
Targeting Careers in Research

Science, Engineering, and Medical Research

Michael C. Wendl

mwendl@wustl.edu

School of Medicine and School of Engineering and Applied Science

Washington University

genome.wustl.edu/staff/mwendl/M/mcw.html

©2004 Michael C. Wendl

Permission is granted to copy, distribute and/or display this document under the terms of the Attribution–NoDerivs–NonCommercial License, Version 1.0 or any later version published by Creative Commons. A copy of the license is available from Creative Commons, 559 Nathan Abbott Way, Stanford, California 94305, USA.

What We Cover Here

- overview of “research”
- realistic assessment of what type of training and time/money commitment you should expect
- why research is an attractive profession
- summary of what has worked for me personally

What We Do Not Cover Here

- aspects of the process that will be specific to you personally
 - financing — loans, scholarships, other financial aid
 - choosing a particular school, major, research field
- clinical medical practice — i.e. being a physician

Research

- “systematic inquiry into a subject in order to discover or check facts”



- discovery
- invention
- development

Some Recent Milestones in the News

- biology — human genome project (2001)
- mathematics — Fermat's last theorem (1995)
- physics — freezing and reconstituting light (2001)
- engineering — Mars rover exploration (2004)
- chemistry — carbon nanotubes (1991)
- medicine — multiple organ transplants (2000)

Research: Basic Science

- university setting or private research institute
- small to medium–size group led by a principal investigator
- aimed at generating basic knowledge or inventions
- physics, biology, chemistry, engineering, mathematics, astronomy, computer science, etc.

Research: Industrial/Commercial

- corporate setting (research division of a company), government lab, etc.
- individual, small, or large group
- application and/or project oriented — often supports product line
- pharmaceutical/chemical, consumer products, aerospace, automotive, defense work, software, etc.

Research: Clinical Medicine

- hospital/university setting
- individual or small group investigation
- focused on medical treatment, prevention, etc.
- surgical, infectious disease, drug trials, genetic intervention, cancer, etc.

What Do These Have in Common?

- requires terminal degree!
- MD
 - clinical medical research (including neurology, psychiatric research, etc.)
 - biomedical research
- PhD
 - life sciences and biomedical research
 - all physical sciences (e.g. physics, chemistry, astronomy) and all engineering specialties
 - mathematics and computer science
 - social sciences, e.g. anthropology and archeology

Career Prep: The Terminal Degree

- MD
 - 4 years undergraduate (you pay)
 - 4 years medical school (you pay)
 - 3–7 years residency (you earn)
- PhD
 - 4 years undergraduate (you pay)
 - 5–7 years graduate school (you break even)
 - 1–3 year post–doctoral training (optional, you earn)

Monetary Reality



- cost, cost, cost!
- how will you fund your training?
- (if you think an education is expensive, try ignorance)

Monetary Cost of MD — A lot

- 4-year undergraduate tuition
- medical school is expensive — and you must (usually) pay

Rank †	Institution	Tuition (2002)
1	Harvard University	\$32,708
2	Washington University	\$35,780
2	Johns Hopkins University	\$32,083

† U. S. News and World Report Annual Survey (2004)

- state schools (in-state tuition) will be somewhat less
- often financed — debt load

Monetary Cost of PhD — A lot Less

- 4-year undergraduate tuition
- grad school is expensive — but you don't (usually) pay
 - tuition covered by advisor funding
 - departmental tuition remission (teaching assistant)
 - research stipend

MCW as a Case Study

- 4 years undergrad Washington University School of Engineering (parent's support, savings, work income)
- 6 years grad Washington University School of Engineering (tuition remission, AIAA fellowship, research stipend, living at home)
- 3 years post-doc Washington University School of Medicine (salary)

Academic Reality

- competition for position
 - GPA
 - academic pedigree
- competition for money
- sustained period of your life of focused dedicated hard work
- the clock is ticking (graduate school is no place to “find yourself”)
- you should be thinking about what you want to do with your life *now!*

The Ideal Case

- hi GPA/SAT/ACT → good undergrad institution
- MD route
 - hi GPA/MCAT → good medical school
 - post-doc/residency in internationally recognized clinical or research lab
 - strike out on your own as a successful researcher
- PhD route
 - hi GPA/GRE → good graduate school (famous advisor)
 - post-doc with internationally recognized lab/investigator
 - strike out on your own as a successful researcher

Important Parts of Your Training

- trend toward interdisciplinary capability



- your field, plus
- mathematics, plus
- computer science

What Should you be Doing Now?

- science and math courses
- looking at high profile national research universities (state or private)
 - exposure to research environment
 - classes taught by researchers
 - academic pedigree
- be thinking about your undergraduate major *now!*
- network with practicing researchers
- look for relevant work experience

Niceties About a Research Career

- make a good living
- work on problems you choose and that you like
- prestige factor
- contribution to society
- play with fun new stuff
- non-routine
- open end to other careers (consulting, private practice, law, corporate management, etc.)
- this is the type of career that will pay “dividends” over your whole life

Would you be Happy?

- committed, disciplined, focused
- think creatively — not a passive activity
- value working independently
- continued learning
- communicate effectively — oral and written presentation

MCW as a Case Study II

- time allotment
 - 80% research work — mathematical theory of DNA sequencing, modeling arterial stenoses, characterizing flow in biomedical devices
 - 10% teaching — 1 engineering course
 - 10% specific learning activities — seminars, reading about new work, etc.
- could not imagine doing anything else
- bottom line — effort was well worth it!

Some Trends for Next 20 – 30 Years

- biomedical: all basic and applied biomedical research
- environmental: env–engineering, remediation, clean energy, pollution control, etc.
- defense: (aging work force)
- novel interdisciplinary work, e.g. nanotechnology
- quantitative work in any classically qualitative branch of science, e.g. biology and chemistry
- any research related to societal trends, e.g. aging baby–boomer population, bio–terrorism, encryption and electronic security, etc.

Parting Advice

- choose a career that . . .
 - you can make a reasonable living at
 - you can look forward to going to work everyday
 - you can be proud of doing
 - that does not compromise any of your principles
- once you get to college, try and remember why you're there
- nobody cares about your future like you (and your parents) do
- adapt, improvise, overcome (marine corps slogan)
- there's no shortcut to anyplace worth going to

Acknowledgment

- Cartoon images are ©1999–2004 www.barrysclipart.com and used by permission
- presentation implemented with free software — the L^AT_EX typesetting system using the PROSPER class
 - L^AT_EX : www.latex-project.org
 - PROSPER : prosper.sourceforge.net