Synberc's Quick Guide to

Graduate School

for Emerging Synthetic Biologists

Synthetic biology is an exciting new field that is building upon advances in biotechnology to make biology easier. Students in biology, chemistry, engineering and physics programs are working to improve human welfare through advances in areas like health, energy, and the environment.

The Synthetic Biology Engineering Research Center (Synberc) is a group of pioneering researchers from leading universities who are helping to lay the foundation for synthetic biology. Synberc students come from a variety of graduate programs to participate in a unique interdisciplinary and multi-institutional collaboration. Synberc offers students with career and research opportunities above and beyond the typical graduate school experience.

This guide gathers together wisdom from students, professors, and admissions experts to help you get into top graduate programs in synthetic biology related disciplines.

Preparing early: What to do now

Applicants who win admission to graduate school have a set of competencies and experiences that set them apart from other students in the applicant pool. Seek these experiences to improve your application.

Seek research experiences and other activities that make for good recommendation letters

- Generally speaking, research is the academic experience most highly valued by graduate admissions committees. Applicants who have research experience often are viewed as *graduate school material* because, at least in doctoral programs, research is at the heart of graduate school. Your research experience must be supervised, documented, and evaluated highly by a faculty member in your department who, in turn, writes a letter of recommendation on your behalf as part of your graduate school application. iGEM is a great example. Stay engaged with your faculty supervisor.
- Understand the benefits of getting involved in research and demonstrate an honest interest. This means that you should seek long-term experiences with potential for publishing, even if they are unpaid.

Make contacts with faculty

- Use office hours, colloquia and seminars to ask questions about faculty research and listen. If you find one of the projects interesting and think you can contribute, ask if he/she could use student help. If you volunteer to work with a professor, recognize that you are making a commitment that the professor expects you to keep. Skipping out on the agreement will not increase your odds of getting into grad school, so only commit to what you can really do.
- Be friendly but professional.
- Participate in journal clubs, seminars, undergraduate research networks, science clubs and other activities where you can interact intellectually with professors and colleagues.

A sample timeline for applying to grad school

The optimized application timeline below is for someone who wants to get things done early. If you are in the midst of applying now and these guidelines suggest that you're behind schedule, don't worry. But completing your applications on the early side is a good idea for a number of reasons:

1) If you're in college, you can use the extra time to avoid working on applications during finals and other crunch-times.
2) Something can go wrong (e.g., your transcripts might not arrive inexplicably). Allow extra time to fix these problems, lest you miss the application deadline to your top choice due to a technicality.
3) You will have more time to work on your personal statements.
4) Professors get inundated with requests for letters of recommendation each year. They need time to write thoughtful letters, so make your request the first one they get.
5) Some schools start reviewing applications early, in which case earlier applications are usually at an advantage.

JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Research graduate schools and potential advisors.									
Start drafting personal statement and curriculum vitae.			Ask faculty/advisors for feedback on your essays		Finalize your essay and statement of purpose			Start planning for interviews	Visit schools that accepted you
Study for GRE— at least two months			Take the GRE/ subject GRE		Arrange for your transcripts to be sent				Discuss your options with faculty, advisors
		Consider which professors to ask for letters	Ask faculty for letters of recommendation — provide your transcript and essay.		Check and record all due dates	Complete and submit your application forms			Notify schools of your acceptance or declining
	Set up your spreadsheet to organize	Watch for applications to come	Note special application	Research fellowships	Apply for fellowships		Follow up with schools that haven't acknowl-		

Choosing a graduate program

Although many graduate programs are beginning to emphasize synthetic biology, most students interested in this emerging field enter into programs in related fields. These include but are not limited to bioengineering, cell and molecular biology, systems biology, chemical engineering, genetics, and the social sciences.

Professors are the heart and soul of the graduate student experience, so find out as much about them as you can. Your graduate school professors will work more closely with you as your mentors and advisors, so they will have a much more profound impact on your experience and education than in undergraduate school. Unlike undergraduate schools, admissions decisions aren't made by an admissions board, but by department faculty. So it's crucial to know something about the professors you will potentially be working with. What are some of their recent publications? Are they known for ground breaking research, insights, or inventions? Are they not merely academics, but also active in their research field? A primary goal of every graduate student should be to find a mentor with whom you can work well with, with similar research interests and good research connections, and then develop a strong working relationship.

As you learn about the well-known researchers in your area of study, you will begin to get a good idea of the best programs in your field. You can also use guides like U.S. News and World Report's "Best Graduate Schools", which ranks graduate schools based on subjective expert opinions and statistical measures of the quality of a school's faculty, research, and students. While these rankings shouldn't be taken too literally, they can help give you a rough sense of a graduate program's strength. The reputation of the program—not so much the school per se, but the specific graduate program—will make more of a difference in how you're perceived by others in your field.

From US News & World Report

2015 Best Graduate Schools:

Engineering:

1. MIT
2. Stanford
3. UC Berkeley
4. Cal Tech
5. Carnegie Mellon

Biological sciences:

1. Harvard
2. MIT
3. Stanford
4. UC Berkeley
5. Cal Tech

Does this grad school fit me?

Besides a program's professional reputation, there are several somewhat intangible, personal criteria to consider. Where's the school located? Could you be happy living there for several years? Even if the faculty is well respected, are their views on important subject matters wildly at odds with yours? If you are a budding synthetic biologist aiming to design the next biofuel, you might be a fish out of water if the professors in your program are mostly traditional cell biologists interested in the developmental differences between bacteria and protozoa. Consider whether you learn best in a small, medium or large environment. Large programs generally offer broad exposure plentiful resources, and many colleagues. But large programs might not provide the personal level of attention desired. Smaller programs often offer greater interaction for students focusing on a more restricted area of research.

If at all possible, visit a school before applying – and certainly before enrolling – to get a feel for the place, the people, and the facilities. Most top schools will pay for your interview visit. Don't just drop in – call or write to make arrangements for a scheduled visit. Walk the campus. Check out the facilities, labs, libraries, classrooms. The university will often arrange for you to talk with some students and professors. Talk with as many people as you can, while also striving to make a good impression. Students may tell you things about the program and professors that the professors themselves won't. Ask which professors are the best ones to work with personally. Walk or drive around town, and see what the housing situation and cost of living are like.

What are my odds?

Almost every graduate program publishes the average GPA and test scores of their current students for you to see how you stack up compared to them. Be realistic about what graduate programs to apply to, but don't sell yourself short, especially if it's a program you really want to get into. You'll need at least a 3.0 GPA to get into most top-tier schools. The admissions process at premier graduate schools is extremely selective. The faculty admissions committee will look to see whether you have a strong GPA and if your undergraduate degree is from a respected institution. Your GRE score is also very important: You'll want to do everything you can, including getting a good study guide and spending weeks preparing and practicing, to get a good score on your test the first time. The admissions committee will also look carefully at your recommendation letters and personal statement. These all have to be excellent to get into a top-notch graduate school. And good applications take a long time to prepare.

Your grad school application

Regardless of discipline, virtually all graduate school applications entail the same basic components. Ensure that your application contains all of these components because incomplete applications translate into automatic rejections.

Components of your application:

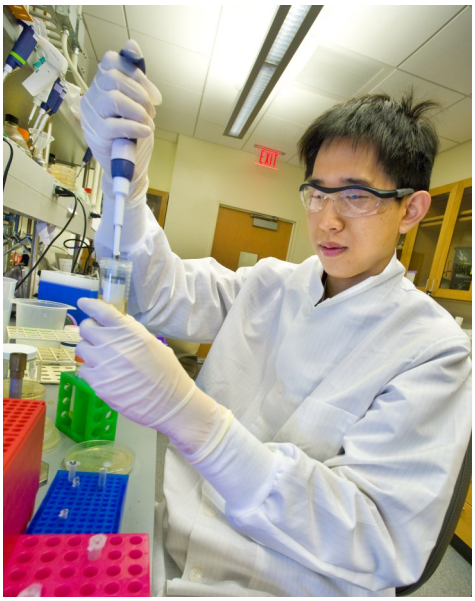
- *Transcript*
- *GRE or other standardized test scores*
- *Letters of recommendation*
- *Admissions essay(s) or personal statement*

Transcripts. Sometimes transcripts never arrive, due to errors on the side of your school, the mail room at the school to which you're applying, or the varied hazards of snail mail. You don't want your application to be rejected because your transcript was late or never arrived. Submit your request for transcripts early enough to request them again, if necessary. Check that your transcript has arrived at each of the programs to which you've applied.

Graduate Record Exams (GREs) or Other Standardized Test Scores. Most graduate programs in synthetic biology related fields require the GRE for admission. Some programs also require the GRE Subject Test, a standardized test that covers the material in a discipline (e.g., Biochemistry, Cell and Molecular Biology; Biology; and Chemistry). Most graduate admissions committees are inundated with applications and only consider applications that have scores above a cut-off point. Take standardized tests early (typically the spring or summer before you apply) to get a sense of which programs you will apply to, and to ensure that your scores arrive well before the deadline. If you take a test more than once, the school will see all of your scores. Studying diligently and taking the test once may look better to the admissions committee than showing an incremental improvement.

Letters of Recommendation. A good letter helps your application tremendously, but a bad or even neutral letter can send your application into the rejection pile. Ask for letters from the professors who know you best. The best choices are those you have done research with and/or who have read your academic writing. Ask if the professor can write you a "strong" letter of recommendation. Most professors will agree to write a letter, but if you ask for a "strong" letter the professor might say, "I don't think I know you well enough." This will give you the opportunity to ask someone else. A letter-writer who is well-known in the field would be great, but do not sacrifice someone who knows you well for someone who does not and is famous. It is ok to ask employers, especially if you have been out of school for some time and/or if your job is relevant to your field. Be courteous and respectful in asking for letters, and provide enough information and at least two months' lead time so that the professor can write a helpful, thoughtful letter. Consider providing him or her with a draft letter, your résumé/CV, or some "talking points" if there are things you want him or her to highlight.

Admissions Essay. The admissions essay is your opportunity to show that you are an informed, creative, and intelligent person as you explain why you want to attend graduate school and why each program is a perfect match to your skills. Think about who will be reading your statement and what they are looking for in an essay. They are scholars who are searching for the kind of motivation that implies a dedicated and intrinsic interest in the matters dealt with in their field of study. And they are looking for someone who will be productive and earnestly interested in their work. In reading your own letter, are you that kind of person? Focus on how your educational, occupational, and research experiences such as **iGEM** led you to this program. Don't rely heavily on emotional motivation (such as "I want to help people" or "my mother has diabetes, so I want to study diabetes"). Describe how this program will benefit you and how your skills can benefit the faculty within the program. Where do you see yourself in the program? How does it fit into your future goals? Really, what do you offer? If the application asks you to address a specific question to test your analytical skills, be sure to directly answer the question.



Narrowing down your choices

After researching as many schools as possible, it's time to decide which ones to apply to. Make a table that lists the schools against the factors above (the faculty, your chances of getting in, how long it will take to earn your degree, financial aid, personal and intangible criteria, etc). Are you able to eliminate any schools based upon any of these factors? Do all of them meet your basic requirements? Are any of these schools long-shots based on your academic record? Are you able to eliminate any schools because they just didn't feel right when you researched them?

What you want is a list of schools that really excite you, any of which you'd be very happy to attend and meet all your criteria. How many should be on your list is up to you, although you should definitely have more than one or two. Many people apply to between five and ten graduate schools; some apply to even more. But application fees are high and add up fast, and filling out all that paperwork and writing all those essays takes a lot of time. Pick a number you're comfortable with, and then do your best to ace those applications.

You made it! Now what?

Average years to complete a PhD

source: NSF (2009)

Life sciences: 6.9
Physical sciences: 6.7
Engineering: 6.7
Social sciences: 7.7
All fields (average): 7.7

You'll probably do a rotation through three labs before finding an advisor and settling into a laboratory. Your experience in this lab will set the tone for your career as a scientist. Your advisor's reputation and mentorship will affect both how you are perceived as well as your scientific thinking and style for many years, even if you eventually change fields.

You'll start to define your dissertation project, attend seminars and conferences, and meet people working in related fields of study. Your thesis work will eventually be completed, culminating in a paper or two. During your years as a graduate student , you will in essence be practicing the art of being a scientist. In earning your PhD, you will have proven that you are intellectually and technically ready to pursue research on your own. Congratulations!

Where can I learn more?

This guide hopes to give you a taste of the graduate school application process. There are many excellent resources available in print and on the web. Here are some of our favorites, and Synberc acknowledges the contribution of these to this guide:

- *About.com: Graduate School Admissions (Includes several useful sections, including Recommendation Letters, Common Essay Questions, Preparing for GREs, and more)*
- ***Graduate School Application Advice from Katherine Sledge Moore.*** *http://goo.gl/7TKjma (Includes helpful downloads such as a planning and school evaluation spreadsheet, sample CV and statement of purpose, and template communications for professors)*
- *GradSchoolTips.com*
- ***Choosing a College or Graduate School: Bear Advice from Marty Nemko.*** *http://goo.gl/0xxQA5*
- ***Department of Education website*** *(graduate school loan information): www.ed.gov/DirectLoan*
- ***So You Want to Be a Scientist?*** *Philip A. Schwartzkroin, Ph.D.(Oxford Press, 2009).*
- ***The Psychology Major's Handbook, Careers in Psychology: Opportunities in a Changing World.*** *Tara Kuther, PhD. (Wadsworth Publishing, 2002)*

Finally, to learn more about the graduate programs associated with Synberc research, please visit us at:

www.synberc.org

Synberc Professors & Research Interests

	J. Christopher Anderson (UC Berkeley): Systems-level bioengineering, applications, BioCAD	Natalie Kuldell (MIT): Synthetic biology education and training, public engagement, mitochondrial manipulation and redesign	
	Adam Arkin (UC Berkeley): Genomics, mathematical theory, computational and experimental approaches to analysis of cellular function	Wendell Lim (UCSF): Molecular logic of cellular signaling systems (signal transduction, protein-protein recognition, protein switches and networks, signaling protein and network evolution)	
	George Church (Harvard): Engineering genomic chassis for safe therapeutic bacteria, synthetic genomics (DNA from chips, error correction & assembly), new in vivo genetic codes	Susan Marqusee (UC Berkeley): Protein folding and function, part optimization, engineering allostery	
	Drew Endy (Stanford): Standards and safety, genetically encoded memory systems, biology easy to engineer	Kenneth Oye (MIT): Science and technology policy, biosafety, biosecurity, and environmental risk (Political Science and Engineering Systems)	
	Kristala Jones Prather (MIT): Design and assembly of recombinant microorganisms for the production of small molecules (metabolic engineering, biochemical engineering, bioprocess engineering)	Pamela Silver (Harvard): Synthetic biology, pathways in disease, RNA dynamics, genome organization	
	Jay Keasling (UC Berkeley): Biosynthetic production of therapeutic molecules, renewable energy, and environmental biotechnology	Christopher Voigt (MIT): Programming language for cells, engineering cellular sensors, organelle refactoring and engineering	
	Tanja Kortemme (UCSF): Computational biology; prediction and design of protein interactions and interaction networks combining computational modeling and experimental analysis	Ron Weiss (MIT): Programming novel systems-level cellular behaviors, design of synthetic gene networks	
	In addition to the core PIs above, Synberc has many other excellent Affiliated Investigators. Visit synberc.org/affiliates for more investigators	**This could be YOU!**	

synberc
Building the Future with Biology.

The **Synthetic Biology Engineering Research Center (Synberc)** is a multi-institution research effort to lay the foundation for the emerging field of synthetic biology. Synberc's vision is to catalyze biology as an engineering discipline by developing the foundational understanding and technologies to allow researchers to design and build standardized, integrated biological systems to accomplish many particular tasks. **In essence, we want to make biology easier to engineer.**

Synberc brings together leading biologists, engineers, and human scientists from top universities and companies to develop the foundational understanding, tools, and techniques needed to design and construct a broad range of biological applications to improve human health, address challenges in energy and environment, and contribute to the responsible development of the field.

Synberc is a National Science Foundation Engineering Research Center