



Computational and Professional Skills for Biomedical Trainees

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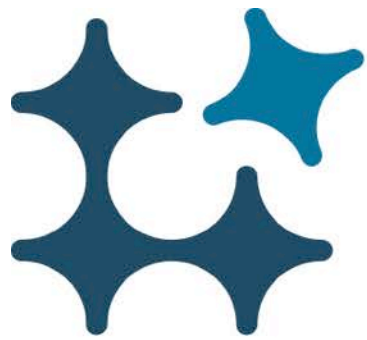
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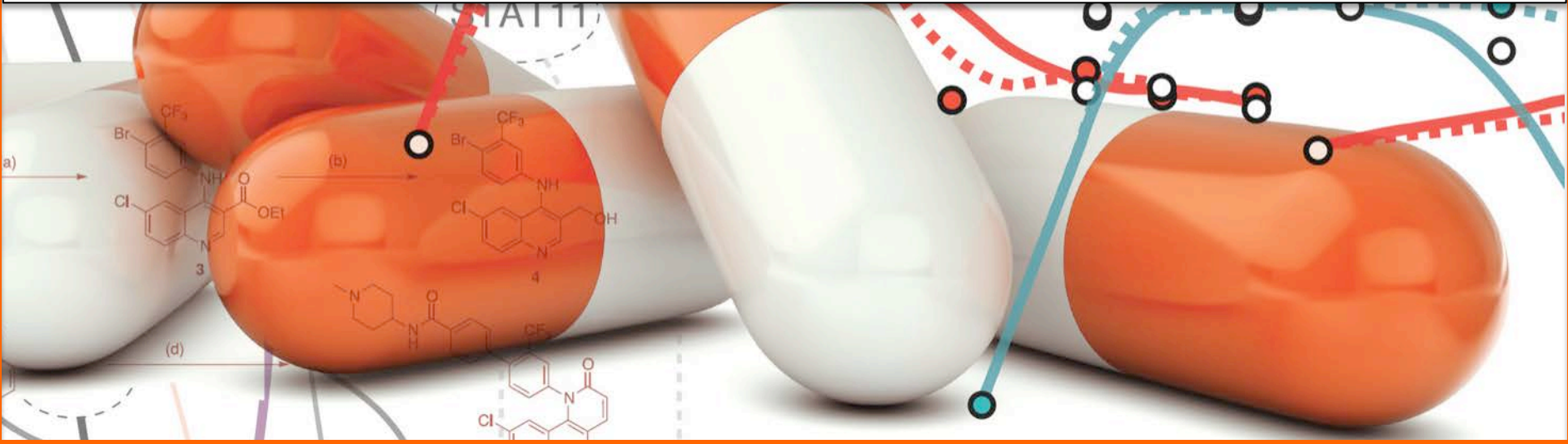
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ASPET 2017



Therapeutics Graduate Program





Therapeutics Graduate Program

- 1. TGP Introduction**
- 2. TGP Requirements**
- 3. Quantitative and Computational Skills**
- 4. Professional Skills**
 - **Internship**
 - **Entrepreneurship Course**

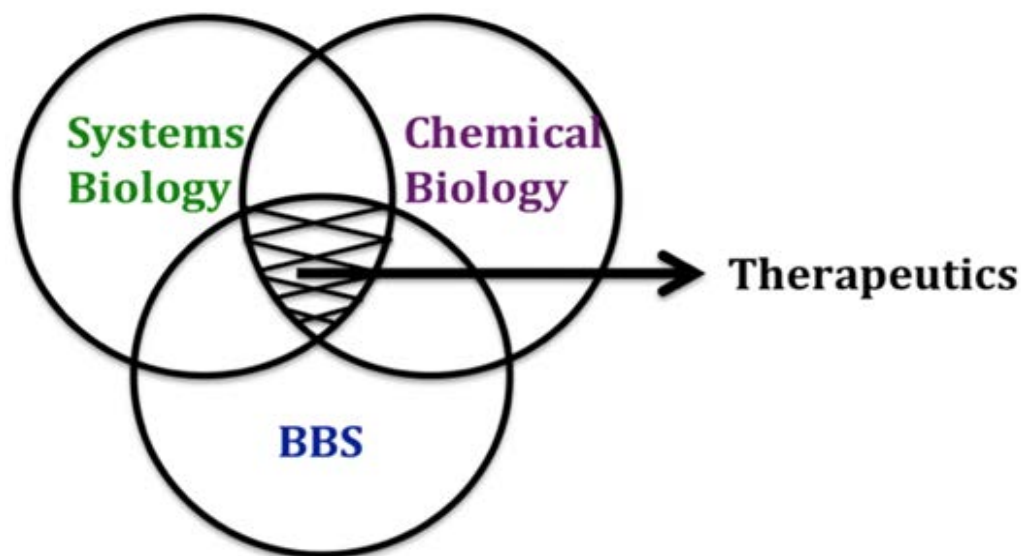




Therapeutics Graduate Program



Harvard-wide certificate program that provides a rigorous curriculum and builds a community of PhD students and faculty with common interests in therapeutic science/development



Hi+H+S

Harvard Program
in Therapeutic Science





TGP Goals

- To provide students with the educational foundation, intellectual tool kit, and practical skills necessary to be productive researchers in therapeutics discovery throughout the workforce
- To link this training to current pharmaceutical, clinical, and regulatory activities, encouraging students to apply their training to real-world problems



TGP Students

Biological and Biomedical Sciences

Chemical Biology

Chemistry and Chemical Biology

Systems Biology

Virology

Speech and Hearing Biosciences and Technology

Biological Sciences in Public Health

Biophysics

Program in Neuroscience





TGP Requirements

Core Scientific Curriculum

Translational Pharmacology

Modern Drug Discovery

Human Physiology, Human Toxicology

Core Skills Curriculum

Experimental Design Skills

Quantitative and Computational Skills

Professional and Career Skills

Required Internship



Innovations in TGP Curriculum

1. Modular curriculum to better serve students with diverse needs and backgrounds
2. Increased focus on skills training
3. Developing quantitative and computational content
4. Developing formal professional skills content
5. Internship

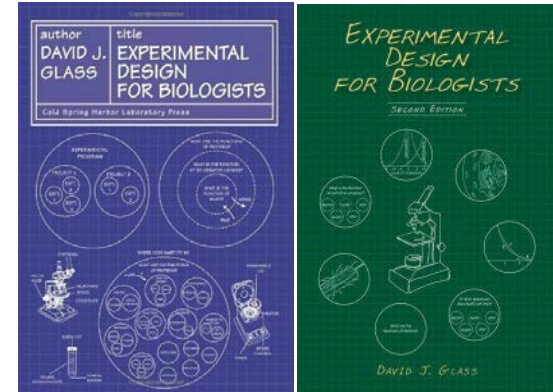
Development of formal content has been accomplished using the T32 Administrative Supplements



Required TGP Skills Curriculum

Experimental Design Skills

Experimental Design for Biologists
David Glass (Novartis) and Randy King (HMS)

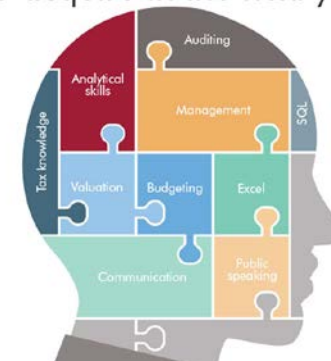


Quantitative and Computational Skills

Biostatistics
Programming (Matlab, R, Python, etc.)
Modeling
Data analysis (Imaging, Mass Spec, etc.)



Top skills employees would like to acquire in the next year:



Professional and Career Skills

Internship
Paracurricular activities



Biostatistics in Matlab

Developed with Administrative Supplement to the Pharmacological Sciences T32 (PA-15-136)

Objectives:

- Apply statistical, analytical, programming (Matlab), and mathematical biology concepts to problems in pharmacology and drug discovery
- Learn to program in Matlab
- Learn basic biostatistics

Sub-Aims:

- Demonstrate the application of dynamic mathematical modeling to various components of the therapeutic pipeline
- Demonstrate the application of statistical analysis to various components of the therapeutic pipeline

Audience: Beginner (no prior knowledge of programming is assumed)

Course has been designed in collaboration with Applied BioMath and taught in collaboration with Applied BioMath scientists and statisticians



Quantitative Methods in Pharmacology

Objectives:

- Use the Matlab SimBiology suite to build quantitative models of drug action
- Through a combination of model building and hypothesis testing, develop basic skills in developing computational models and using them to understand drug action
- Learn how to model enzyme kinetics and inhibition and whole-body pharmacokinetics, and use these skills to model specific problems in pharmacology

Sub-Aims:

- Teach rigorous, quantitative data analysis
- Teach experimental design paradigms for PK/PD experiments
- Demonstrate the impact of modeling experiments on experimental methods/design

Audience: Beginner to Intermediate

Course was designed in collaboration with Mathworks and co-taught with Mathworks scientists



Principles of Quantitative Measurement and Analysis

Administrative Supplement PA-16-142 awarded to the HMS Systems Biology T32

Objectives:

- Provide students with core principles for building an assay, characterizing its performance, and obtaining reproducible and statistically significant results
- Understand and identify assumptions in experimentation and measurement

Sub-Aims:

- Teach best practices in determining whether a measurement is sufficient to answer a question
- Provide formal training for biomedical students on measurement principles and assay design
- Quantitatively analyze data sets in Python
- Initial set of modules includes mass spectrometry, RNAseq, quantitative microscopy, and UV/VIS spectrophotometry

Audience: Intermediate to Advanced

Course was developed in collaboration with the TGP



Therapeutics Graduate Program

Professional Skills List



Decision-Making Skills

- gather information
- brainstorm and list different possible choices
- evaluate each option
- determine the best alternative
- put the decision into action



Organization Skills

- general planning
- coordinating resources
- meeting deadlines
- attention to details



Stress Management

- physical activity
- relaxation techniques
- positive thinking
- manage your time



Communication skills

- listening skills
- body language
- verbal and written communications
- being positive and patient
- being respectful and confident
- respect



Leadership Skills

- analytical skills
- conflict resolution abilities
- creativity and creative thinking
- organization skills
- negotiation skills
- goal settings



Time Management Skills

- set goals
- prioritize your goals
- create a schedule
- make lists
- use optimization tools



Flexibility

- self-management skills
- keeping calm in the face of difficulties
- optimism
- be open to new ideas and changes



Professional Skills



The Need to Acquire a Variety of Skill Sets

Where will a biology PhD take you?

Arrows represent annual fluxes. Circles are total current workforce numbers.

86,000

current US biology PhD students

Every year, 16,000 students start biology PhD programs

9,000 Receive PhDs

7 years

average time to degree

1,900 to 3,900 foreign-trained PhDs start postdocs

720 Leave the US

30% do more than one postdoc¹

37-68,000

current postdocs

70% (5,800) Postdoc

? years

US PhDs spend an average of 4 years, but others must spend longer to account for number of postdocs.

37% drop out

30% (2,500) Don't postdoc

A faculty job is an "alternative" career.



At this rate, <8% of entering PhD students will become tenure-track faculty. Yet, 53% rank research professorships as their most desired career.³

15% of postdocs get tenure-track faculty jobs within 6 years post PhD.²



29,000

current tenured and tenure track faculty



17,000

current bio PhDs doing non-science jobs



22,500

current industry researchers

20% get non-tenure track academic jobs within 6 years post PhD.²

25,000

current non-tenure track academic positions



24,000

current non-research, science related jobs



7,000

current gov't researchers

10% of former postdocs (up from 2% in 2010) consider themselves unemployed.¹

Sources:

1 - Science Careers Annual Postdoc Survey (2012) <http://goo.gl/nmVYCN>
2 - doi:10.1038/472276a <http://www.nature.com/news/2011/110420/full/472276a.html>
3 - Sauermann & Roach 2012 PLOS ONE, DOI: 10.1371/journal.pone.0036307
Unless otherwise noted, NIH Biomedical Workforce Working Group (2012)





TGP Internship Requirement

Goals:

- To gain practical work experience and professional skills
- Highlight real-world applications of therapeutic development
- Promote interactions, collaboration, and network-building experiences for both students and institutional partners

Students are required to complete an internship in **one** of the following settings:

Industry (pharma/biotech)

Clinical investigation

Regulatory science



TGP: Internships to Date

Completed by December 2016 (17 students)

- 1 student at Novartis, created an ongoing collaboration
- 2 students in a longitudinal internship at Novartis
- 2 students at Novartis
- 5 students at Biogen
- 2 students at Merck
- 1 student at OvaScience (lab collaboration)
- 1 student at Merrimack (lab collaboration)
- 1 student at Genentech
- 1 student at Pfizer
- 1 student at White House OSTP internship

Planned for Summer 2017 (8 students)

- 3 students at Vertex
- 1 students at Novartis
- 1 student in Regulatory Science (in process of scheduling)
- 3 students (in process of scheduling)



Skills-Focused Paracurricular Activities

1. Annual Symposium/Retreat

Scientific presentations

- *Faculty*
- *Industry collaborators*
- *Student posters*

Skills / Professional Development

- *Skills identification workshop*
- *Leadership and management*
- *Giving and receiving feedback*
- *IDP workshop*



2. Student-Led Discussion Sessions

- Discussions with guest speakers about career paths and skills
- Internship reports, discussions about acquired skills, skills to learn and perfect



Fundamentals of Entrepreneurship

Developed with Administrative Supplement to the Pharmacological Sciences T32 (PA-16-133)

Objectives:

- Teach and measure professional skills in communication, leadership, and management
- Broaden the training of graduate students to better prepare them for research careers in a variety of venues

Sub-Aims:

- Communications skills: how to present your science to various audiences
Content developed with the Alan Alda Center for Communicating Science
- Leadership skills
Case-based content developed with faculty from Harvard Business School
- Management skills
Case-based content developed with faculty from MIT Sloan School of Management

Course is being developed in collaboration with the Center for Primary Care at HMS and with Dr. Krishna Yeshwant, venture capitalist at Google Ventures



Acknowledgments

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Edward Harvey (G3)
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