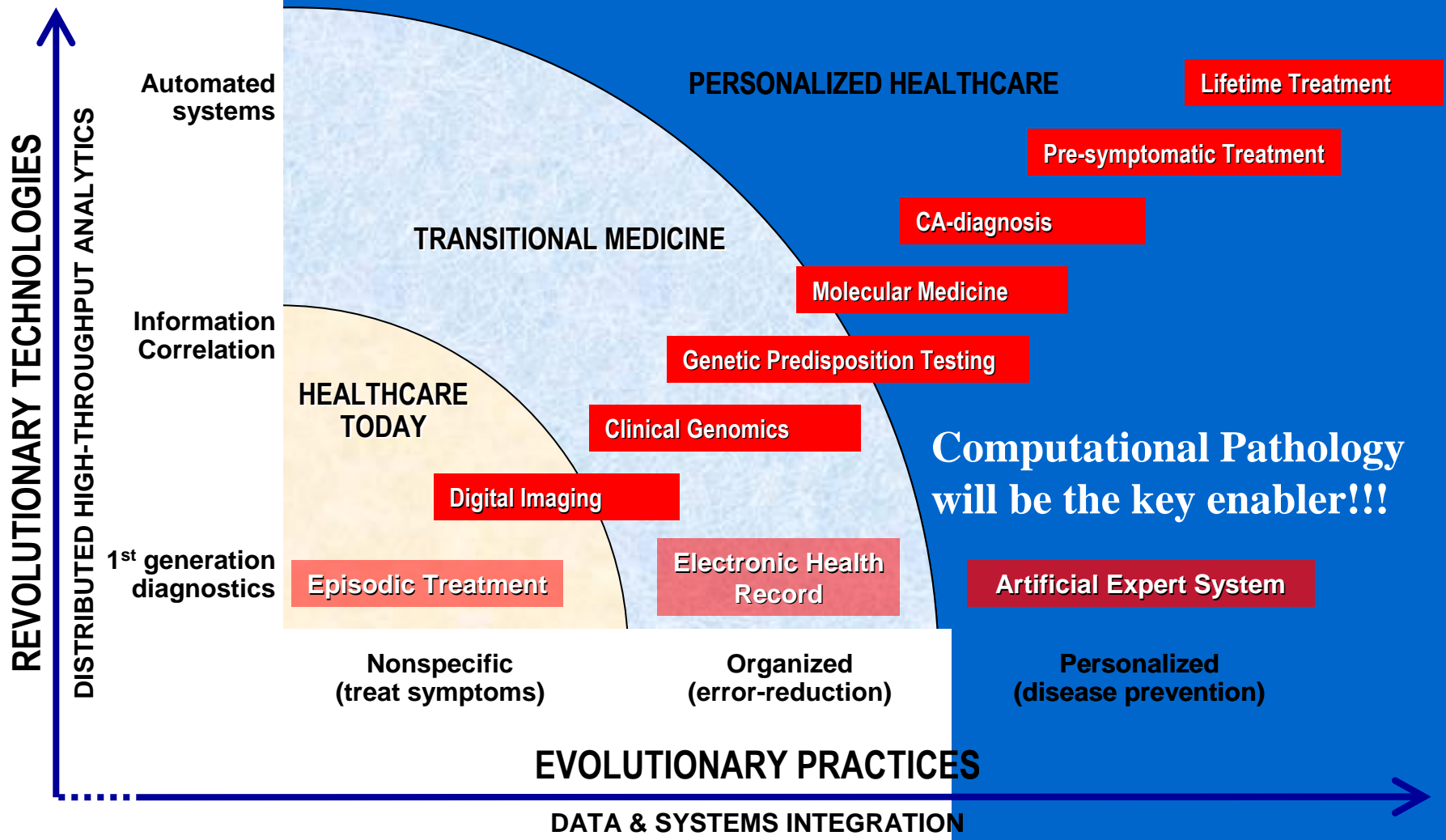
Tomorrow: Analyse the cancer genome of every patient in the clinic (now underway at Wash U).

- Variations in a patient and cancer genetic makeup play a major role in how effective a particular drugs will be.
 - Clinicians will use this information to tailor therapies.
- • • • • • • • • •

Personalized Medicine Will Rely Heavily on Pathology

- **Tumor diagnostics are becoming increasingly important and complex**
 - In our aging population patients survive with multiple cancer occurrences & die with their tumors not from them
- **Pathology itself is changing from primarily diagnostics to increasingly complex theranostics (personalized medicine)**
 - NGS will have a major impact on this area!!!
- **Pathology Informatics, particularly the LIS and its communication with bioinformatics tools/databases will be key to the implementation of personalized medicine**
 - Need to couple genotype with phenotype (clinical information) and outcomes (Comparative Effectiveness Research or CER).

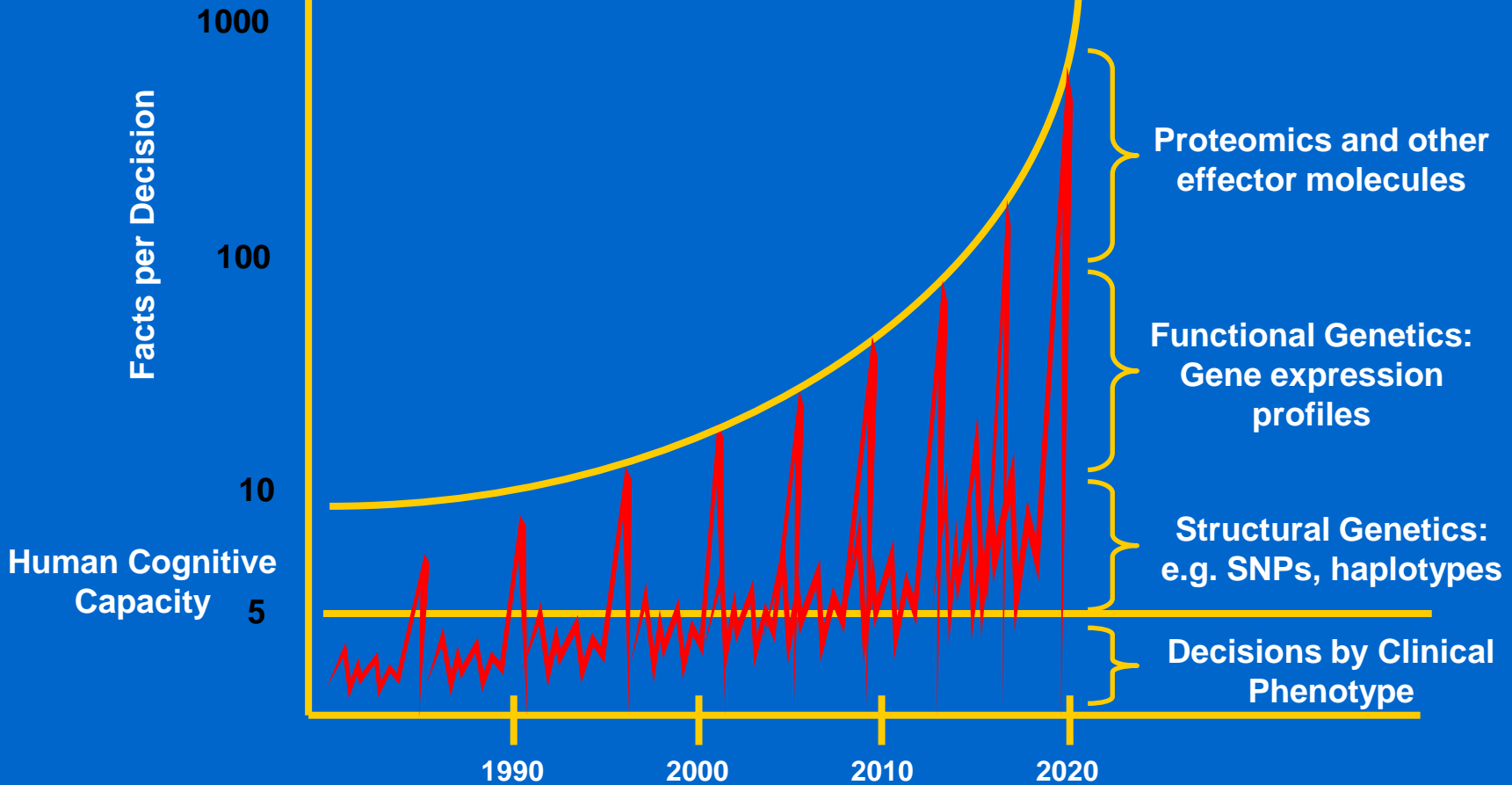
As Medicine evolves from the treatment of illness to aggressive promotion of wellness – genomics/informatics will be key!!!!



Barriers to Implementing NGS in Clinical Practice

- **Superiority of NGS to current Molecular Diagnostic Tools (Quantitative PCR, etc...) must be proven**
 - Collaboration with industry for testing, validating and implementing “stable and version controlled” hardware will be key
- **Bioinformatics analysis of NGS data must be “reduced” to practice**
 - Mostly done by research groups today, collaboration is key
- **Clinically certified laboratories with the proper technical infrastructure is also a critical barrier**
 - Infrastructure for **storage of specimens, data mass storage, high speed network connectivity and supercomputing** are all critically needed
- **R&D is Key - New U01 NHGRI grant to clinically implement sequencing to clinical practice – see <http://grants.nih.gov/grants/guide/rfa-files/RFA-HG-10-017.html>**

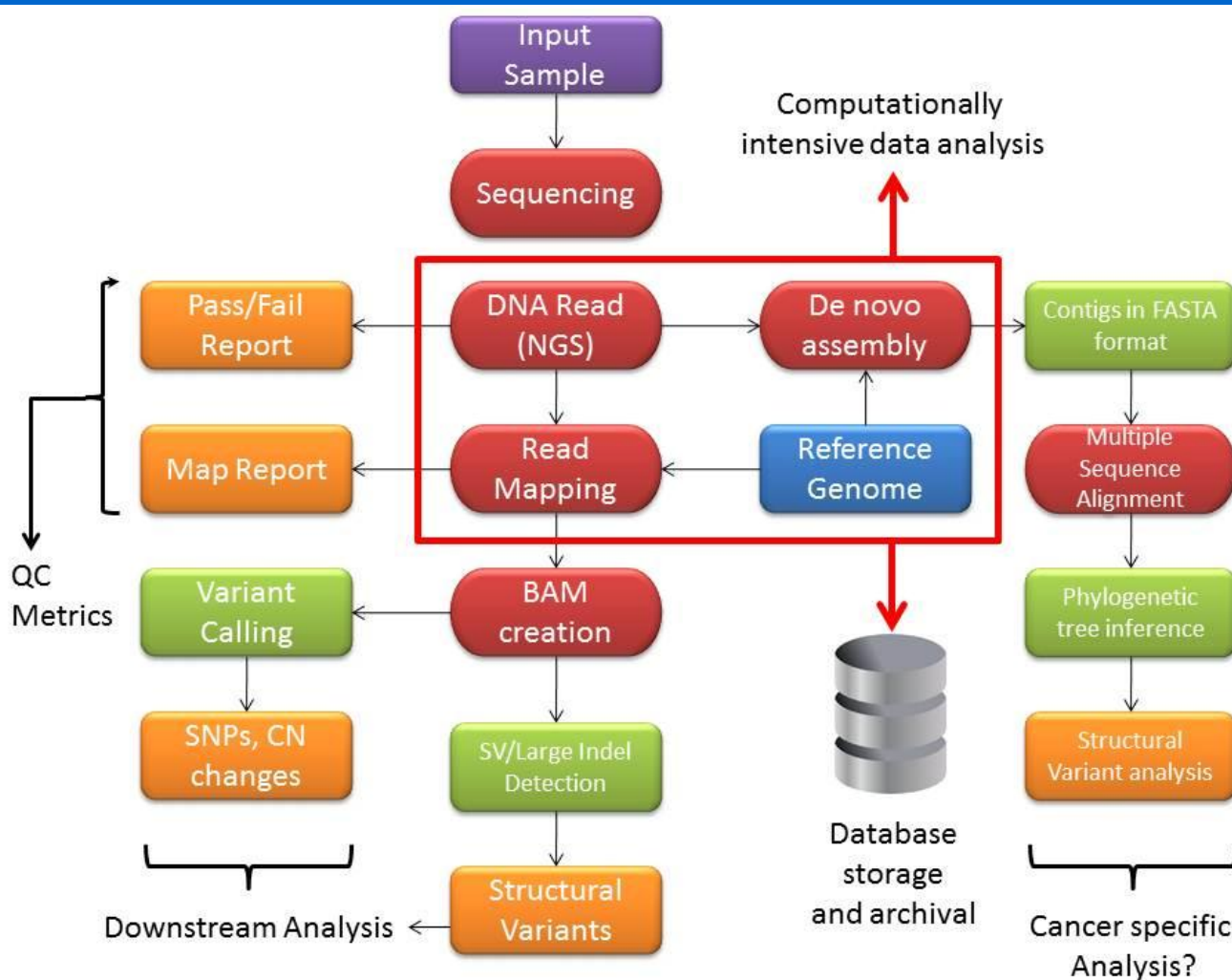
The demise of expert-based practice is inevitable



From William Stead: http://courses.mbl.edu/mi/2009/presentations_fall/SteadV1.ppt
& http://www.mbl.edu/education/courses/special_topics/pdf/med_sched09_fall.pdf

From “NGS: Implementation Guidelines and the Role of Pathology and Informatics”, Gullapalli, et al (submitted JPI)

NGS Analysis for Cancer – Gullapalli, 2011



- **Multiple Issues including:**
 - Reference Genomes – {huge problem}
 - Tertiary Analysis (cancer specific)
 - How to do QC on the analysis? (no standards)

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Recommendation – Pathology Informatics & Personalized Medicine

- **Phase One**

- Build Multidisciplinary (Dedicated) Team
 - Oncologist, Pathologists, Translational Researchers, Tissue Bankers and Pathology Informatics
 - Build Data Warehouse and NGS Strategy
- Focus on Developmental Informatics Agenda
 - Secure Intramural (Health System) & Extramural Funding

- **Phase Two**

- Implement Pilot Programs which involve:
 - Report Integration, Data Warehousing, Next Generation Sequencing and Decision Support
- -
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Washington University – A Leader in NGS in Practice

ClusterFASTQ: A Method for the Identification of Translocations in Clinical Next Generation Sequencing Data

Eric J. Duncavage¹, Haley Abel²

¹Department of Anatomic and Molecular Pathology, ²Division of Statistical Genetics, Washington University College of Medicine, St. Louis, MO. E-mail: eduncavage@path.wustl.edu

Clinical Genomicist Workstation

Rakesh Nagarajan¹, Mukesh K. Sharma¹, Joshua Phillips², Saurabh Agarwal², Wesley S. Wiggins², Savita Shrivastava¹, Sunita B. Koul¹, Madhurima Bhattacharjee¹, Caerie D. Houchins¹, Raghavendra R. Kalakota¹, Bijoy George¹, Rekha R. Meyer¹, David H. Spencer¹, Christina M. Lockwood¹, TuDung T. Nguyen¹, Eric J. Duncavage¹, Hussam Al-Kateb¹, Catherine E. Cottrell¹, Suhasini Godala², Ravi T. Lokineni², Sameer M. Sawant², Vasudev Chatti², Suresh Surampudi², Raja Rao Sunkishala², Ramakant Darbha², Sharath Macharla², Jeffrey D. Milbrandt³, Herbert W. Virgin¹, Robi D. Mitra³, Richard D. Head³, Shashikant Kulkarni¹, Andrew Bredemeyer¹, John D. Pfeifer¹, Karen Seibert¹

¹Department of Pathology and Immunology, Washington University in St. Louis, St. Louis, MO, ²SemanticBits LLC, Herndon, VA, ³Department of Genetics, Washington University in St. Louis, St. Louis, MO. E-mail: rakesh@wustl.edu

Progress to date:

- 250 Oncology Patient Tumors
- Reporting Workflow Established
- Not using a commercial solution
- Real opportunity for Pathology Informatics Units

Already in J Path Informatics - Pages 38 & 42
http://www.jpathinformatics.org/temp/JPatholInform3137-3932596_105525.pdf

Vanderbilt University – A Leader in NGS in Practice

The Diagnostic Management Team : How it Works and its Clinical and Financial Implications

Michael Laposata, MD, PhD
Edward and Nancy Fody
Professor of Pathology
Vanderbilt University School of Medicine
Pathologist in Chief, Vanderbilt University Hospital

Progress to date:

- Implemented Cardiology Drugs and Genomic Phenotyping – clopidogrel, warfarin and statins
- Reporting Workflow Established
- **Not Using a Commercial Solution**
- U Pitt, Geisinger and Northwestern have an R18 implementation grant pending with Epic and Cerner help
- Real opportunity for Pathology Informatics

**On Path Info website – Wednesday Plenary Session –
Personalized Medicine**

http://pathinfoarchives.dbmi.pitt.edu/apiii_archives/2012/Wednesday/Plenary/Laposata/Diagnostic_Management_Team/Diagnostic_Management_Team.html

-
-
-

Recommendation – Expansion Strategies

- **Phase Three**

- Partner with other Specialties
 - Pharmacology, Biostatistics and Health Care Economists
- Scale out pilot programs
 - Expansion in Cancer and Non-Cancer Programs
- Leverage infrastructure to build out research funding
 - Molecular Pathology Informatics
 - Personalized Medicine for Cancer
 - Pathology Informatics Science for Honest Brokering of Phenotype Data and Genomic Data for Translational Research

Computational Pathology Fellowships

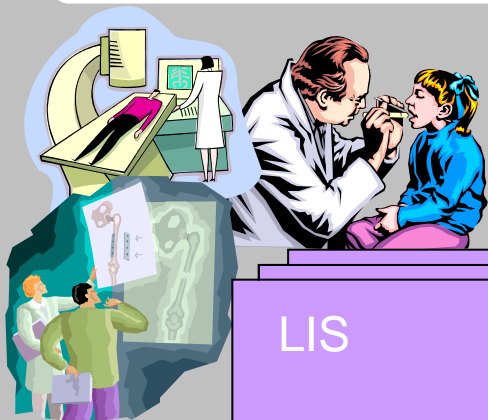
- **Why this “new” fellowship is key!**
 - Pathology Informatics is now established as a “division” or “subspecialty” in many practices
 - This is perceived as a service component to Pathology Practice – the Information Technology component
 - Academic Pathology Informatics is emerging
 - Struggles from the lack of defined research focus
 - PathoBioinformatics (coined by Friedman, 2007) is the domain of Computational Pathology
 - This is the true “Informatics” component of Path Info
 - These fellows will help build the research leaders!!!

Summary

- **Pathology Informatics is critical to the development of a Cancer Personalized Medicine strategy and Enterprise Analytical Data Warehouse in partnership with Health System Health Information Technology (HIT)**
- **Aggressively expand research opportunity and recruit trainees in Computational Pathology, Pathology Informatics and Biomedical Informatics**
- **Influence leadership to grow the solutions in this space (begin with high quality fellows)!!!**

the Ultimate Goal.....

Pathology Informatics



LIS

Tissue Bank

Molecular Pathology

Modified from Anil Jegga

Division of Biomedical Informatics,
Cincinnati Children's Hospital Medical
Center (CCHMC)
Department of Pediatrics, University of
Cincinnati
<http://anil.cchmc.org>

- Diagnosis
- Histological
- Grading
- Staging
- LN Involvement
- Margins
- Localization
- Molecular Markers
- Sequence
- SNPs
- Methylation Status
- Biospecimens Inventory
- Genomic DNA Store
- Disease DNA Store

Disease World

PubMed

► Personalized Medicine
► Decision Support System
► Outcome Predictor
► Course Predictor
► Diagnostic Test Selector
► Clinical Trials Design
► Hypothesis Generator.....

Computational Pathologists

Bioinfo & Comp/Sys Bio

Regulome

Genome

Transcriptome

Variome

Proteome

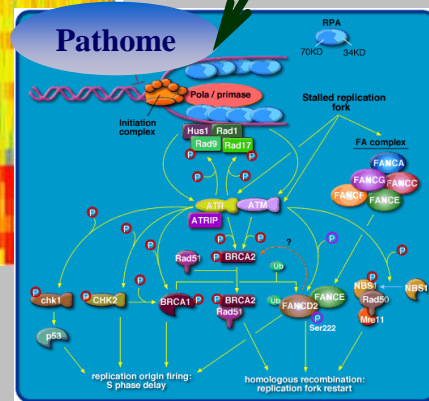
Interactome

Metabolome

Physiome

Pharmacogenome

Pathome



-
-
-
-
- End of Talk – e-mail me at becich@pitt.edu if you have
- questions/clarifications not covered in the discussion.
-
-
-

NOTE: E-mail me if you want PDFs of articles or presentation.



**Thank you for attending
Pathology Informatics 2012
(our 17th Annual meeting!!!)**

• Pathology Informatics 2012 - 17th Annual Conference • • October 9-12th, Chicago, IL

1996-1999 Anatomic Pathology,
Imaging & Internet

2000-2003 Anatomic and Clinical
Pathology

2004-2007 Oncology &
Bioinformatics

2008-11 Imaging Informatics –
Radiology and Pathology

2012- Lab InfoTech Summit &
APIII present
Pathology Informatics 2012
Chicago, IL

<http://pathinformatics.pitt.edu>



The screenshot shows the official website for the Pathology Informatics 2012 conference. The header features the APIII and LabInfoTech Summit logo, the conference title "PATHOLOGY Informatics 2012", the dates "October 9-12, 2012", and the location "Chicago, IL". Navigation links include "Home", "Contact Us", and a search bar. A secondary navigation bar lists "About", "2012 Schedule", "Faculty", "Exhibitors", and "Venue". The main content area is divided into several sections: "APIII + Lab Infotech Summit = Pathology Informatics 2012", "CONFERENCE UPDATES" with links for presentations, schedule, and Twitter, a large image of the Chicago skyline, "Conference Tracks, Plenary Lectures and Workshops" detailing three tracks (Clinical Information Management, System Support and Connectivity, Digital Imaging) and various workshops, "Conference Highlights" including travel awards and CME credit, and a "Plenary Lectures" section. A "Conference Schedule" link is also present at the bottom.

Association for Pathology Informatics (API)

<http://www.pathologyinformatics.org>



“...to advance the field of pathology informatics as an academic and a clinical subspecialty of pathology...”

A screenshot of the Association for Pathology Informatics (API) website. The header includes the API logo, the full name 'Association for Pathology Informatics', and a 'Member Lc' status. A navigation bar contains links for Home, Membership, Meetings, Journal, Awards, Membership Forms, Training, Donate, Sponsors, and Press Releases. The main content area is divided into three columns. The left column has sections for 'Job Opportunities' (with links to Fellowship Posts and Other Job Posts) and 'Corporate Sponsors' (listing logos for Altosoft, Atlas Medical, Cerner, ID Solutions for Healthcare, General Data, Lifepoint Informatics, mTuitive, Omnyx, and SCC). The middle column features a 'Deadline for Pathology Informatics 2012 Travel Award Application - June 15, 2012' with a description of the award and a link to the application page. Below this is a section for 'Online Registration and Renewal Available on the API Website' with a link to the membership page. The bottom of the middle column announces the 'API Strategic Summit: The Future of Pathology Informatics and the LIS' in Pittsburgh, June 7 and 8, with details about the event and a link for more information. The right column is titled 'Teaching Institution Sponsors' and lists logos for Einstein (Albert Einstein College of Medicine of Yeshiva University), Cleveland Clinic, Dalhousie University, Emory University School of Medicine, Henry Ford Health System, Massachusetts General Hospital, UMDNJ (University of Medicine & Dentistry of New Jersey), University at Buffalo (The State University of New York), The University of Alabama at Birmingham, and The University of Arizona.

:Journal of Pathology Informatics

• Co-Editors Liron Pantanowitz, MD PhD and Anil Parwani, MD PhD

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Informatics as the
Home for Digital
Pathology -
Great Academic
and Strategic
Partnership with
Multiple
Benefits!!!

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Publication of Association for Pathology Informatics, USA

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 **Latest published articles**

Review of advanced imaging techniques

Yu Chen, Chia-Pin Liang, Yang Liu, Andrew H Fischer, Anil V Parwani, Liron Pantanowitz

Pathology informatics encompasses digital imaging and related applications. Several specialized microscopy techniques have emerged which permit the acquisition of digital images ("optical biopsies") a...

J Pathol Inform 2012, 3:22 (28 May 2012)

[\[Abstract\]](#) | [\[HTML Full text\]](#) | [\[PDF\]](#) | [\[Mobile HTML Full text\]](#) | [\[EPub\]](#)

Managing beyond the laboratory information system

Gregory J Buffone

Sir, Prior to the advent of electronic health records (EHRs) the issue of segregating or integrating laboratory observations reported from two or more independent laboratories was of little or no co...

J Pathol Inform 2012, 3:21 (24 May 2012)

[\[Abstract\]](#) | [\[HTML Full text\]](#) | [\[PDF\]](#) | [\[Mobile HTML Full text\]](#) | [\[EPub\]](#)

Computer-assisted imaging algorithms facilitate histomorphometric quantification of kidney damage in rodent renal failure models

Marcin Klapczynski, Gerard D Gagne, Sherry J Morgan, Kelly J Larson, Bruce E LeRoy, Eric A Blomme, Bryan F Cox, Eugene W Shek

Introduction: Surgical 5/6 nephrectomy and adenine-induced kidney failure in rats are frequently used models of progressive renal failure. In both models, rats develop significant morphological...

J Pathol Inform 2012, 3:20 (28 April 2012)

[\[Abstract\]](#) | [\[HTML Full text\]](#) | [\[PDF\]](#) | [\[Mobile HTML Full text\]](#) | [\[EPub\]](#)

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Robert Half Technology (334)
Kforce (245)
TEKsystems, Inc (205)

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Atlanta (454)
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Job Title / Description (show titles only)	Company	Location	Posted
 Biomedical Informatics Software Engineer - View similar jobs Job type: Full-Time Position Summary:The division of medical informatics seeks highly motivated individuals with ... A Bachelors degree in computer ... View full job description Save to MyCareerBuilder Email to a friend	University of Kansas Medical Center	KS - Kansas City	1 Week Ago
 Clinical Informatics Nurse Specialist - View similar jobs Job type: Full-Time	Marvel Consultants, Inc.	MD - Maryland	2 Weeks Ago

CoS²BBI and “The Pipeline”

- **Provide High School Students with an introduction to Computational/Systems Biology and Biomedical (Pathology) Informatics as a research career (CoSSBI Summer Academy)**
- **Prepare them for what college courses they would need to be competitive in computation and informatics via an immersion in our science.**
- **Give them a “real” research experience unlike other summers at Brown, Duke, Hopkins, Stanford, etc...**
- **Encourage them to undergraduate degree programs in bioinformatics (like ours at Pitt)**
- **Recruit them to Pathology (and Biomedical) Informatics**

Pitt's Bioinformatics Undergraduate Degree



University of Pittsburgh

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BIOINFORMATICS <http://www.cs.pitt.edu/undergrad/bioinformatics/>

ABOUT THE DEGREE

Bioinformatics is the theory, application and development of computing tools to solve problems and create hypotheses in all areas of biological sciences. Biology in the post-genome world has been and continues to be transformed from a largely laboratory-based science to one that integrates experimental and information science. Bioinformatics has contributed to advances in biology by providing tools that handle datasets too large and/or complex for manual analysis. Examples of some of these tools include assembling the DNA sequence of entire genomes, gene finding algorithms, microarray expression analysis, molecular systems modeling, and biomarker discovery from mass spectra. Computational tools are central to the organization, analysis and harvesting of biological data at the level of macromolecules, cells and systems. Consequently, there is a growing need for trained professionals who understand the languages of biology and computer science. Biologists trained in more traditional programs may not have a working knowledge of statistics and algorithms, whereas computer scientists trained in more traditional programs may not have a working knowledge of the chemistry and biology required in the field.

The Undergraduate Bioinformatics Degree at the University of Pittsburgh, which is operated jointly by the Departments of Biological Sciences and Computer Science, program offers training that builds a solid foundation in chemistry, biology, computer science, mathematics and statistics. This training will enable students to communicate fluently with experts across these disciplines, and to have the skills necessary to apply computing tools to address contemporary problems in biology and medicine. The training will enhance the professional opportunities for undergraduates to pursue careers in pure or applied research in academia, government, pharmaceutical, medical, or biotechnology sectors.

QUICK LINKS

[Course Descriptions](#)

[Spring 2012 Schedule](#)

[Summer 2012 Schedule](#)

[Fall 2012 Schedule](#)

[Financial Assistance](#)

<< **August 2012** >>

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U Pitt's Bioinformatics Course Curriculum

http://www.cs.pitt.edu/undergrad/bioinformatics/bsbi-sample_schedule.php

- Curriculum Loaded with Biology and Computer Science
- Focused learning in:
 - Chemistry
 - Math
 - Statistics
- Includes a “real” research experience with “Capstone” mentored research project.
- 2 yrs electives (CoSB & BMI)
- Work your summers in a research laboratory with the Department of Biomedical (Pathology) Informatics
 - Now a job guarantee!!!
 - i-STEM (Informatics for Science Technology Engineering and Math)
 - 501c3 (not for profit) now proposed to fund summer research for high school and college undergrads

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Bioinformatics Sample Schedule

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BIOINFORMATICS SAMPLE SCHEDULE

SAMPLE SCHEDULE PLAN

(see a Bioinformatics advisor for a customized schedule plan)

Fall 1

BIOSC 0150(3 credits)
CHEM 0110 (4 credits)
CS 0007 (3 credits)
2 GEN ED (6 credits)
Total 16

Spring 1

BIOSC 0160(3 credits)
CHEM 0120 (4 credits)
CS 0401 (4 credits)
1 GEN ED (3 credits)
Total 14

Fall 2

CS 0445 (3 credits)
CS 0441 (3 credits)
CHEM 0310(3 credits)
MATH 0220(4 credits)
1 GEN ED (3 credits)
Total 16

Spring 2

BIOSC 0350(3 credits)
CHEM 0320 (3 credits)
STAT 1000 (4 credits)
2 GEN ED (6 credits)
Total 16

Fall 3

BIOSC 1810(3 credits)
CS 1501 (3 credits)
MAJ ELECT (3 credits)
2 GEN ED (6 credits)
Total 15

Spring 3

BIOSC 1903(2 credits)
BIOSC 1540(3 credits)
MAJ ELECT (3 credits)
2 GEN ED (6 credits)
SEMINAR (1 credit)
Total 15

Fall 4

CAPSTONE (3 credits)
2 GEN ED (6 credits)
STAT 1221(3 credits)
MAJ ELECT(3 credits)
Total 15

Spring 4

2 GEN ED (6 credits)
MAJ ELECT (3 credits)
OPEN ELECT(3 credits)
UG research(3 credits)
SEMINAR (1 credit)
Total 16