The Cancer Biology Workforce: A Vision for the Future

Arthur Gutierrez-Hartmann, MD

Professor, Medicine and Biochemistry & Molecular Genetics

Director, MSTP and PSTP

Associate Dean for Research Education

University of Colorado Anschutz Medical Campus

October 19, 2014

CABTRAC Annual Meeting: Stanley Hotel

The Past:
Trainees were expected to phenocopy their mentors

PhD/MD Years

G1/2		Thesis Years		
M1	M2	Thesis Years	M3	M4

Postdoctoral Fellowship

Residency/SubspecialtyFellowship

Critical Transition

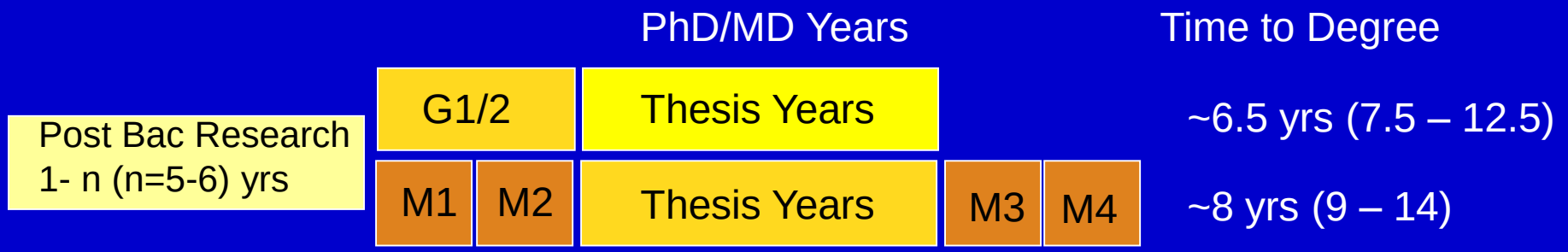
Chair
Director
Cure Cancer
Prizes
Fame

Promotions
Awards
Grants

Independent
First Job

The Reality:

Training has been taking too long
Too many biomedical PhDs for available jobs
Only 20% find independent, tenure-track jobs
First R01 at age ~42
Pay is comparatively low at each level of training
Best & brightest not attracted to science careers
Minimal formal training for alternative careers

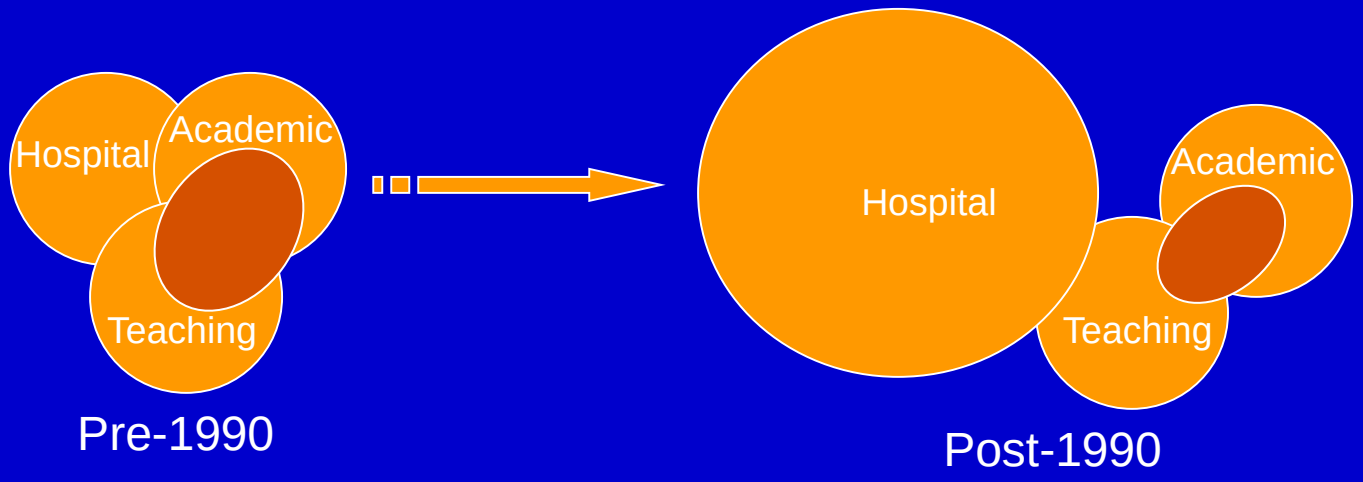


Cheap labor, with little to no evidence-based testing to determine which training approaches and whether longer time-to-degree provide optimal outcome(s)

Training is less competency based, and criteria for PhD varies and is subjective

Changing Aspects in the Academic Biomedical Enterprise

- Established, older faculty not retiring: Limited new positions
- Reorganization of Basic Science Departments: Most often driven by money issues to limit financial liability of the SOM, since diminishing grant $$s is main income source in basic science departments- fewer net positions
- Less basic science in Med school curriculum, and now often taught by MDs
- Clinical Departments growing due to full-time clinical service physicians, increasingly without SOM appointments or scholarly requirements
- MD/PhDs and PhDs increasingly recruited to clinical departments to maintain a cadre of biomedical scientists



Advisory Committee to the Director: Biomedical Research Workforce Working Group- 2011-2012

Shirley Tilghman, Princeton University, N.J., *co-chair*
Sally Rockey, NIH, *co-chair*
Sandra Degen, University of Cincinnati and Cincinnati Children's Hospital
Laura Forese, New York Presbyterian Hospital/Weill Cornell Medical Center
Donna Ginther, University of Kansas
Arthur Gutierrez-Hartmann, University of Colorado AMC
Freeman Hrabowski, University of Maryland, Baltimore County
James Jackson, University of Michigan, Ann Arbor
Leemor Joshua-Tor, Cold Spring Harbor Laboratory
Richard Lifton, Yale School of Medicine
Garry Neil, Johnson & Johnson
Naomi Rosenberg, Tufts University School of Medicine
Bruce A. Weinberg, Ohio State University
Keith Yamamoto, University of California, San Francisco

Report: http://acd.od.nih.gov/bmw_report.pdf
Additional data: http://report.nih.gov/investigators_and_trainees/ACD_BWF

State of PhD and Physician-Scientist Training: 2014

- ACD-Biomedical Research Workforce Working Group: Report June 2012
  - http://acd.od.nih.gov/biomedical_research_wgreport.pdf
  - We are training too many biomedical PhDs!!

- ACD-Physician Scientist Workforce Working Group: Report June 2014
  - http://acd.od.nih.gov/reports/PSW_Report_ACD_06042014.pdf
  - Physician-scientists are becoming extinct!!

Satirical Borowitz Report: NewYorker

"It's a very human reaction," said Harland Dorrinson, a prominent anti-science activist from Springfield, Missouri. "If you put them under enough stress, perfectly rational people will panic and start believing in science."

Additionally, he worries about a "slippery slope" situation, "in which a belief in science leads to a belief in math, which in turn fosters a dangerous dependence on facts."

At the end of the day, though, Dorrinson hopes that such a doomsday scenario will not come to pass. "Time and time again through history, Americans have been exposed to science and refused to accept it," he said. "I pray that this time will be no different."

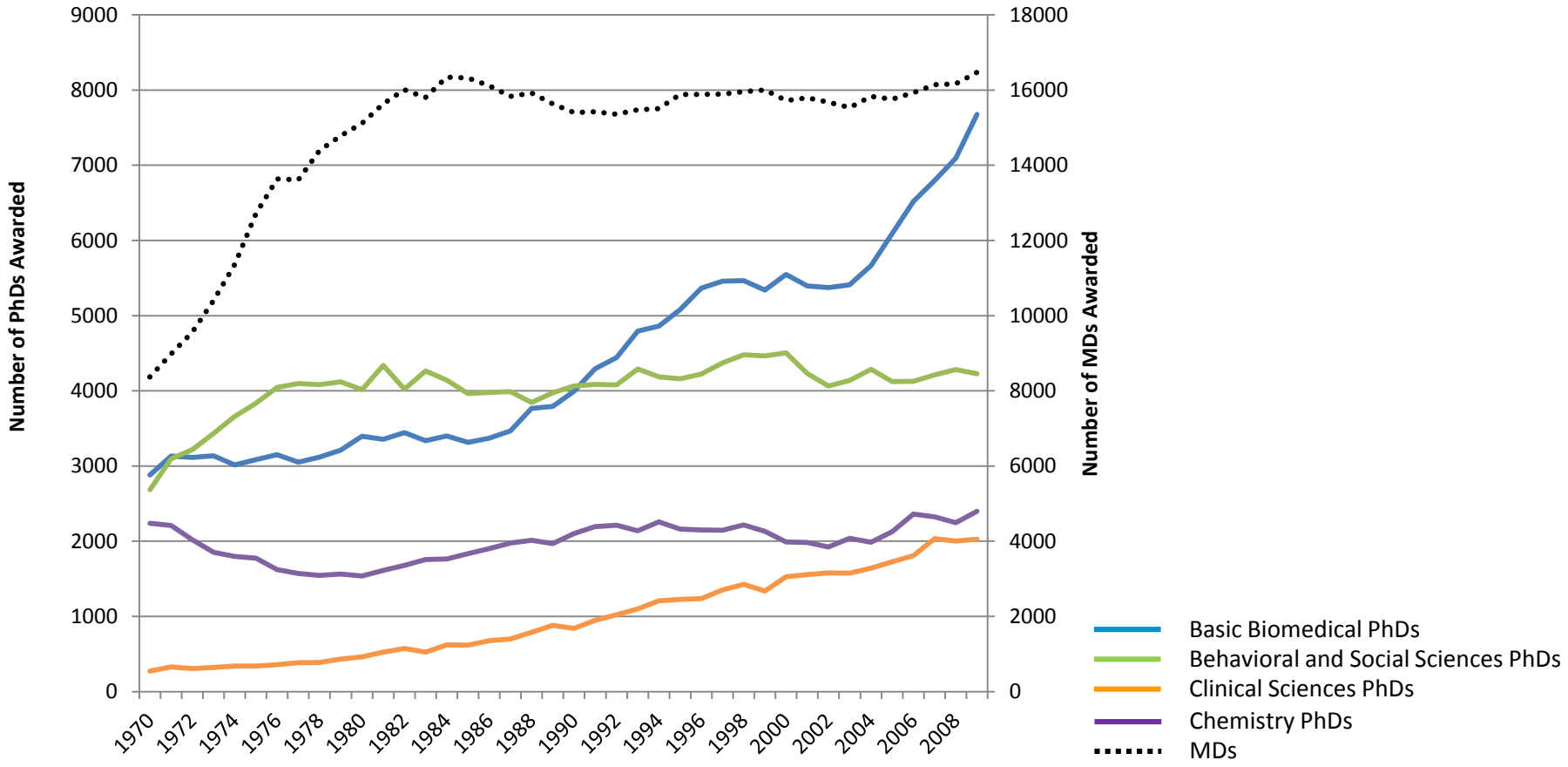
Anti-Science Beliefs of the American People

1. Anti-vaccination
2. Anti-climate change
3. Anti-evolution
4. Anti-cosmology
5. Anti-stem cell
6. Technology is magic
7. All of science is magic
8. Our DC representatives are American people

Biomedical Sciences Career Paths

- Traditional career paths
  - Academics: Research Professoriate
  - Teaching: HS, Junior or Liberal Arts College
  - Federal Govt Lab: NIH, CDC,FDA
  - Biotech/Pharma: staff scientist, management
  - For-profit analytical laboratory: diagnostics
  - Bio suppliers: Sales, R&D
- Less traditional career paths
  - Computing/data management
  - Project management/science administration
  - Scientific journalism
  - MD, JD, MBA
  - Forensics

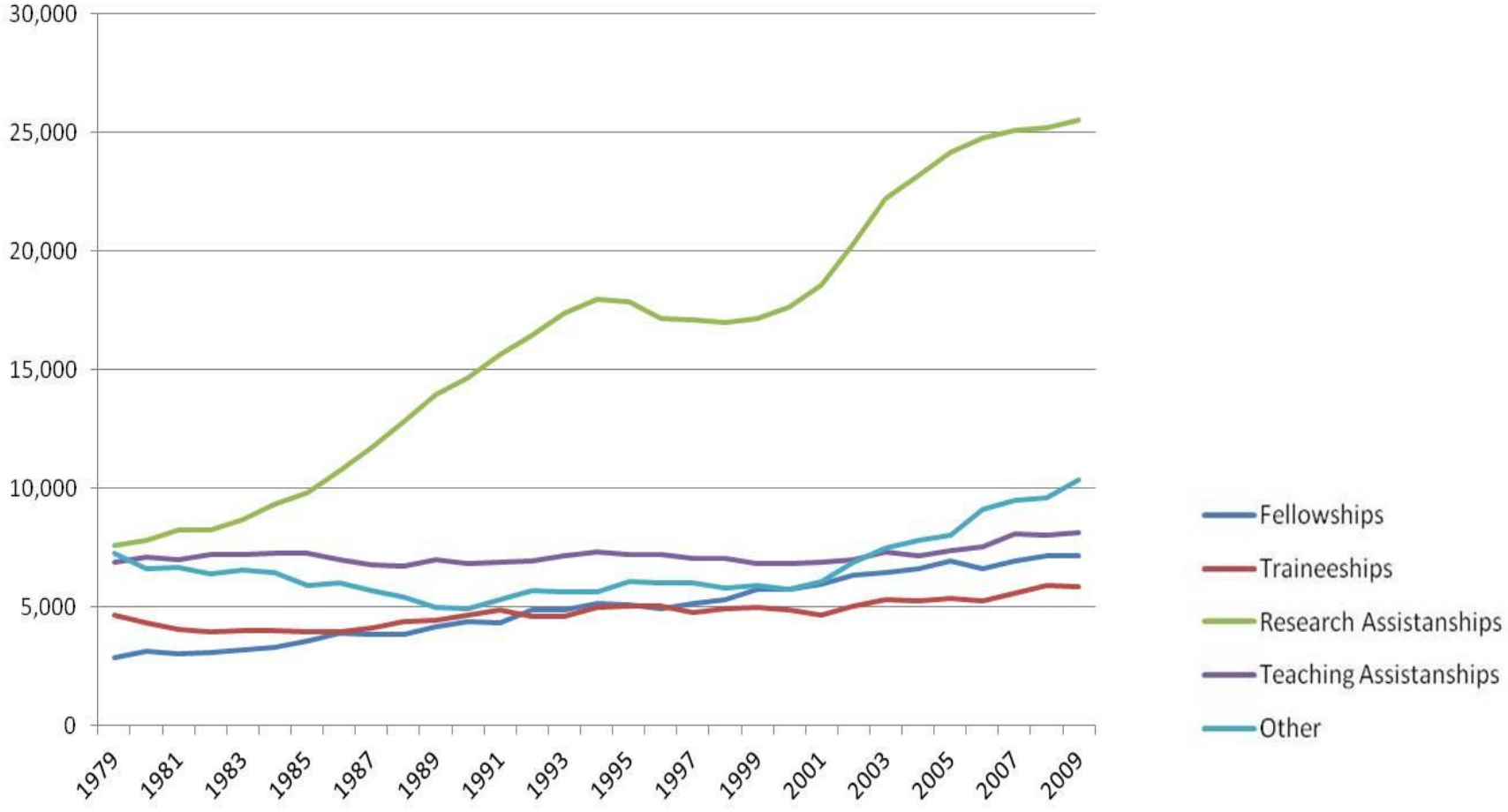
US PhD and MD Degrees Awarded, by Field



- BioMed PhDs awarded remained stable from 1970 to ~1987: ~3200/yr
- BioMed PhDs awarded more than doubled from 1987 to 2008
- Chemistry & Behavioral Science PhDs awarded remain unchanged.

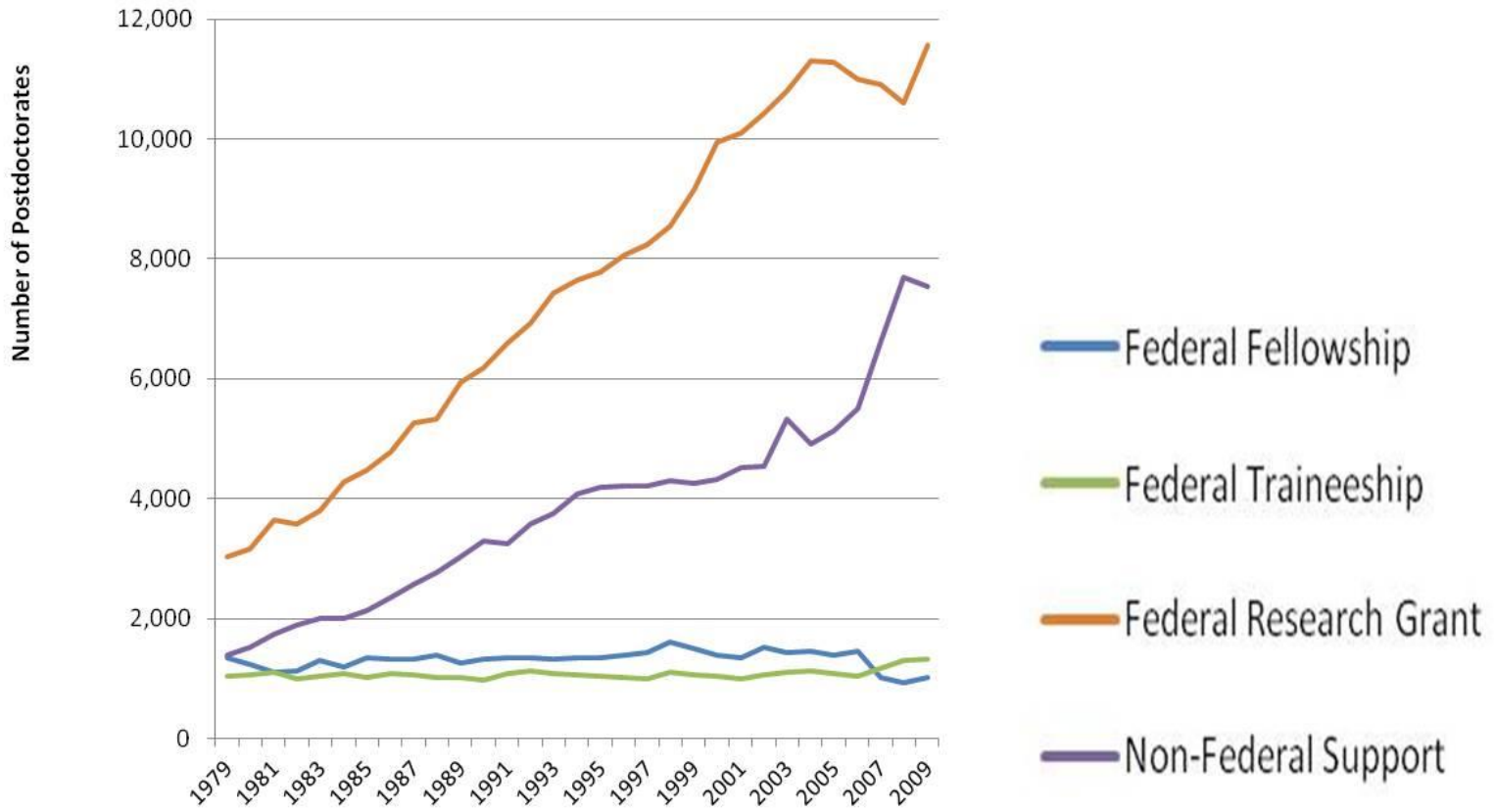
Source: Survey of Earned Doctorates

Doctorate Students by Type of Support



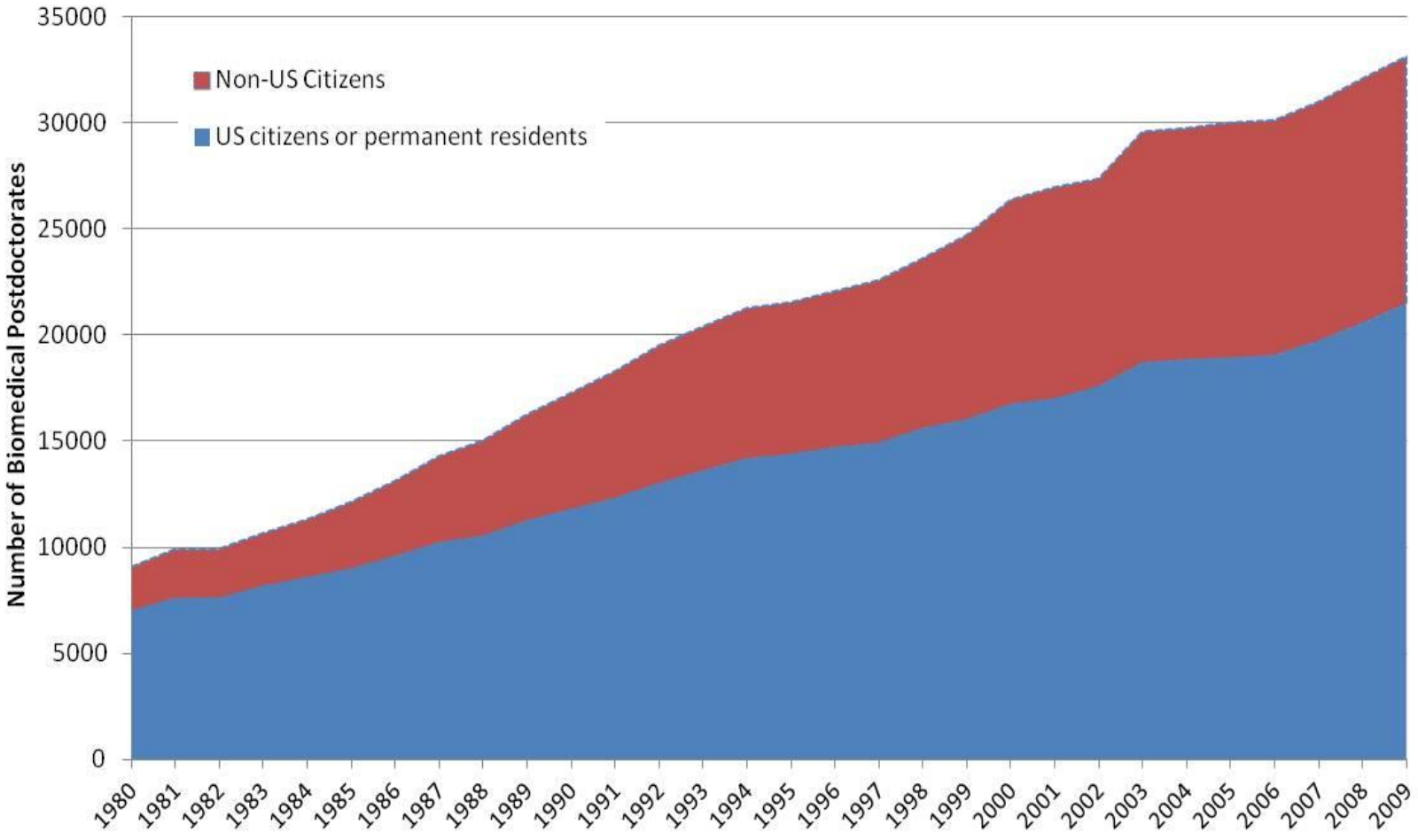
Source: Graduate Student Survey

Postdoctoral Researchers by Type of Support



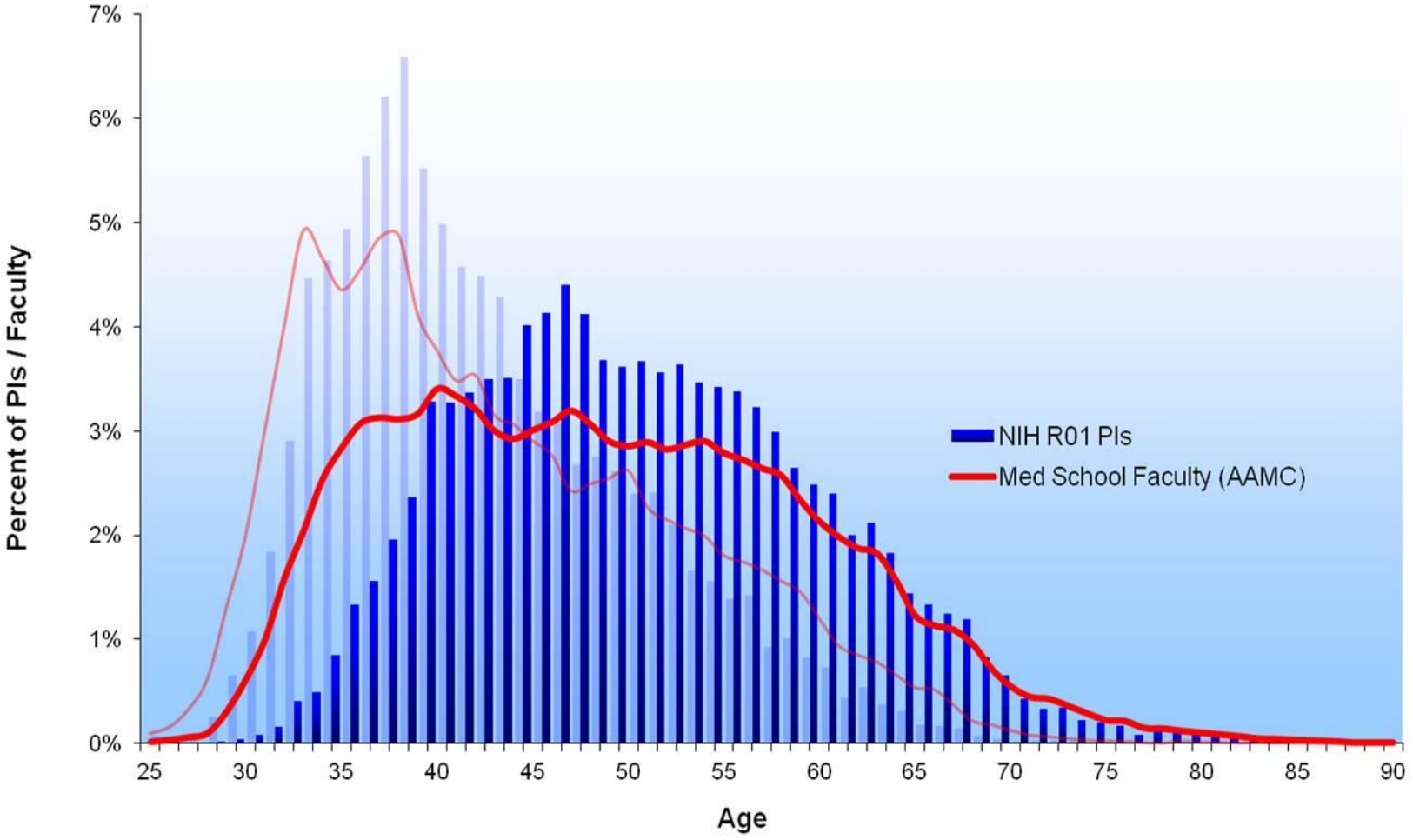
Note: "nonfederal support" is defined as support from state and local government, institutions, foreign sources, foundations, industry and other private sources.

Biomedical Postdoctorates by Citizenship



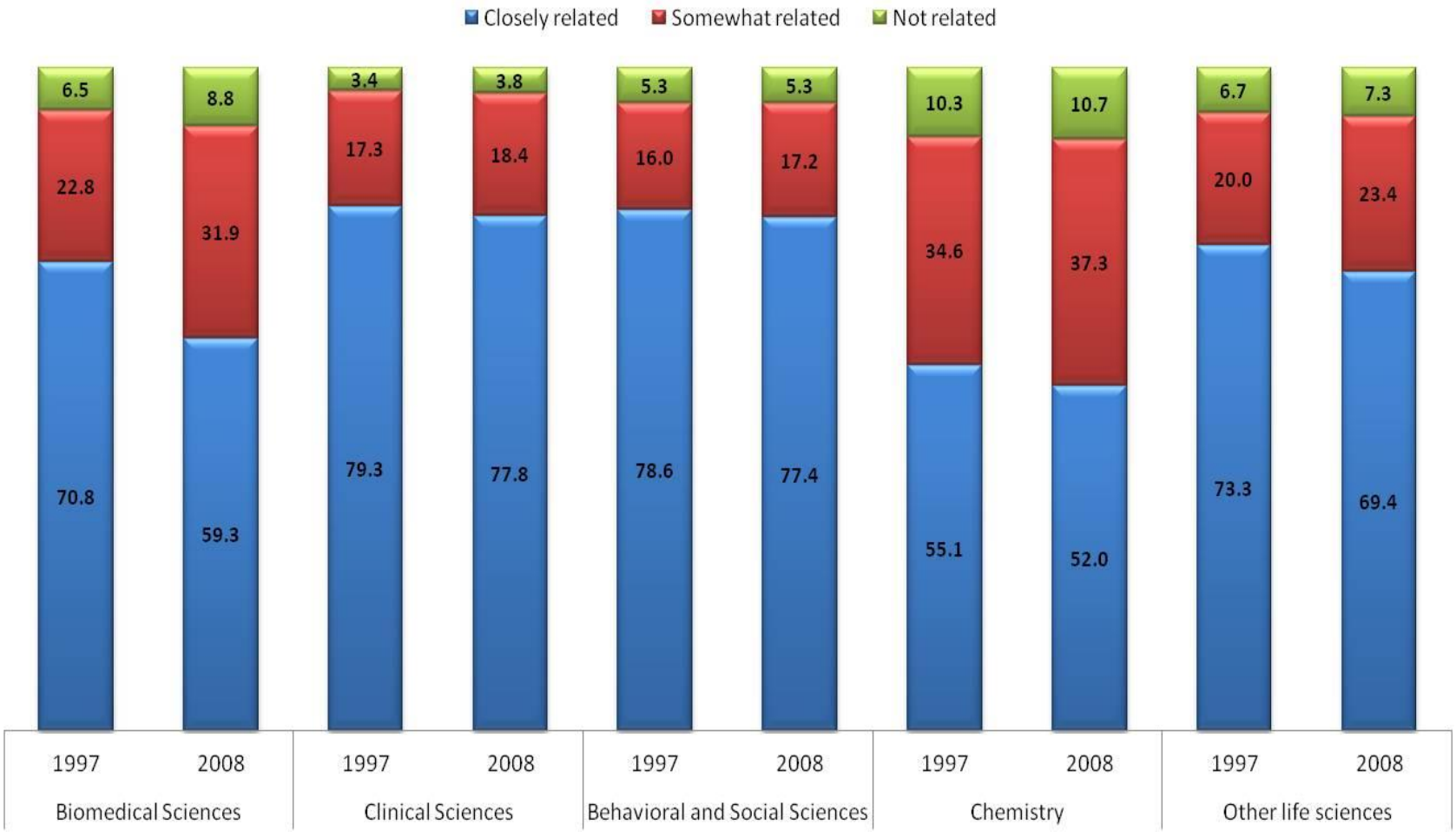
Source: Graduate Student Survey

Age Distribution in 1980 (background) and 2010 (foreground)



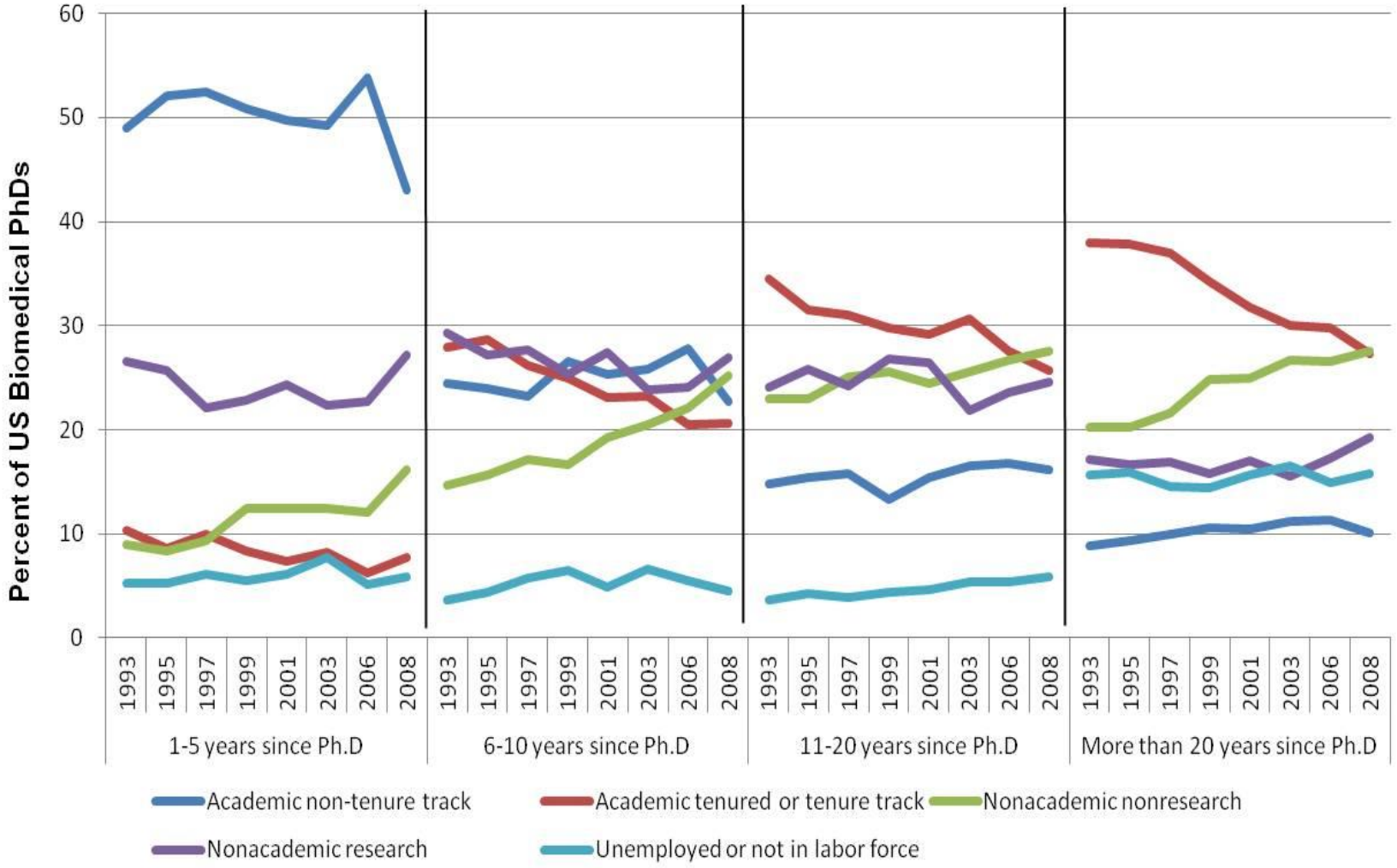
Sources: NIH and AAMC

Relationship between Science and Engineering PhD Field and Occupation



Source: Survey of Doctorate Recipients

U.S. Trained Biomedical PhD employment, by Years Since Degree



Source: Survey of Doctorate Recipients

Earnings comparison

Years Since PhD	BioMed	Comp/ Math	Physical Science	Social Science	Engineer
0	51,594	66,804	57,775	55,532	72,992
10	87,766	99,972	94,180	87,853	113,314
30	123,959	109,277	122,148	107,321	133,292

Source: Survey of doctorate recipients

ACD-BRWG Conclusions

- Weighing all the data analyzed, the working group concluded that :
  - The combination of the large upsurge in US-trained PhDs, increased influx of foreign-trained PhDs, and aging of the academic biomedical research workforce make launching a traditional, independent, academic research career increasingly difficult.
  - The long training time and relatively low early-career salaries when compared to other scientific disciplines and professional careers may make the biomedical research career less attractive to the best and brightest of our young people.
  - The current training programs do little to prepare people for anything besides an academic research career, despite clear evidence that a declining percentage of graduates find such positions in the future.

ACD-BRWG Recommendations

- NIH should create a program to supplement training grants through competitive review to allow institutions to provide additional training and career development experiences to equip students for various career options, and test ways to shorten the PhD training period.
- Institutions to develop pilot programs in partnership with private foundations and industry to prepare Ph.D. graduates for careers that involve translational research and development.
- Institutions also could be encouraged to develop other degree programs, e.g. master's degrees designed for specific science-oriented career outcomes, such as industry or public policy.
- To encourage timely completion of graduate degrees, NIH should cap the number of years a graduate student can be supported by NIH funds (any combination of training grants, fellowships, and research project grants), with an institutional average of 5 years and no one individual allowed to receive support for more than 6 years.
- To ensure that all graduate students supported by the NIH receive excellent training, NIH should increase the proportion of graduate students supported by training grants and fellowships compared to those supported by research project grants, without increasing the overall number of graduate student positions
- NIH should revise the peer review criteria for training grants to include consideration of outcomes of all students in the relevant PhD programs at those institutions, not only those supported by the training grant.
- The very different requirements and characteristics of training programs at each NIH Institutes and Center (IC) constitute a substantial burden on the institutions. All NIH ICs should offer comparable training programs and fellowships and their requirements should be harmonized

A Vision of the Future Training for a Diverse Cancer Workforce

- Recruitment of the Best & Brightest
  - Eliminate trade school approach to applicant review
  - Focus on critical thinking skills, resiliency and ambition
  - Accept applicant's desire for nontraditional career goal
- PhD Training For Diverse Outcomes
  - Inculcate culture of excellence and leadership regardless of career path
  - Protect and nurture traditional professoriate pathway
  - Include formal, rigorous and unique training opportunities in nontraditional career paths
- Assess Whether Training Approaches Achieve Outcomes
  - Great service/administration won't get you tenure

Cancer PhD Training for Diverse Outcomes

- Protect and Improve Traditional Professoriate Training Pathway
  - Formal grant writing courses and require F30/F31 submission
  - Establish objective, uniform, competency-based criteria for PhD degree
  - Require IDPs with clearly stated time-to-degree goal
- Include Formal and Informal Nontraditional Training Opportunities
  - Courses in writing, communication, marketing, business, law
  - Internships in Biotech/Pharma, in teaching at local colleges, in patent law firms, in government, in public policy think tanks
  - Should all students sequence their genome and assess cancer risk? Should all perform community cancer activities?

IDPs: Early & Frequent Discussion of: Which path is right for you? What is important to you?

- The intangibles
  - Ambition, drive, tenacity, delayed gratification
  - Team player vs. maverick
  - Job stability vs project stability
  - Financial stability: Raising your salary via grants
  - Time to acquire skill set or additional degrees
  - Career interruptions to raise a family
- Money, freedom, fame?
  - Financial: Compensation vs. total package
  - Ability to move around the country
  - You choose research area and work independence
  - Scientific creativity

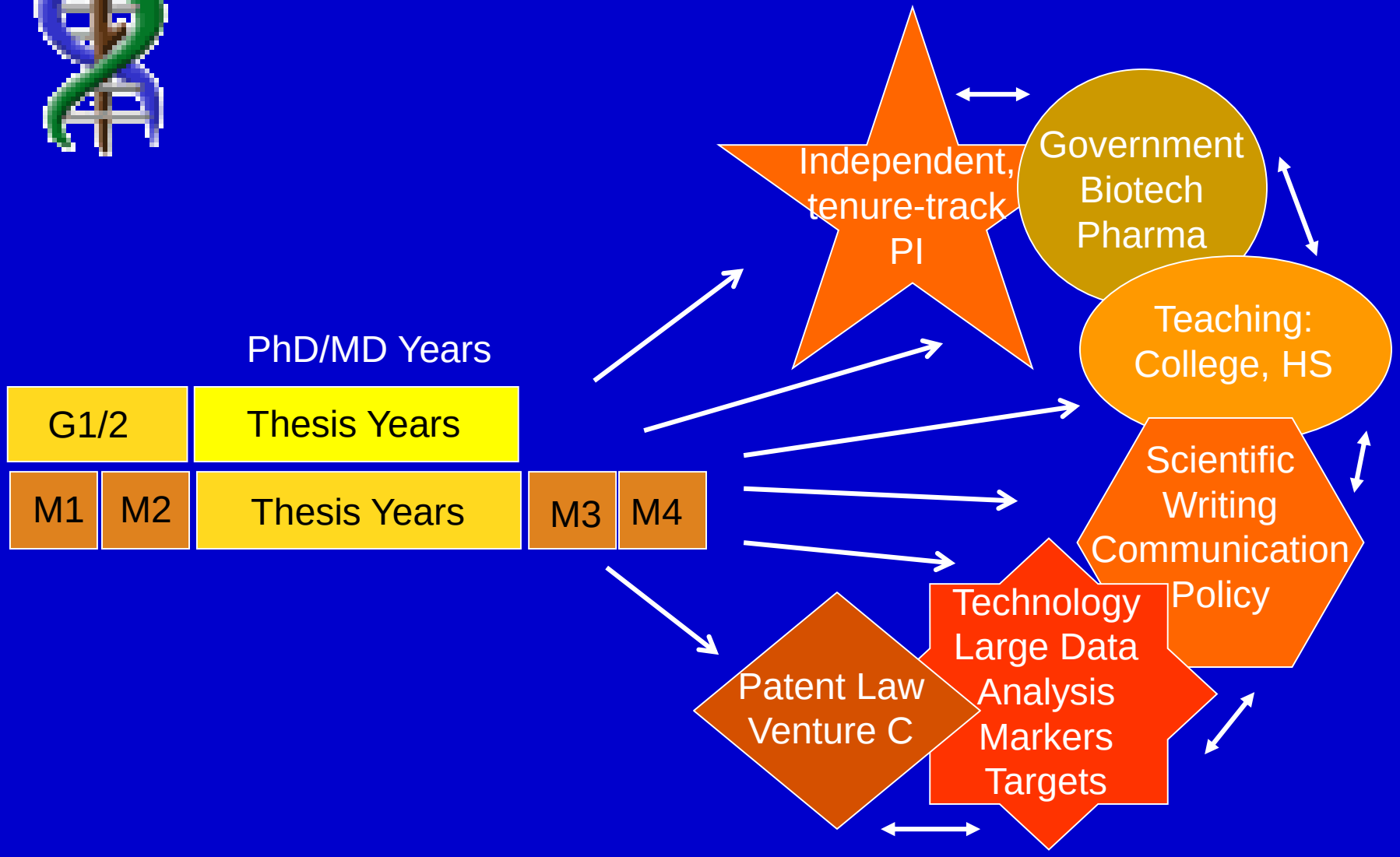
Anticipating the Future: Skills for Every Pathway

- Require bioinformatics and/or computational biology courses so that trainees can analyze “large data”
- Require a better understanding of statistics and critical assessment of clinical studies
- Require that trainees attend a clinic and find a clinical mentor relevant to the cancer they are studying
- Expose trainees to the critical aspects of cancer drug development, from the bench to the bedside
- Develop interdisciplinary journal clubs: biomedical engineering, tumor immunology, radiation biology etc
- Develop writing activities whereby trainees integrate their knowledge and learn to communicate effectively

Secrets from the Other Side: Useful Guidelines for all Career Paths

- Pursue *your* best ideas and set high goals
- You are not alone: Establish strong network of mentors, colleagues, collaborators, and support
- Continuously assess your strengths and pursue career path(s) that deal to your strengths
- Be highly opportunistic (and even somewhat selfish) in pursuit of science and career paths
- Enjoy each moment, have fun, celebrate success!!

Cancer PhD Career Pathways: Diversity and Resiliency



The Real World of Academics

- Research
  - Cutting edge & distinctive area within the department
  - Grants, publications, patents
  - Awards, impact factor
- Teaching
  - Great teaching won't get you tenure
  - Undergraduate, Graduate &/or Medical school curricula
  - Graduate Program role
- Service/Administrative functions
  - Great service/administration won't get you tenure
  - Program Direction, Committees
  - Core Laboratory