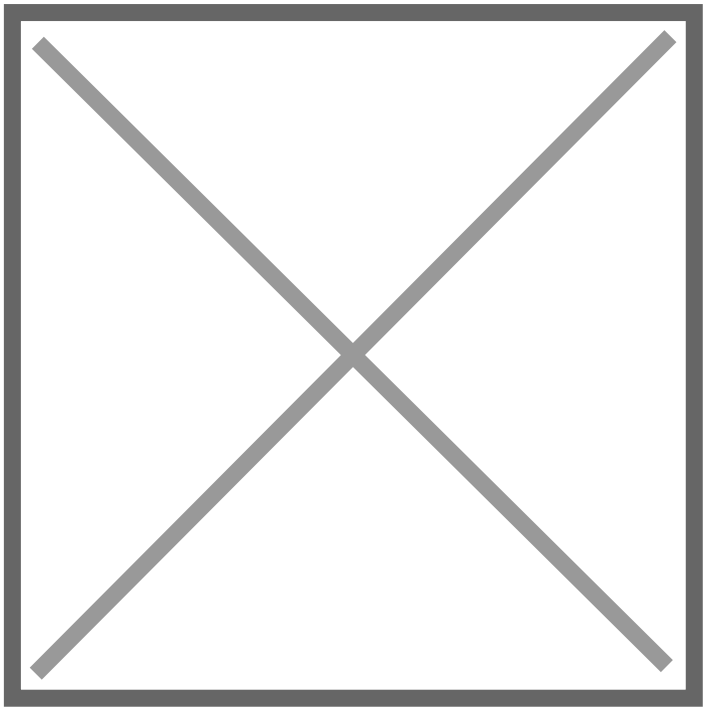


Biotechnology Education, The American Way

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A unique feature of biotech programs in the US is the flexibility in admissions.

Biotechnology can be pursued at different levels in the US. For high school graduates, community colleges in the US offer certificate and associate degree (AS) programs in biotechnology that prepare them for jobs as biotechnology laboratory technicians. As these programs offer low level positions, they may not be very attractive to Indian students. A bachelor's degree (BS) study in biotechnology is more appropriate for them as it prepares for entry-level biotechnology positions beyond the technician level and also offers scope for academic and career progression. For students with a bachelor's degree in a related science or engineering discipline, graduate study in biotechnology is recommended if they are aiming at senior managerial, and lead positions in any area of biotech industry. Graduate programs in the US offer masters and doctoral degrees. Some universities may also offer masters-level certificate programs. Masters degree in biotechnology gives access to mid-management level jobs in nearly all areas of the field, from bioinformatics to clinical research. PhD degree will lead to academic careers or top industry positions (particularly in research).

Nature of biotechnology programs in the US

Biotechnology is essentially an interdisciplinary field to train students in the application of modern technology, quantitative engineering methods, and principles of mathematics, chemistry and physics to the concepts of biology and medicine. Programs in US universities offer a range of focuses and often promote collaborative research across several departments within the university. The diverse fields of study are: biocontrols; bioengineering; biomedical engineering; biochemical engineering; bioinstrumentation; bioinformatics; biomechanics; biopharmaceuticals; biophysics; biosystems / biotransport engineering; biotechnology; cell, molecular, and tissue engineering; computational biology; and others. Due to its interdisciplinary nature, the field appeals to engineering as well as science students equally. As a general rule, graduate biotechnology programs with engineering focus originate from the college of engineering within a university; with clinical focus from the school of medicine; those with biology focus from the bio department of the college of arts and sciences; environmentally focused programs from the school of environmental sciences; and programs with agricultural orientation from the school of agriculture. It is also not uncommon to find more than one graduate biotechnology program within a US university or one program shared between two departments of a university.

Other unique features

Another unique feature of biotech programs in the US is the flexibility in admissions. For example, biotech programs with engineering focus such as a MS or PhD in bioengineering is not closed for admission to undergraduate students with biology or other science majors. For such students interested in switching majors, US universities design innovative programs that address the deficiency areas of a student and offer remedial ways. Some examples of remedial programs are as follows:

- At Arizona State University, a transition program is available for students without undergraduate degrees in the major fields offered by the department. Such transition students with a Bachelor of Science degree will be required to take a suitable number of undergraduate courses to remedy deficiencies in their undergraduate program of study. For specific information, visit: http://www.eas.asu.edu/~bme/graduate/prospective_students.htm

- Late Entry Accelerated Program (LEAP) at Boston University enables students with Bachelor's Degree in the Liberal Arts, Business or Education to obtain a graduate degree in engineering. The LEAP program will first bring them to parity in undergraduate engineering through a set of core courses, and then allows them to earn a masters degree in one of seven engineering fields. For further information, please visit: www.bu.edu/eng/leap/index.shtml

- Drexel University's crossover program is intended for students who want to earn a masters degree in biomedical engineering but have no prior engineering qualifications. Such students may be admitted to the Biomedical Science (BMS) program and can transfer to Biomedical Engineering (BME) via the crossover program. More details can be had from: www.biomed.drexel.edu/new04/Content/grad_prog/FAQ/grad_faq.cfm#q3

The above are only indicative examples and there are many such student-friendly, flexible programs across the country. The US Educational Foundation in India (USEFI) has well-stocked libraries providing such information. These offices also offer professional and unbiased advising services to students interested in studying in the US.

Selecting suitable programs

For students opting to study biotechnology in the US, the biggest challenge seems to be how to select and apply for the best program. The USEFI advising centers conduct elaborate advising sessions on such topics but here are a few pointers. Undergraduate applicants should review the following factors:

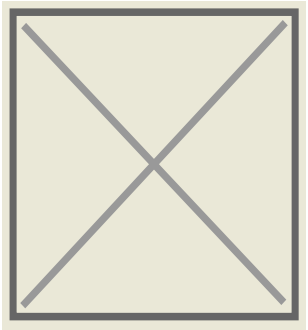
- Curriculum: Do students at this college follow a traditional science curriculum, or they focus from the beginning on biotechnology? Is there a full biotech major at this college? Does the college provide good grounding in the traditional subjects before focusing on biotech specializations?

- Internships: Does the college provide real world experience? Does it arrange a research or industry internship in a biotech company?

- Faculty: Other than the student-faculty ratio for the program, one needs to consider the profile of the faculty. How plugged-in are the professors to the local biotech industry? Do they have prior industry experience? Can they provide you access to local biotech companies?

- Facilities: Does the institution have a biotechnology research center? Do undergraduate students have access to the facilities at this center? The research centers and faculty at these centers often serve as gateways to making networking connections.

Applying to US institutions



Dr Vijaya Khandavilli

Applying to colleges and universities in the US is somewhat different from applying to Indian institutions. One of the main differences is that one needs to apply almost ten months in advance of the start of the session. If a student is interested in Fall (August / September) session, applications may have to reach the institution by December 1 of the previous year. Consequently, students have to start the process including registering for standardized admission tests, and requesting application forms by the summer of the previous year. Just as there is a wide variety in the biotech programs at US universities, application requirements of these universities also vary significantly. It is, thus important for students to make a shortlist of universities one plans to apply to and then look at the individual universities' requirements, including deadlines for application. TOEFL and GRE are the most common standardized admission tests required by all programs. PhD applicants may have to take the subject GRE test.

Career preparation

Biotech programs in the US prepare students for a wide spectrum of careers in industry, government, healthcare, agriculture, academia, legal profession, non-profit sector, and as entrepreneurs. Following is a partial listing of specialized positions for biotech graduates:

- Biotech research positions in an academic environment, such as a university, or for a for-profit or a not-for-profit company or for a government agency.
- Positions in healthcare sector involving all aspects of healthcare from disease diagnosis to rehabilitation products.
- In veterinary medicine and livestock production: production of genetically engineered vaccines, monoclonal antibodies, and growth hormones are the areas for biotech workers.
- In agriculture sector: biotech scientists work in the genetic modification of food crops to achieve desirable characteristics like high yield, increased protein or oil production, disease resistance, or pest resistance.
- In law enforcement sector, biotech scientists with specialization in forensic biotechnology (DNA fingerprinting) are hotly pursued.
- In energy production sector, mining and oil production and biomass energy are the areas
- Regulatory service sector employs biotech scientists to work with company, government, or university researchers to review proposed research plans and assess the safety of resulting products.
- In corporate as well as government public relations offices, biotech professional are expected to provide understandable information to the general public about new biotechnology products and processes. They translate complex scientific information about new discoveries for nonscientists.
- Sales people work with dealers and distributors of biotechnology products.
- Patent lawyers who specialize in biotechnology help scientists, companies, or universities protect their legal rights to new discoveries. They file patent applications for their clients.
- Bioinformatics: Bioinformatics specialists can handle the massive flow of research information, categorizing, analyzing, replicating, cross-referencing, and archiving knowledge.

Funding prospects

Funding for US study could come in the form of scholarships / fellowships, tuition fee waivers, assistantships, on and off-campus work, and internships. Funding is more at the graduate level, admitted PhD students being more or less assured of funding. The USEFI places information on fellowships on its website and notice board as and when it receives such information. Its libraries have profiles of past students with detailed description of the funding they received.

Why the US?

In view of world-class biotech research centers and well-known universities in India, the question seems valid. It is indeed true that India has biotech centers as well as institutes of high reputation yet one cannot ignore the advantages of international exposure. In addition to the unique features of biotechnology education in the US, interaction with international peers; exposure to biotech industry in the US, gaining insights into US work culture; and most importantly getting access to global biotech networks are other important prospects of studying abroad.

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List of biotechnology research institutes in the US

- Biotechnology at Iowa State University
  http://www.biotech.iastate.edu/
- Biotechnology at the University of Arizona
  http://ag.arizona.edu/biotechnology/index.html
- Biotechnology Program at North Carolina State University
  http://www2.ncsu.edu:8010/ncsu/CIL/biotech/
- Boyce Thompson Institute for Plant Research
- http://bti.cornell.edu/
- Carnegie Institution of Washington Department of Plant Biology
  http://carnegiedpb.stanford.edu/
- Center for Agricultural Biotechnology, University of Maryland
  http://www.umbi.umd.edu/~cab/index.html
- Center for Engineering Plants for Resistance Against Pathogens, UC Davis
  http://www-ceprap.ucdavis.edu/cephome.htm
- Center for Soybean Tissue Culture and Genetic Engineering
  http://www.cropsoil.uga.edu/homesoybean/
- Cereal Genetics and Biotechnology, Oregon State University
  http://www.css.orst.edu/CGB/default.html
- Clemson University Genomics Institute
  http://www.genome.clemson.edu/
- College of Agriculture and Life Sciences, Cornell University
  http://www.cals.cornell.edu/ofr/
- College of Agricultural Sciences, Pennsylvania State University
  http://research.cas.psu.edu/research_programs/plant_biotech.htm
- Crop Biotechnology Centre, Texas A&M University (USA)
  http://cbc.tamu.edu/
- Donald Danforth Plant Science Center
  http://www.danforthcenter.org/
- Department of Crop Sciences, University of Illinois at Urbana-Champaign (USA)
  http://www.cropsci.uiuc.edu/
- Department of Horticulture & Landscape Architecture, Purdue University (USA)
  http://www.hort.purdue.edu/hort/hort.html
- Department of Plant and Microbial Biology, University of California, Berkeley
  http://mollie.berkeley.edu/
- Department of Plant Biology, Ohio State University (USA)
  http://www.biosci.ohio-state.edu/~plantbio/plantbio.html
- Animal Biotechnology Center, University of Minnesota (USA)
  http://abcenter.coafes.umn.edu/
- Environmental Biotechnology Institute, University of Idaho (USA)
  http://image.fs.uidaho.edu/biotech/EBI.html
- Fralin Biotechnology Center at Virginia Tech
  http://www.biotech.vt.edu
- Georgia Biotechnology Center, University of Georgia
  http://www.uga.edu/gbc/
- Illinois-Missouri Agricultural Biotechnology Alliance
  http://www.ssu.missouri.edu/IMBA/
- Institute of Biological Chemistry, Washington State University
  http://ibc.wsu.edu/
- Interdisciplinary Center for Biotechnology Research, University of Florida (USA)
  http://www.biotech.ufl.edu/main.html
- Institute for Biotechnology Information
  http://www.biotechinfo.com
- Institute for Plant Genomics and Biotechnology
  http://ipgb.tamu.edu
- Laboratory of Plant Molecular Biology, Rockefeller University
  http://www.rockefeller.edu/labheads/chua/chua-projects.html
- Michigan Agricultural Experiment Station
  http://www.maes.msu.edu/
- MSU Biotechnology Institute, Mississippi State University
  http://www.mafes.msstate.edu/biotech/
- National Agricultural Biotechnology Council
  http://www.cals.cornell.edu/extension/nabc/
- National Center for Genome Resources

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