Pathology Perspectives on Clinical Genomics

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May 3, 2012

Overview of Presentation

- IOM Report on Recommended Pathway for Omics Test Evaluation Framework
- College of American Pathologists Evaluation of Genomics
- Genomics from a Molecular Pathologist's Perspective

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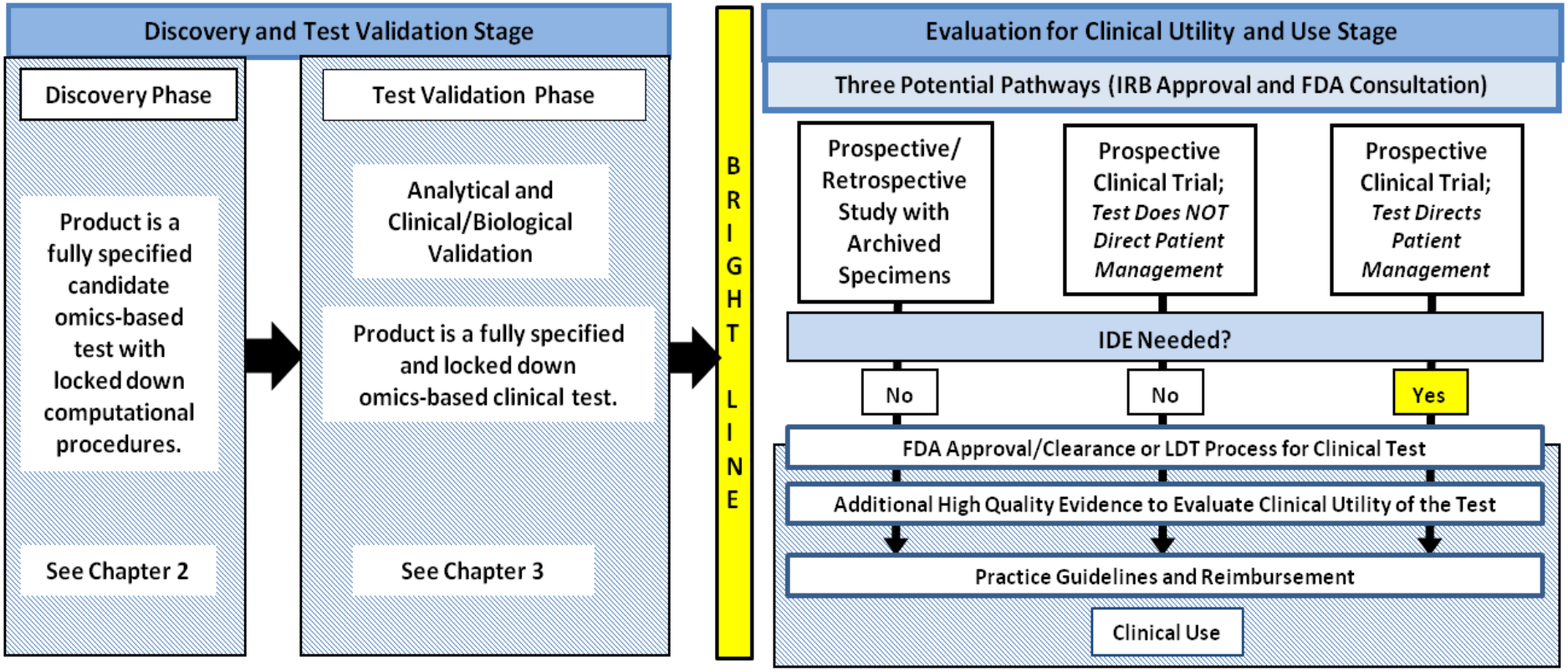
Recommended Framework for Evaluation of Omics Tests from Discovery to Test Validation and Clinical Utility Assessment




COLLEGE OF AMERICAN PATHOLOGISTS
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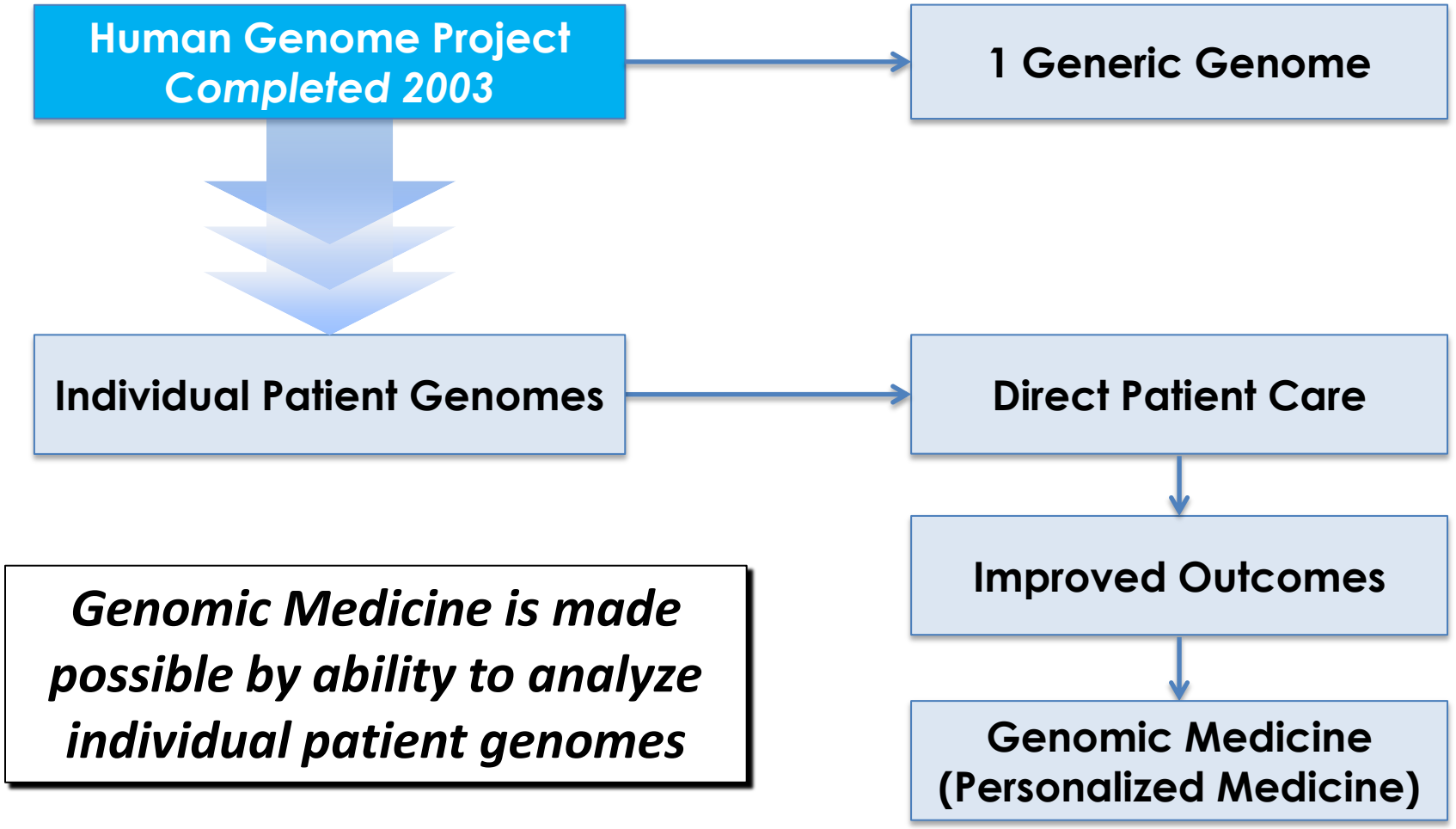
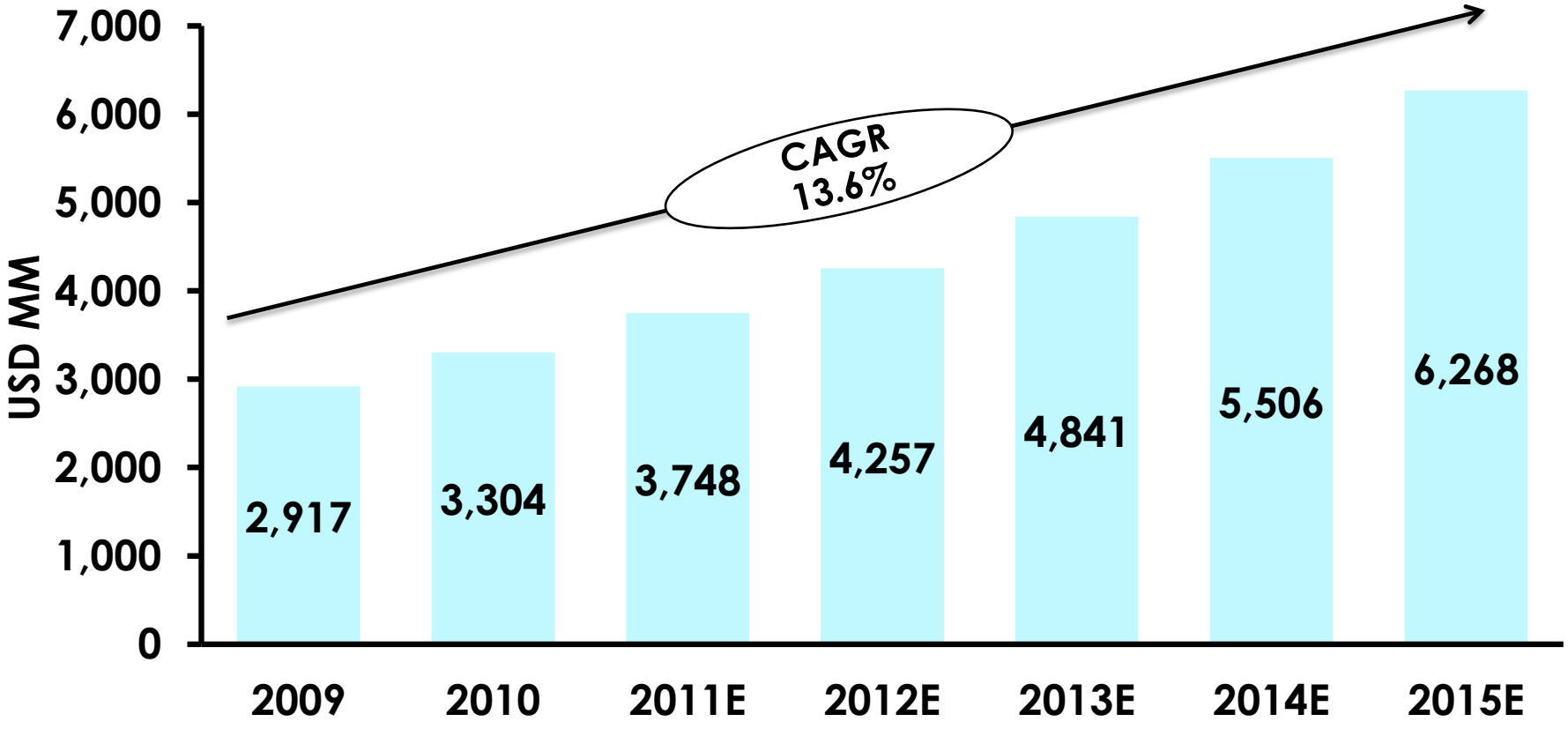
Understanding of the Human Genome Combined with Sequencing Technology Advances are Moving Us Toward Genomic Medicine



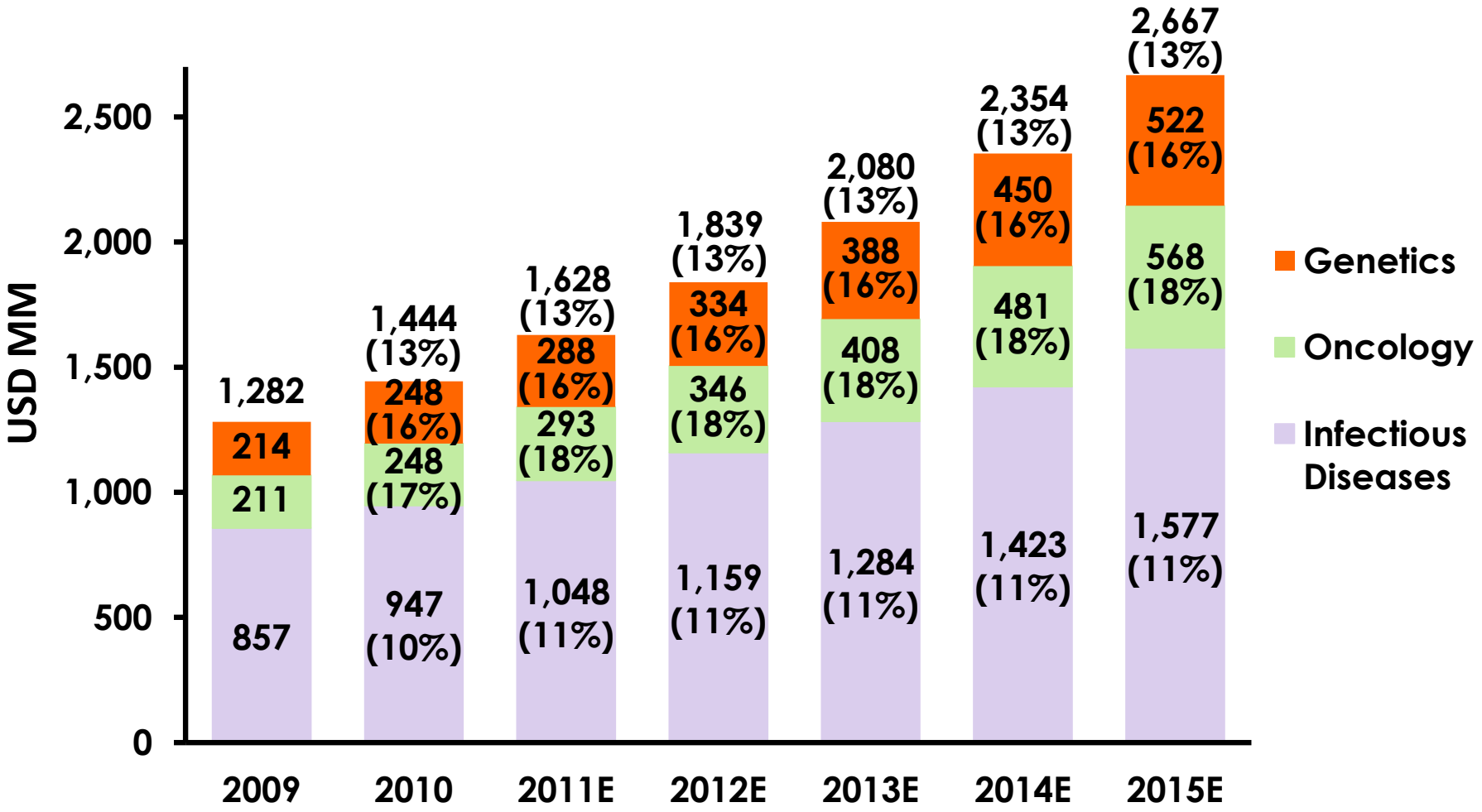
Genomic Medicine is Driving a Strong Global Molecular Diagnostics Market with Estimated Annual Growth of 13.6%

World Market for Molecular Diagnostics, 2009-2015E



Source: 'Valuation of Carried Intangible Assets', Acuity Technology Management, June 2011

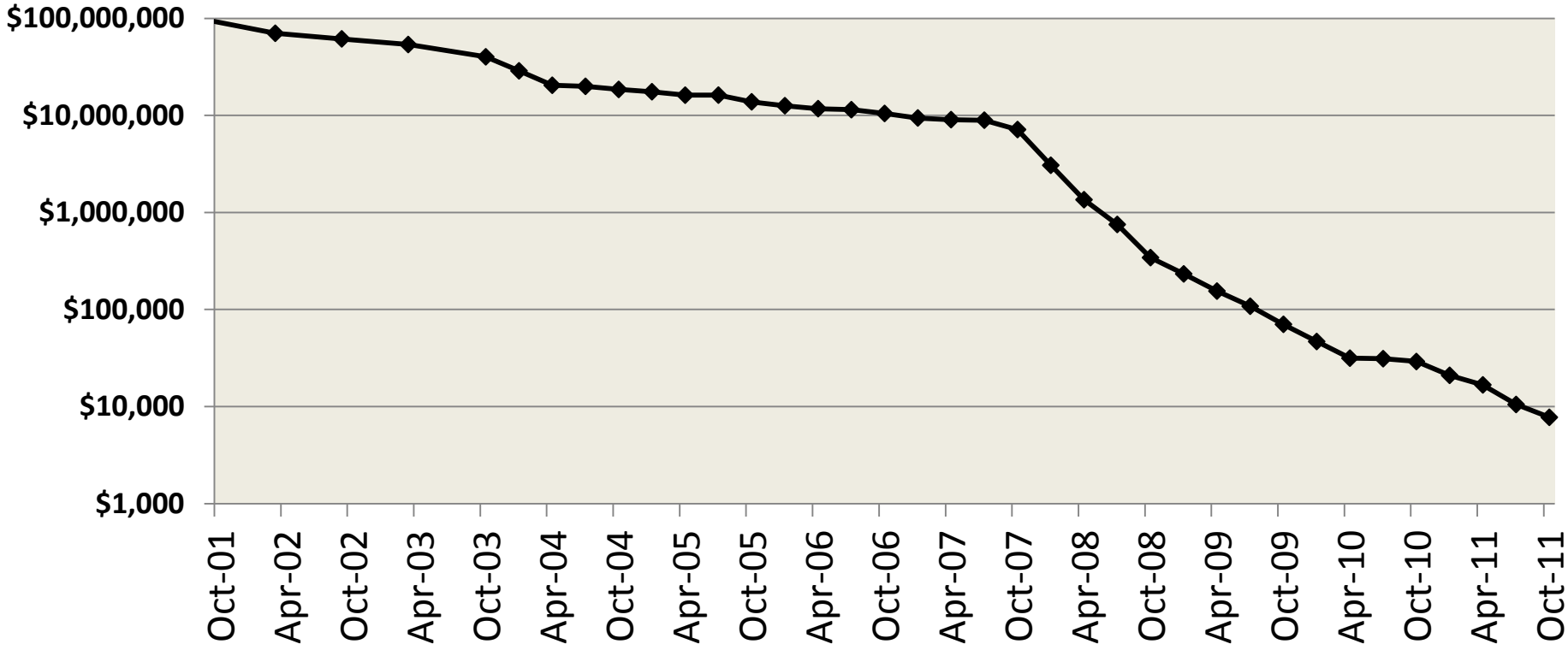
Genetics & Oncology Show Highest Growth with Continued Growth in Infectious Diseases in North American Market



Source: 'Valuation of Carried Intangible Assets', Acuity Technology Management, June 2011; The Future Of Molecular Diagnostics: Innovative technologies driving market opportunities in personalized medicine. Business Insights report No: BI00021-012. 23 June 2010.

The Cost of Genome Sequencing Is Decreasing Rapidly and Driving Clinical Adoption of Genomic Analysis

Cost per Genome Data Generation, 2001 – 2011



Cost for genome sequence data generation today is <$3,000

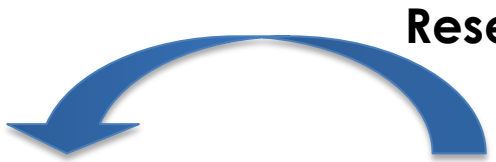
Source: National Human Genome Research Institute

Advances in Sequencing Technology is Driving Adoption of Clinical Genomic Analysis in Molecular Pathology Laboratories

	1st Genome	Research/ Clinical	Clinically Relevant Cost & TAT		
	ABI	HiSeq	MiSeq	Ion Torrent (Q1 2012)	Ion Proton (Q4 2012)
Sequencers	Hundreds	One	One	One	One
Instrument Price	$ 250,000	$ 750,000	$ 125,000+	$ 75,000	Unknown
Time	Years	Weeks	27 hours	8 hours	8 hours
Output	NA	~50 Gb	2 Gb	1 Gb	50 Gb
Genomic Analysis	Single Genes	Gene Panels, Exome, Genome	Gene Panels	Gene Panels	Gene Panels to Genome

Clinical Genomics is possible today & technology continues to advance

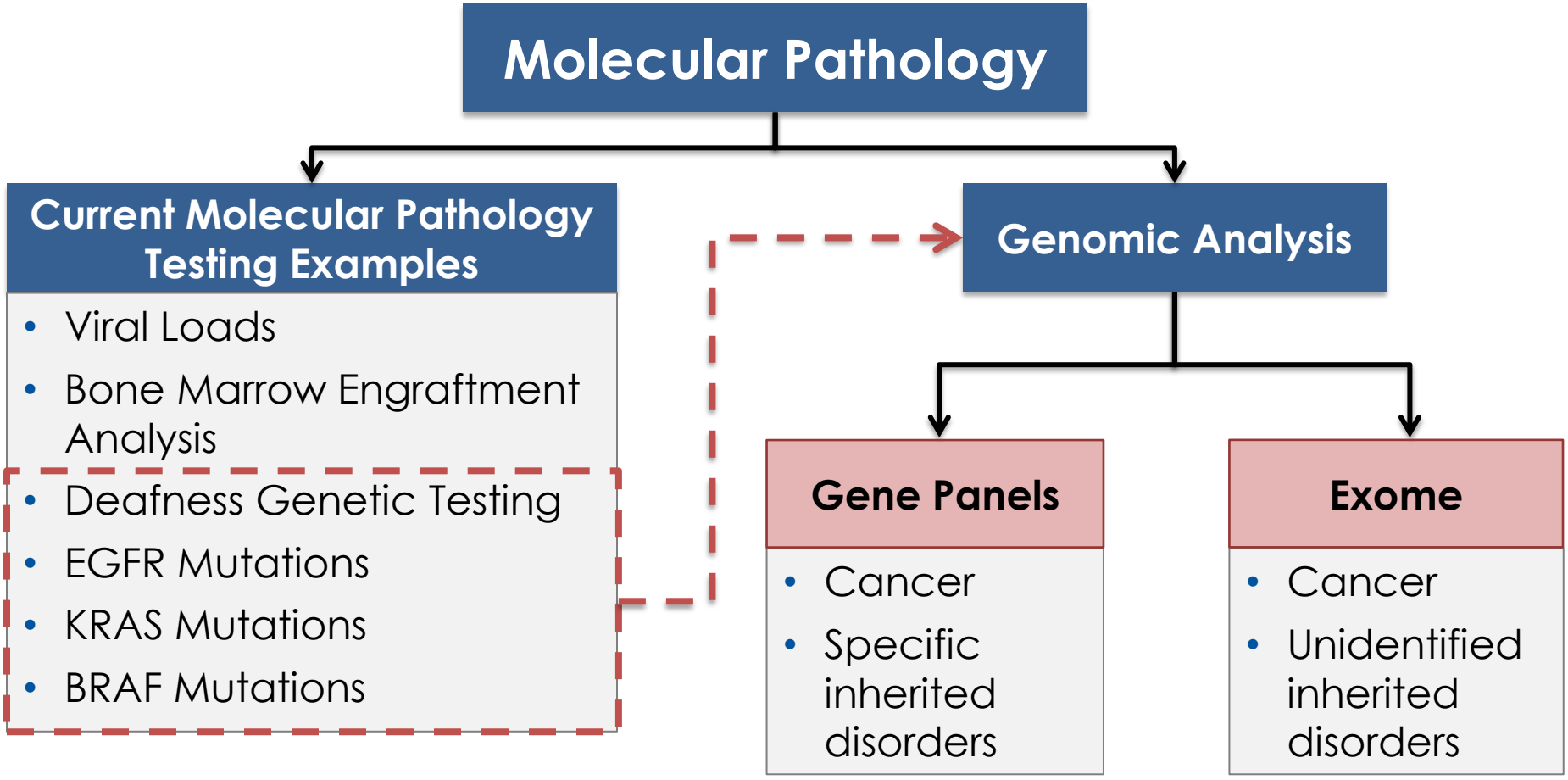
Genomic Testing by Next Gen Sequencing is Being Used in Molecular Pathology Practice Today



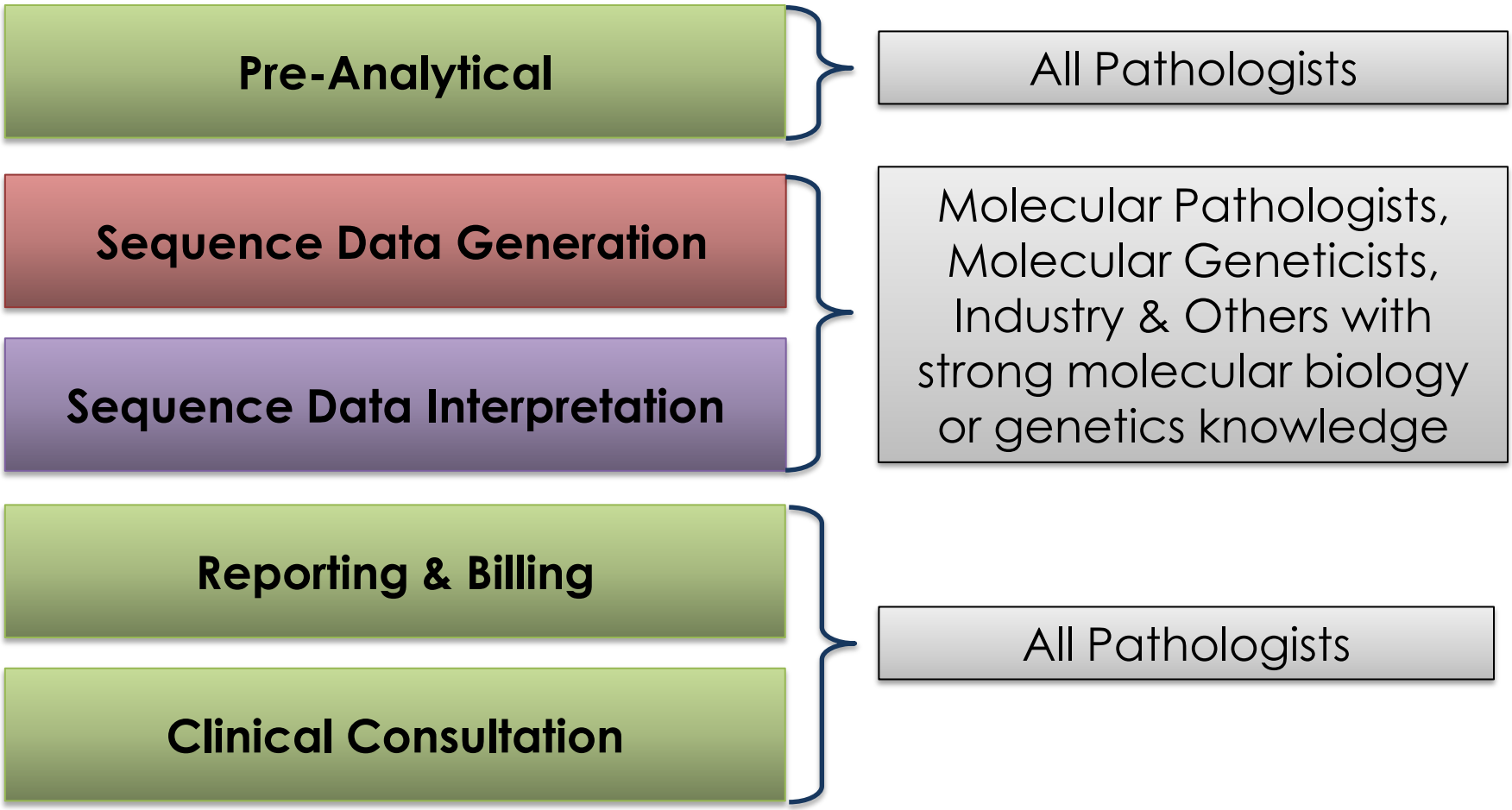
Past and Continuing Molecular Pathology Tests	Genomic Analysis: Clinically Useful Now	Genomic Analysis: Research & Future Potential
Single/Few Mutations	Gene Panels	Genome
Single Gene/Pathogen	Exome	Transcriptome
Few Genes/Pathogens		

Next Gen Sequencing is the newest Molecular Pathology technology and is being used now

Some Molecular Tests Will Move to Next Generation Sequencing While Others Will Remain on Current Platforms



Opportunities Exist for *ALL* Pathologists to Play Key Roles Within Genomic Medicine

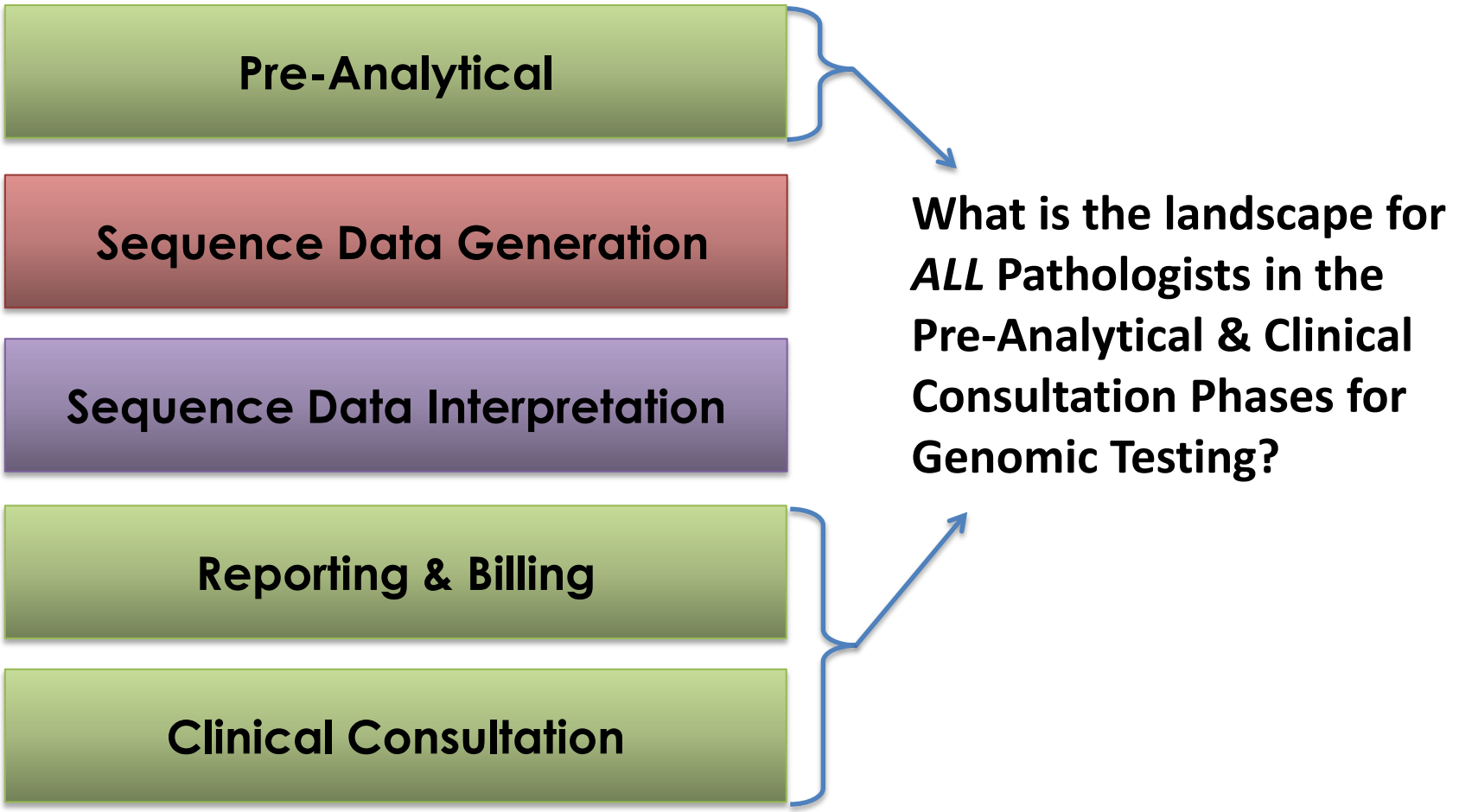


Early Adopters Identify Clinical Grade Databases and Bioinformatics Tools as a High Priority Need

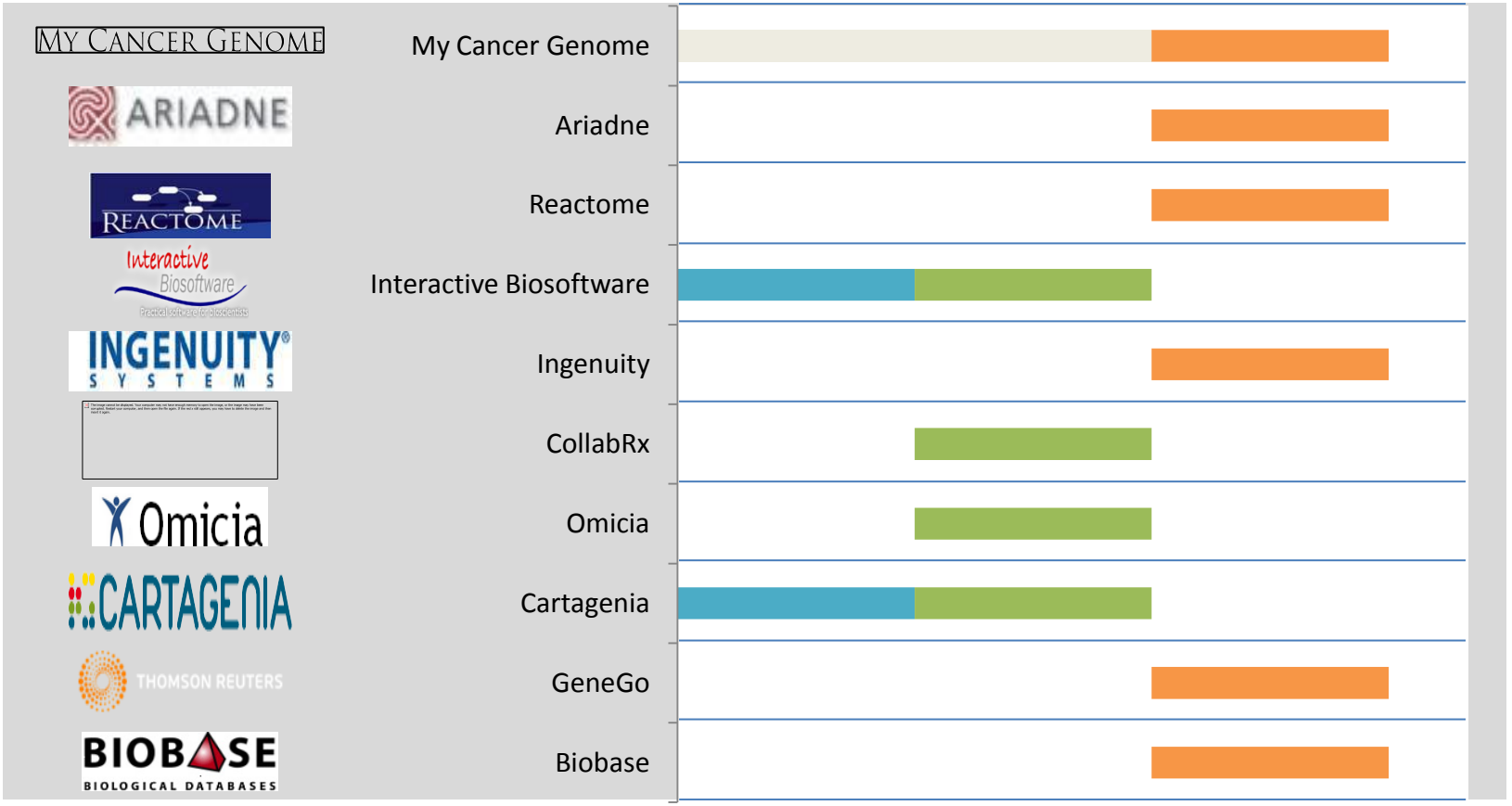
- **Clinical Database(s):**
  - Require significant time & money
  - Need to define quality & submission standards
  - Need to define access & IP issues
- **Software Tools for Interpretation and Clinical Usefulness**:
  - Require significant time & money
  - Many software tools being developed
  - No interoperability standards
  - Will facilitate role for *ALL* pathologists in Genomic Medicine

Pathologists should be at the table in the development of bioinformatics tools & should learn to use tools as developed

Opportunities Exist for *ALL* Pathologists to Play Key Roles Within Genomic Medicine



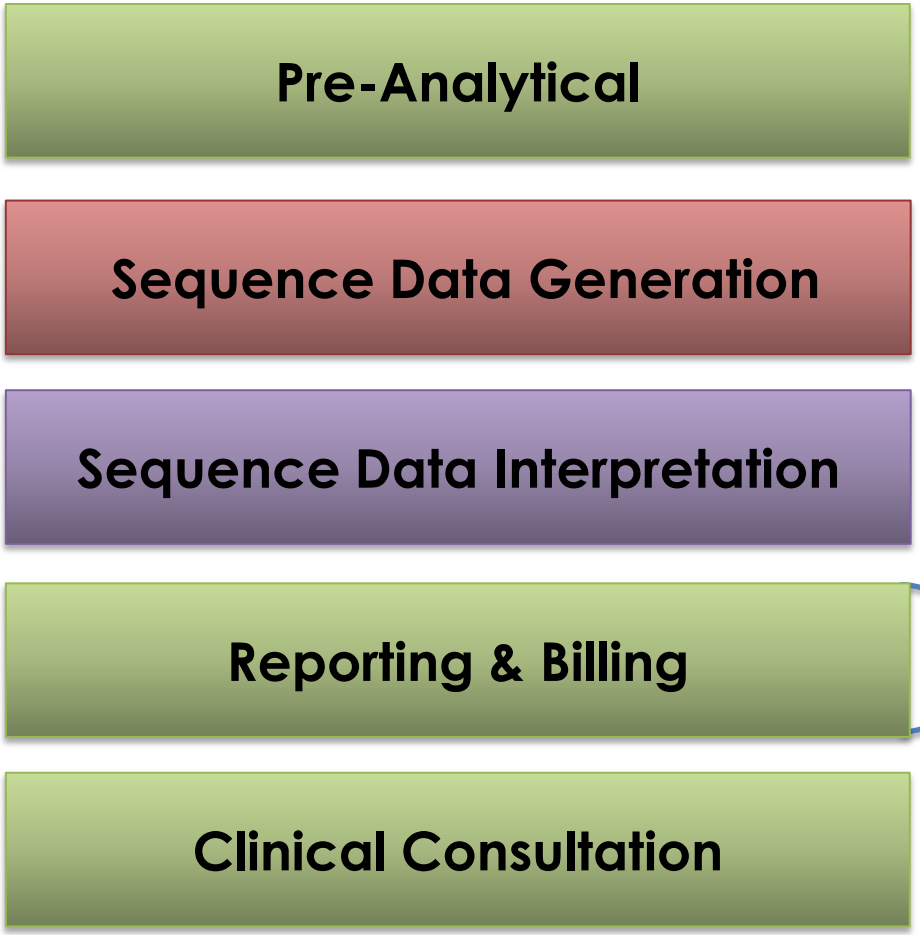
Clinical Decision Support Tools Can Assist *ALL* Pathologists with the Pre-analytical and Clinical Consultations for Genomic Medicine



Speed of Clinical Adoption Hinges on Several Factors

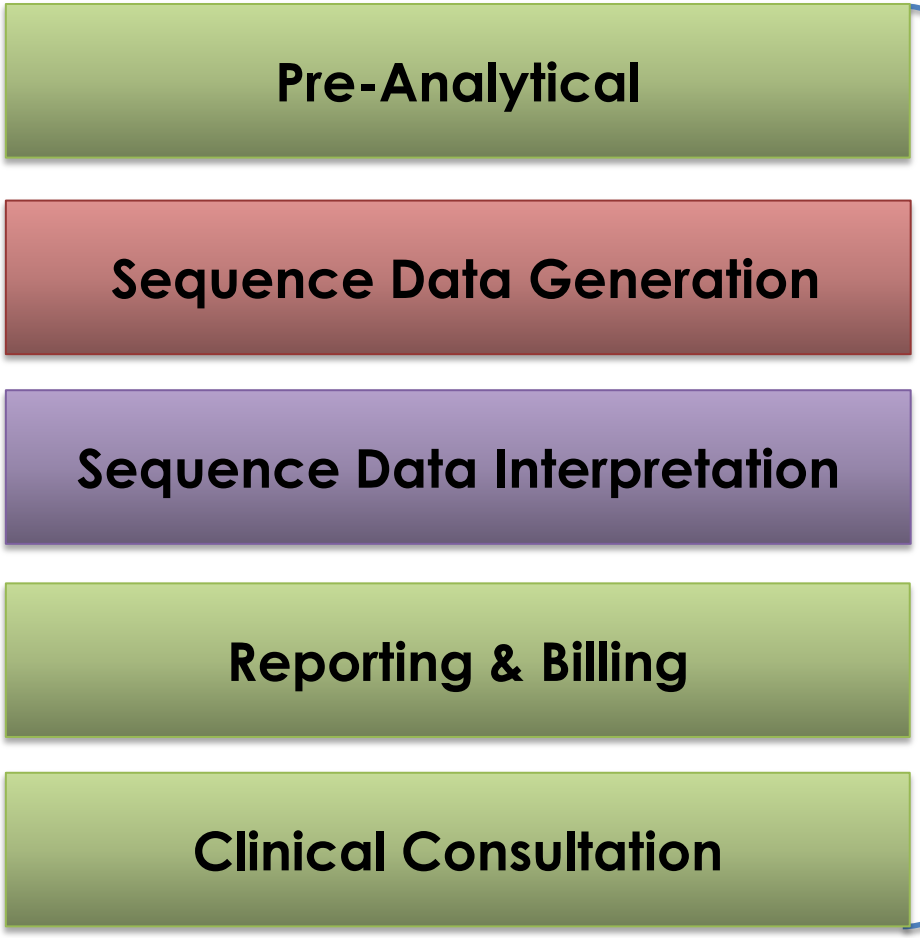
Decreasing Costs	• Cost of genome analysis is rapidly decreasing • Sequencing instruments now are clinically affordable
Increasing Speed	• Can generate sequencing data in 10-36 hours • Clinically relevant TAT available today for data generation
Bioinformatics	• Need clinical quality databases and software tools • Pathologists must participate in development
Clinical Usefulness	• Genomic Analysis is in clinical use now (small but growing) • Research/discovery will increase clinical applications
Payment Uncertainty	• Currently, no specific CPT codes exist for Genomic Analysis • Payers do not understand Genomic Analysis
Regulatory Uncertainty	• Federal regulatory uncertainty today • Quality standards being led by CAP with AMP & ACMG

Current GA Reporting and Payment Environment is Uncertain



- No IT standards for reporting in LIS, EHR & PHR
  - Interoperability standards
  - Terminology standards
- Molecular CPT Codes under revision
- No GA CPT Codes available
- Payers do not understand GA
- Early adopters negotiating coverage & reimbursement with each payer for each patient by early adopters

Current GA Regulatory Environment is Uncertain



- FDA held meeting to understand early clinical users needs & concerns
- No FDA position/guidance
- No CLIA standards for GA
- CAP Next Generation Sequencing (NGS) Work Group
  - NGS Checklist questions
  - PT Exchange

Pathologists Have an Opportunity to Lead the Medical Community in Genomic Medicine

- No single medical specialty is well informed about Genomic Medicine
- Pathologists have an opportunity to be leaders in Genomic Medicine as another diagnostic testing modality
- While genomic technology is rapidly advancing, the discovery process for clinical genomics applications will be an evolution rather than a revolution
- Pathologists can lead in the application of genomic testing as evidence for clinical applications and utility develops

Thoughts on Genomics from a Molecular Pathologist

- Genomics is the next adventure for Molecular Pathology
- Need quality guidelines for data generation and bioinformatics
- Standards hard to develop when everyone still learning ad technology changing so rapidly
- Basic accreditation standards developed for 2012 (CAP, ACMG, AMP) and will evolve as we develop standards/guidelines
- PT is complicated but is coming (CAP)
- Appropriate billing codes needed
- Need to train next generation for genomics

Many Thanks to IOM & CAP Committee Colleagues