

# Concurrent Master's in Genomic Medicine for Medical Students 4 years to MD/MS

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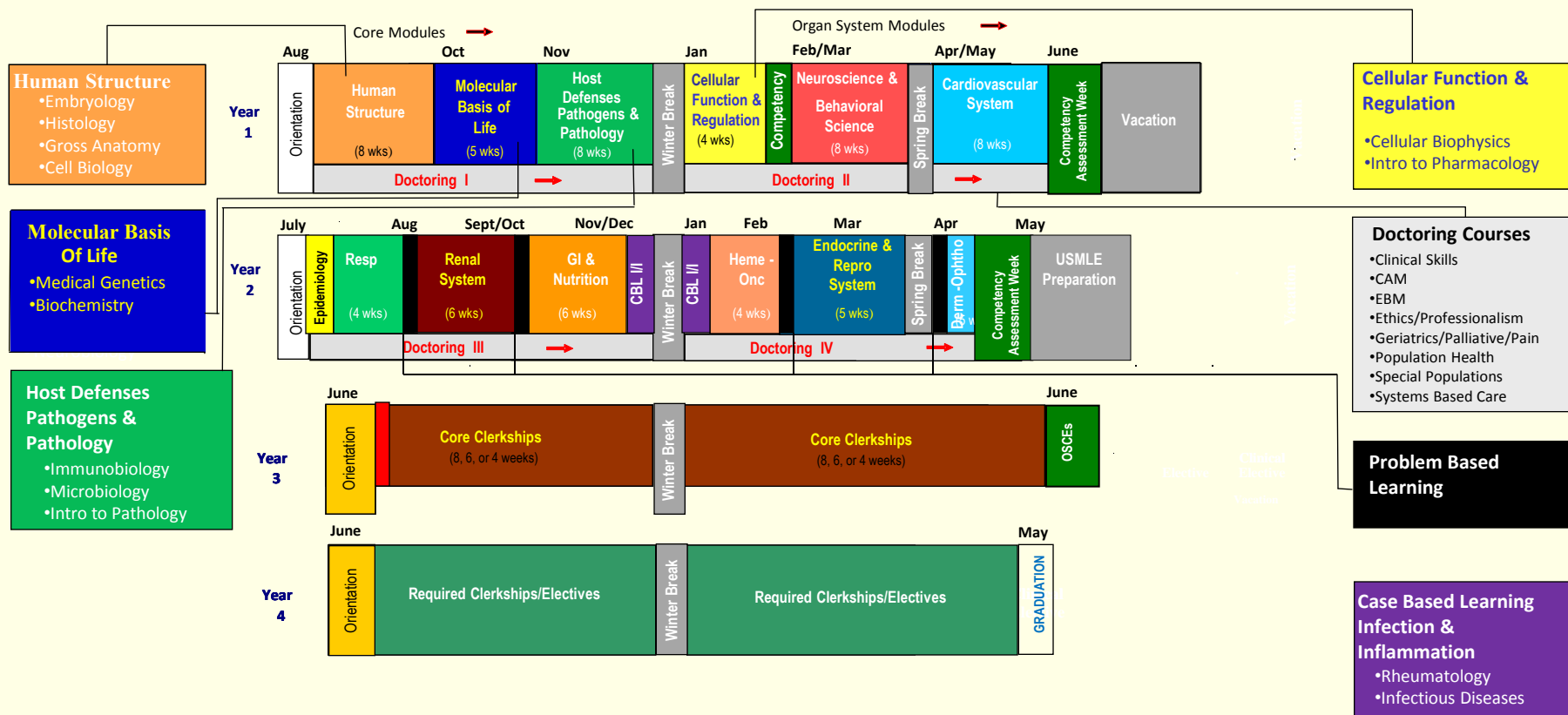
# There is a great need for broad physician training in genomics

- ② Experience: Genomedical Connection early 2000's
  - Primary care practices in Guilford Co., NC
  - Goal: increase awareness in PCP of need for referral to genetic services
  - Computerized self-reported family history (MeTree)
- ② Difficulty in Educating Practicing Physicians
  - Competing versus their clinical time and specialty training
  - Competing against what GM applications are available to them now
  - Concern about liability

# Focused on Medical Students

- ① In a learning environment
- ① Can act as trainers themselves over 8 years of training
- ① Train for the future when there are more GM opportunities

# UMMSM CURRICULUM



Core Clerkships	
•IM	8 weeks
•Surgery	8 weeks
•OB/GYN	6 weeks
•Psychiatry	6 weeks
•Pediatrics	6 weeks
•Electives	6 weeks
•GPC	4 weeks
•Family Med	4 weeks

**Patient Safety Transition to Wards**

Required Clerkships/Electives	
•Subinternship A	4 weeks
•Subinternship B	4 weeks
•Geriatrics	4 weeks
•EMed	4 weeks
•Radiology	4 weeks
•Neurology	4 weeks
•Anesthesia	2 weeks
•Electives	14 weeks
•Externships	up to 12 weeks

Medical curriculum is full – where can additional genomic content be added?



# MBL – Medical Genetics (33 hours)

- @ Genetic variation & mutation
- @ Pathophysiology
- @ Not covered: ‘precision medicine,’ ethics, GENOMICS, technologies, the application of genomics, complex genetics
- @ Clinical case presentations (x 4)
- @ Metabolic disorders
- @ Pharmacogenetics
- @ Neurodevelopmental disorders, auditory system disorders

# MD/MS curriculum

④ Students earn MS concurrently with MD, graduating in four years with both degrees.

- Focused on clinical application
- Understanding the concepts of genomic medicine.
- Create a foundation of knowledge for future discoveries

④ Parallel approach

- avoids problem with space in MD curriculum
- Less intense course schedule/infrastructure to develop compared to an additional 1-2 years of training
- Minimal added cost and time for students
- Learning continues up to residency
- Gives time for questions and hopefully reinforces training

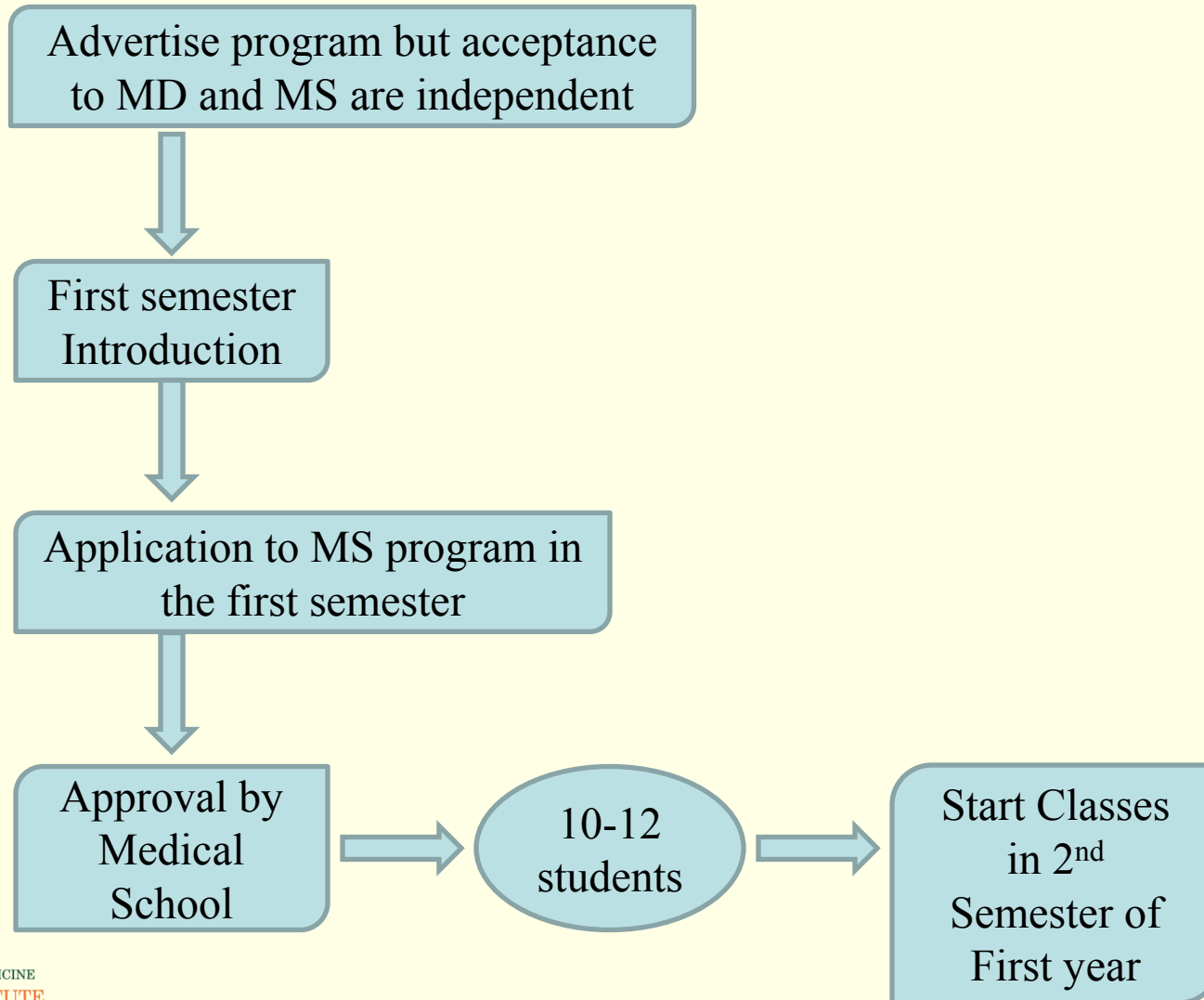
# MD/MS program

## Additional Advantages

- Increases the strength of their residency application
- Increases awareness in other medical students and Attendings over 4 years
- Training others through the students

 Goal is create a qualified consumer and advocate

# Student Recruitment

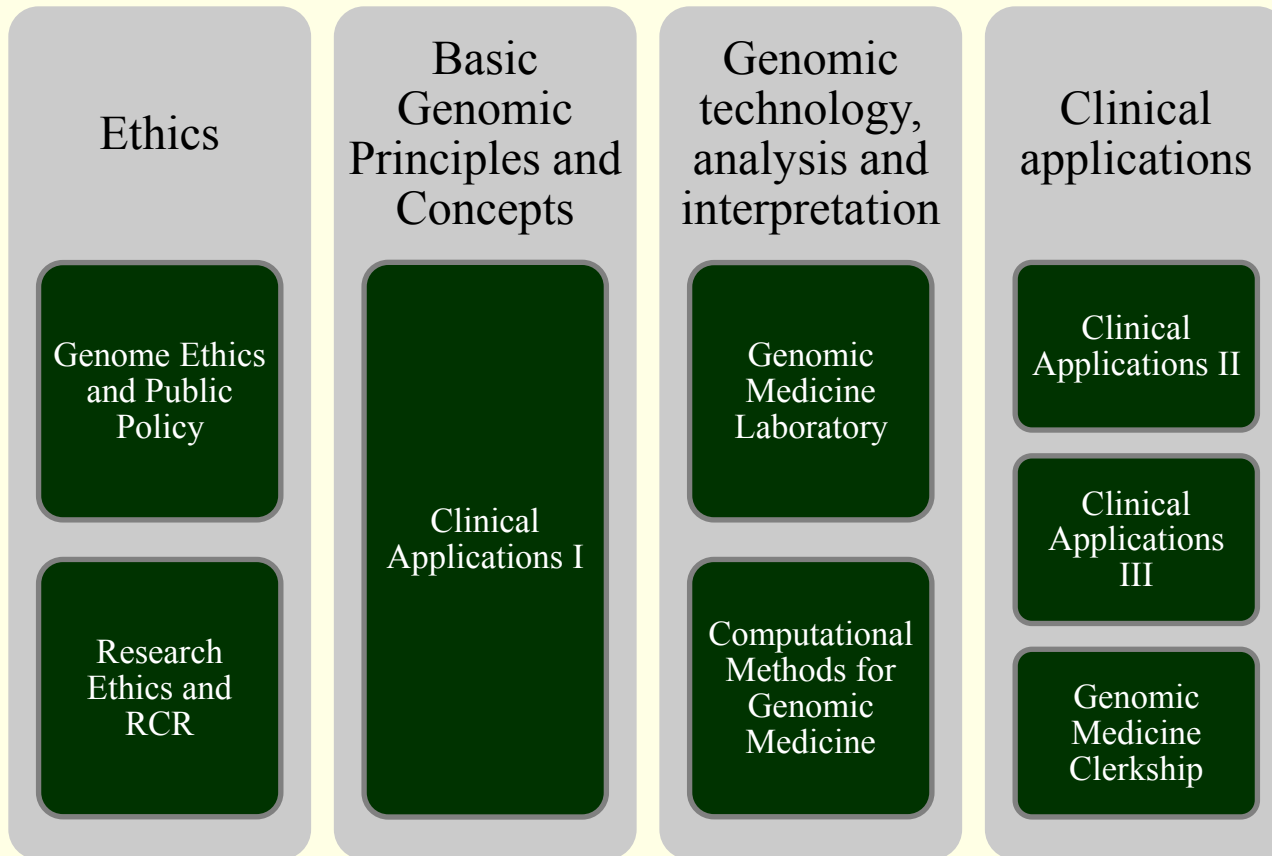




# Blended modes of instruction


- ② “Flipped classroom”: Didactic content online
  - Inspired by student habits with MD lectures
  - 50% of hours
- ② In person small group discussion 1-2x/week
  - Case study, problem based learning, discussions of literature
  - Team teaching when possible
  - 50% of hours

# MSGM Curriculum: 4 Themes



Capstone Experience

# MSGM Curriculum

Year 1(second semester)	Year 2	Years 3 & 4
		
<p><b>Clinical Applications of Genomic Medicine I:</b> The Clinical Applications of Genomic Medicine series provides genomic medicine case studies and systems-based learning paralleling the medical school core curriculum.</p>	<p><b>Computational Methods for Genomic Medicine:</b> Provides instruction on basic biostatistical terminologies and tests as well as risk assessment and bioinformatics tools.</p>	<p><b>Genomic Medicine Clerkship:</b> An elective clerkship in genomic medicine or medical genetics completed as part of the MD curriculum.</p>
<p><b>Genome Ethics and Public Policy:</b> A case-based approach to discussing ethical, legal and social issues related to genomic medicine.</p>	<p><b>Clinical Applications of Genomic Medicine II &amp; III:</b> Topics covered include respiratory system, nephrology, gastroenterology and nutrition.</p>	<p><b>Journal Symposiums:</b> Students meet five times a year to discuss new papers in the field, present at least once a year.</p>
<p><b>Research Ethics:</b> Prior to research practicum, training in the responsible conduct of research, protection of human subjects, and obtaining regulatory approval.</p>	<p><b>Genomic Medicine Laboratory:</b> Students rotate through the molecular genetics and biochemical genetics diagnostic laboratories and gain hands-on experience with interpretation of whole-exome and whole-genome sequencing results.</p>	



Capstone Experience

	Year 1	Year 2	Years 3 & 4
<b>Research (40hrs)</b>	→		
<b>GM Case Reports (40 hrs)</b>		→	
<b>Journal Presentations (GME)</b>		→	
<b>Research Presentation</b>			→

Mentored Research Project



Any subject with genetics, genomics

10 Case Reports



Describe case, potential for genomics (whether done or not), results and outcomes

Genomic Medicine Education (GME)



Mini-symposium 5 times per year, present at least once a year



# Laboratory Research Experience

- ④ Identify causal genes using local families with rare, syndromic phenotypes
- ④ Started as “optional” enrichment opportunity
  - Most of students ended up participating
- ④ Incorporated into core laboratory course in 2015
  - Students wanted more hands on data
  - Good concept of what test results mean for NGS
  - Can do this on computer, so time is flexible

# Laboratory Course

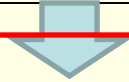
**Raw Data  
Analysis**

**Image processing and  
base calling**



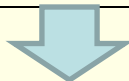
**Whole-Genome  
Mapping**

**Alignment to reference  
genome**



**Variant Calling**

**Detection of genetic variation  
(SNPs, Indels, SVs)**



**Relevance**

**Linking variants to  
biological information**



# Impact of Laboratory Experience

- ④ Key point: motivation to do the work => clinical relevance & utility
  - Better than analyzing own sequence (w/attendant issues)
    - Contrasted with experience reported by Sanderson et al., 2015
  - Much better than analyzing public data (> impact)
  - Exposed to programs, websites and databases they can use in future practice

# Examples of Laboratory Research course

- 🌀 Macrothrombocytopenia families- MYH9 mutations identified
- 🌀 Intellectual disability with microcephaly families
- 🌀 MMIH syndrome without ACTG2 mutations
- 🌀 Dyskeratosis congenita/undiagnosed disease

Eur J Pediatr (2014) 173:827–830  
DOI 10.1007/s00431-014-2320-8

CASE REPORT

## Novel adenosine deaminase 2 mutations in a child with a fatal vasculopathy

Nisha Garg · Ozgur Kasapcopur · Joseph Foster II ·  
Kenan Barut · Ayşe Tekin · Osman Kızılkılıç ·  
Mustafa Tekin

THE JOURNAL OF PEDIATRICS • www.jpeds.com



CLINICAL AND LABORATORY  
OBSERVATIONS

## MORFAN Syndrome: An Infantile Hypoinsulinemic Hypoketotic Hypoglycemia Due to an *AKT2* Mutation

Nisha Garg, MD candidate<sup>1</sup>, Guney Bademci, MD<sup>1</sup>, Joseph Foster II, BSc<sup>1</sup>, Zeynep Sıklar, MD<sup>2</sup>, Merih Berberoglu, MD<sup>2</sup>, and Mustafa Tekin, MD<sup>1</sup>





# Examples of Capstone Research Projects

- 📍 “Literature review on the Genomic Medicine in Preventive Cardiology”
- 📍 “Review of risk factors for contralateral breast cancer”

## Original Investigation

### Driver Mutations in Uveal Melanoma Associations With Gene Expression Profile and Patient Outcomes

Christina L. Decatur, BS; Erin Ong, BS, BA; Nisha Garg, BS; Hima Anbunathan, MS; Anne M. Bowcock, PhD; Matthew G. Field, MS; J. William Harbour, MD

Int J Breast Cancer. 2016; 2016: 4792865.

PMCID: PMC4927988

Published online 2016 Jun 16. doi: [10.1155/2016/4792865](https://doi.org/10.1155/2016/4792865)

### Breast Cancer in Africa: Limitations and Opportunities for Application of Genomic Medicine

[Allison Silverstein](#), <sup>1,2,3,4,\*</sup> [Rachita Sood](#), <sup>1,2,3</sup> and [Ainhoa Costas-Chavarri](#) <sup>1,2,4</sup>

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Academic Editor: Lei Shi





**Why We Can't Wait:**  
Conference to Eliminate Health Disparities in Genomic Medicine  
*The role of policy*

September 4-5, 2014 ~ W Hotel ~ Washington, DC

# Conference attendance can significantly shape program outcomes



# Intermediate Outcomes lead to opportunities

- ① One student (Allison Silverstein) just completed a Paul Farmer fellowship for one year, working in Rwanda and Zambia
  - Inspired by Why We Can't Wait Conference
  - Worked on setting up surgical programs for Zambian government with WHO <http://www.allisonsilverstein.com/>



## Adventures Abroad: Rwanda and Beyond

DON'T JUST TEACH A MAN TO FISH, GO FISHING WITH HIM.



# Intermediate outcomes

good to excellent satisfaction with courses

- @ Changed laboratory course to current structure
- @ Data analysis course reoriented to bioinformatics/sequence data
- @ Ethics courses rated very important and effective
- @ Clinical applications courses more positive reviews than basic concepts, asked for more clinical topics
- @ Flipped classroom works; small group discussion is key and most popular.

# Intermediate outcomes

## student confidence in genetic knowledge

- ② Students report increased confidence in genetic knowledge as they enter clinical rotations
- ② Report increased sharing of genetic knowledge with peers in MD classes
  - Some non-MSGM students express wish that these topics were taught to all students
  - Some MSGM students report concern that their peers are *not* learning these topics
  - Some report errors in their normal lectures on genetic content
- ② Students have increasing number of interactions with attendings/residents pointing out genetic aspects of cases

# Longer-term outcomes

- ④ Impact of MSGM on knowledge, beliefs and attitudes at end of program (starting 2016)
- ④ Assessment of residency choices (2016)
- ④ Evaluation of perceived impact on clinical practice
  - Residency (2016) - the 4 graduated students matched on 1<sup>st</sup> or 2<sup>nd</sup> choice.
    - All indicated MSGM was a very positive factor in their interviews and matching

# Barriers to meeting objectives and potential solutions

- ② Student time during medical school courses
  - Package material for flexible completion
  - Use valuable (limited) class time for interaction and active learning
  
- ② Additional financial costs of second degree
  - Scholarship, grant funding



# Barriers to meeting objectives and potential solutions

## @ Faculty time and commitment

- Small group format requires more instructors
- Incentivize mentors for capstone

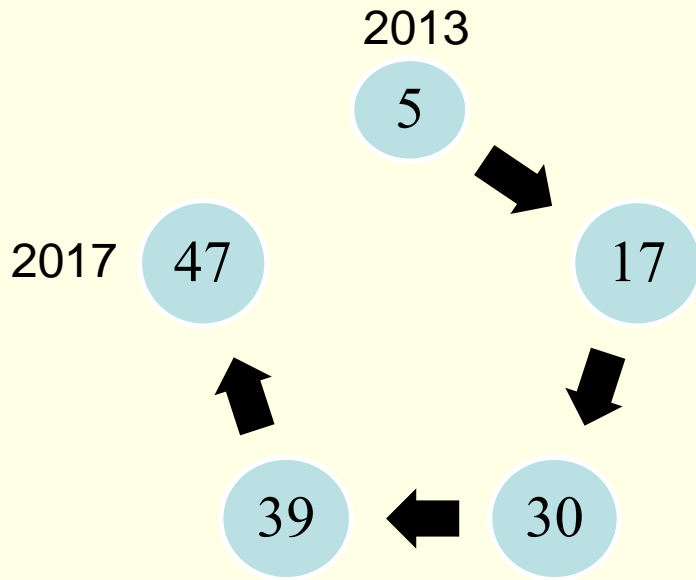
## @ Capacity

- Restrict enrollment to 10-12
- Increased faculty involvement would expand capacity



# Students

Program Growth each year



## Funding

- Currently self-supporting on tuition
- John T. and Winifred Hayward Foundation first 3 years
- Hayward support continues for
  - Capstone Research support
  - Family medicine project
  - Travel funds to attend meetings (students)

# Future directions

- ② Genomic medicine initiative in Family Medicine Clinics
  - Provide additional clinical experience to MSGM students
  - Add to the existing Medical Genetics clinical rotation
- ② Potentially extend MSGM curriculum to other audiences (residents, fellows)
  - Need to determine how to package materials for more heterogeneous audiences
  - Retaining small group component
  - Capacity of faculty and training opportunities?

# Conclusions (after 4 years)

- ④ Active learning strategies are key to program success
  - Different from didactic lectures
  - Teaching students to evaluate the support for a test or treatment decision
- ④ Laboratory data exercises that have clear clinical utility (and publication potential) improve enthusiasm
- ④ Journal discussions in 3<sup>rd</sup> and 4<sup>th</sup> years key to keeping students up-to-date
- ④ Have to be able to adapt and change as med school changes

# Conclusions

- 🌀 Students are very interested in genomic medicine
  - Recognize this as “wave of the future”
  - Like being in the vanguard
  - Perceive an advantage for residency matching
  - Like being able to share knowledge with peers
  - However, they are disappointed when reach clinics in the lack of knowledge and opportunities in applying GM by their current Clinical Attendings
  - Hopefully as residents they will be help educate and lead the use of GM and become knowledgeable Attendings.

# Acknowledgements

- 🌀 Program Director: William Scott PhD
- 🌀 Capstone Director: Jeff Vance PhD, MD
- 🌀 Program Coordinator: Dori McLean
- 🌀 Teaching Faculty:
  - Susan Blanton, PhD
  - Michael Cuccaro, PhD
  - Anthony Griswold, PhD
  - *Susan Hahn, MS, CGC* (now at Quest)
  - Rosario Isasi, J.D., M.P.H
  - Karen Nuytemans, PhD
  - *Stephanie Sacharow, MD* (now at Boston Childrens)
  - William Scott, PhD
  - Mustafa Tekin, MD
  - Jeffery Vance, MD PhD
- 🌀 Funding from John T. and Winifred Hayward Foundation