

Short Course on Best Practices for Rigor and Reproducibility in Research

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at CHAPEL HILL**

Department of Health and Human Services

PA-15-136 - Availability of Administrative Supplements to NIGMS Predoctoral Training Grants (Admin Supp)

The National Institute of General Medical Sciences (NIGMS) announces the availability of funds for Administrative Supplements to NIGMS-funded predoctoral T32 training grants. **These funds are designed to provide support for the development and implementation of curricular activities aimed at providing graduate students with a strong foundation in research design and methods in areas related to conducting reproducible and rigorous research**



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Rob Nicholas
T32 Director
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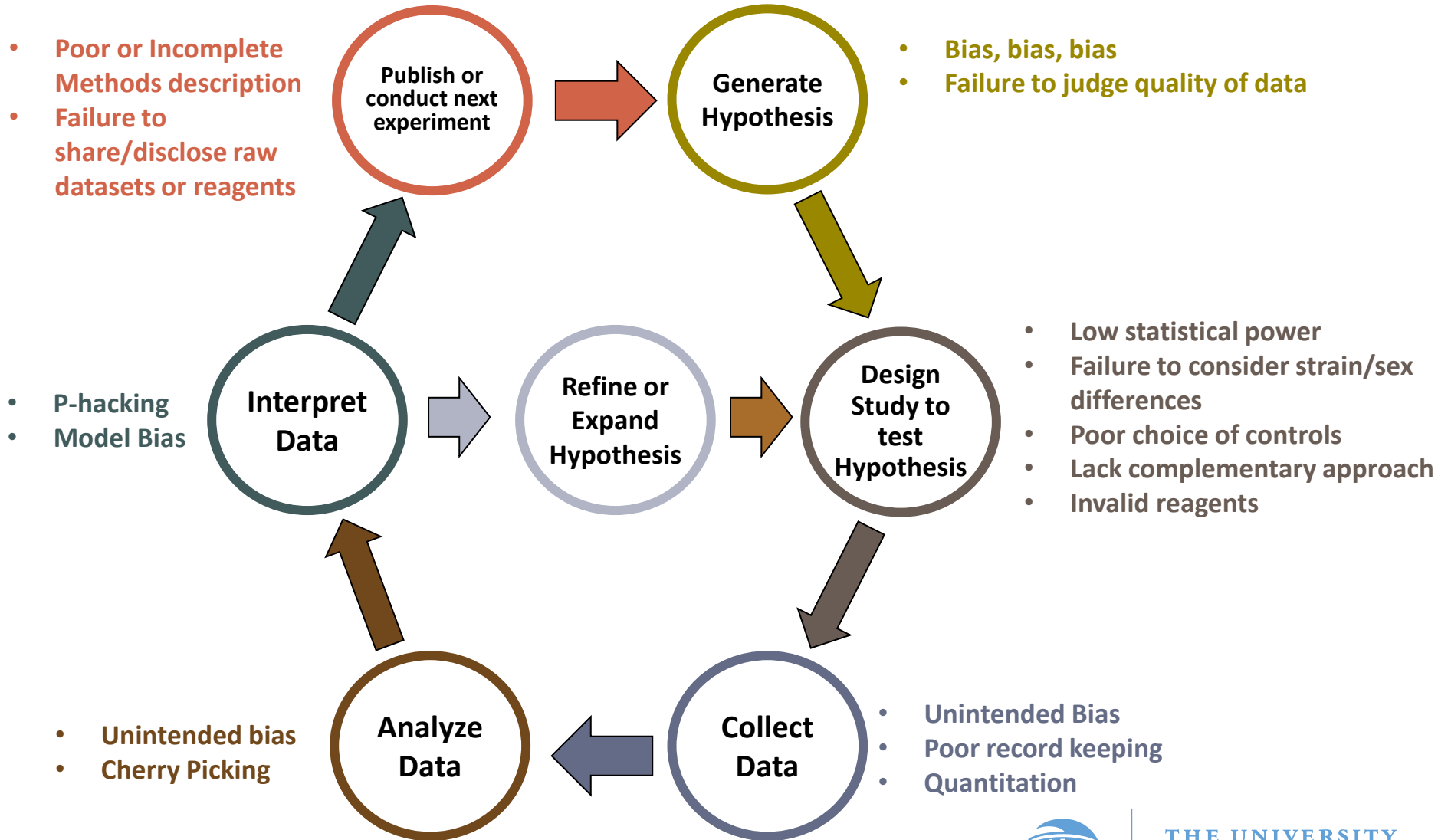
Mohanish Deshmukh
T32 Co-Director
Medical Sciences Training Program



Planning and Execution

- UNC developed the Biological & Biomedical Sciences Program (BBSP)-1st year umbrella program that feeds 14 departments/curricula in the Medical School and College of Arts & Sciences (Biology & Chemistry)
 - Brings in ~100 students/year
- We met with other T32 Programs to discuss how we would proceed
- Wrote Supplement and UNC was one of 16 institutions that was funded
- Organization
 - Short Course focused on the various steps of Hypothesis-Driven Research and where things can go wrong at each step

The Scientific Process



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 - Short Course focused on the various steps of Hypothesis-Driven Research and where things can go wrong at each step
- Recruited productive and engaged faculty to teach each session
 - Provided partial salary support for 1 year to compensate for their time and effort
 - Got commitment for 3 years (several are still teaching)
- Worked with T32 Program Directors to recruit PhD2 or PhD3 students

Best Practices to Ensure Reproducibility and Rigor in Research

- Classes are an ~equal mixture of didactic lecture, class discussion, and class exercises
- Classes are 5 consecutive 1.5 hrs sessions at the very end of the spring semester
- Initially, we capped enrollment at 40 students to allow for optimum class participation in a classroom setting
- With online classes the past two years, we opened enrolment to all students and have had ~100 students each year
 - The last two years have been conducted over zoom, with multiple breakout rooms, class exercises, and discussions

1. *Experimental Design*

- Introduction to the problem: Industry perspective
- Key principles
 - *What is the question?*
 - *What is the appropriate model system?*
 - *Multiple approaches*
 - *Controls: Positive and Negative*
 - *Multiple timepoints, concentrations, etc.*
- Personal experiences and lessons learned:
 - P2Y receptors
 - Staurosporine and neuronal death
- Covid-19 studies



Rob Nicholas



**Mohanish
Deshmukh**



2. Experimental Rigor

- What is Scientific Method?
 - *Factors that compromise Scientific Methods*
- Best practices for scientific rigor
 - *Pre-determination of sample sizes, end points, data handling (statistical methods)*
 - *Technical versus biological replicates*
 - *Limitations and quantitative range of detection and measurements*
 - *Using parallel approaches*
- Forming a scientific hypothesis
 - *Write down a hypothesis*
 - *What about an alternative hypothesis?*
 - *List two parallel approaches to test these hypotheses*



Kevin Slep



3. *Experimental Models and Reagents*

- Models and reagents: considerations and complications
 - *Purified proteins*
 - *Chemical reagents*
 - *Antibodies*
 - *Cells and cell lines*
 - *Animal models*
- Appropriate endpoints for experiments
- Biological heterogeneity and complexity
- Established cell lines vs genetically engineered models vs patient-derived xenografts



Adrienne Cox



4. Metadata and Data Management

- Complexity of data gathering
 - *Meta data (data about data!)*
 - *Human subjects (age, disease status, gender, etc.)*
 - *Animal models (strain, litter, genetics modifications, etc.)*
- Establishing global standards
 - *Disease classifications, toxicity criteria, nomenclature and annotation*
- Software pipelines
 - *Version numbers*
- Published databases
 - *Geo, dbGap, ENCODE*



Corbin Jones



5. Data Analysis and Publishing

- NIH standards for rigorous reporting

<http://www.nih.gov/research-training/rigor-reproducibility/principles-guidelines-reporting-preclinical-research>

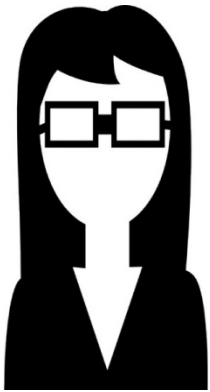
- Lab notebook
- Peer review and publication process
 - *Expectations from Journals*
 - *Image manipulations*
 - *Data trimming and analysis*
- Case studies



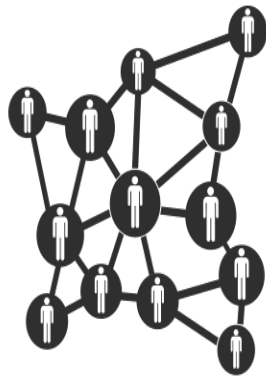
Greg Copenhaver



Stakeholders in Rigorous Scientific Investigation and Reporting



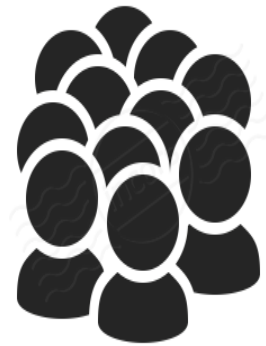
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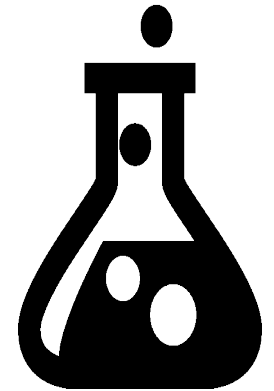
Colleagues



Patients



The Public



Science Itself

Outcomes and What We Learned

- Offered this course for the past 5 years
- T32 Directors really love it!
- Important to have an official course number designated to ensure credit for faculty participation
- Overall, the course has been a success and the students have found it useful
- Diversity of scientific interests needs to be taken into account



Survey of Students - 2020

Q36 - Please rate your agreement with the statement: "I feel I am more knowledgeable about the pitfalls/areas of concern associated with the following topics."

#	Question	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	Experimental Design	25.35%	61.97%	9.86%	2.82%	0.00%	71
2	Experimental Rigor	30.99%	56.34%	9.86%	1.41%	1.41%	71
3	Experimental Models & Reagents	28.17%	50.70%	15.49%	4.23%	1.41%	71
4	Data Management and Record Keeping	33.80%	49.30%	15.49%	1.41%	0.00%	71
5	Data Analysis and Reporting	35.21%	53.52%	9.86%	1.41%	0.00%	71



~80%

Survey of Students - 2020

Q24 - Overall, did you find the short course worth your time?

