Biology Careers for the Next Century

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What a challenge! How can biology instructors provide accurate guidance on preparing for a career in biology when it is the most diverse and rapidly changing of all the scientific fields?

Figure 1 Students interested in biology career should be encouraged to take a variety of science and math courses.

Training in biology prepares an individual for a very large number of occupations. Consider the following, which represent less than 10% of the identified occupational categories related to life science: *agronomy, biophysics, developmental biology, environmental law, forensic entomology, forestry, genetic counseling, immunology, medical practice, molecular biology, neurobiology, secondary school teaching, systematics, veterinary medicine.* Some of these deal exclusively with molecules and cells, others concern entire ecosystems; some involve daily interaction with dozens or hundreds of people, others can be done in complete isolation; some are narrowly specific, others require knowledge far beyond science.

A student expressing general interest in "biology" is at the threshold of a bewildering array of career options. That student must be given a broad enough training, beginning at the secondary school level, to recognize this diversity and to begin matching interests, skills, and personality with the requirements of the various occupations. At the college level, a student should take a spectrum of biologically oriented courses and add courses in other sciences and mathematics. Encourage the student to take advantage of internships or undergraduate research programs, to provide a realistic view of possible careers.

Flexibility appears to be a key trait for anyone entering the job market in the future. While the educational requirements for most fields of biology and medicine tend toward specialization, the actual jobs developing for the 21st century place a premium on adapting to change, moving into new settings, and combining diverse areas. For instance, a typical research project in the pharmaceutical industry lasts

only a few years, after which a scientist might be asked to tackle an entirely different project. Or consider the biotechnology industry, where many research scientists find themselves moving into management positions and working with such topics as patent law and marketing.

Look for the Connections

In analyzing current job offerings, one is immediately struck by the number of positions that ask for expertise in two or more areas. Look at these occupations, gleaned from the "Positions Open" section of a recent issue of *Science,* the weekly journal that serves as a good source of information on jobs in biology: e*volutionary ecology, genetic toxicology, environmental microbiology, molecular systematics, bioinformatics.* Successful applicants will have had cross-disciplinary training and will be working on projects that were not feasible (or imagined) 30 years ago. A good start toward being ready for such jobs is to take the variety of courses typically available in a college biology major. Even the budding biochemist going through a chemistry major should try to fit in several diverse biology courses.

Some exciting careers involve combining biology with nonscience skills. Put together biology and English to become a *technical writer* or even a *science fiction novelist*. Combine biology and art to go into *medical and scientific illustration*. Link biology and history to become a *historian of science or medicine.* Work in both biology and religion/philosophy as a medical ethicist or bioethicist. Combine biology and psychology as a *neuroscientist.* Join biology and political science to carry out *science policy studies* or work as a *patent lawyer* in biotechnology. Try mixing biology with business to get into hospital administration and biotechnology administration. Some of these may involve obtaining double majors in college, a path increasingly taken.

Admirably, some students want a career that improves the lot of humanity. A number of fields in biology can provide this opportunity. Direct impact for good can be made in any area of *medicine*. The Peace Corps and a number of private foundations offer many opportunities to take skills in *agriculture* to developing nations. *Pharmacologists* working on the development of new antibiotics and vaccines can see the impact of their efforts, as can molecular geneticists working in areas such as gene therapy. *Epidemiologists* must be prepared to rush into isolated areas where disease has broken out. And there are the workers in *conservation, ecology,* and *biosystematics* who study the endangered rain forests and coral reefs.

Trends, Predictions

Figure 2 A number of fields in biology will provide students an opportunity to improve the good of humanity.

It is easy to document the changes that have occurred in the past, but it is dangerous to predict even the near future. The 20th century has been a period of exciting maturation for biology, and maturity stimulates a great deal of growth in any field of science. Many believe that the next century, which our students will occupy, will be a "golden age" for biology. A current student of biology must be told that he or she can participate in very exciting times.

But will the job market, responding to quite different stimuli than intellectual excitement, find places for biologists of various sorts? A count of advertisements in a typical weekly issue of *Science* from 1996 yielded a total of 118 jobs. Compare this with a typical issue from 1973, in which only 26 positions were being offered. This increase of over 400% is encouraging. Of course, the number of qualified college and postcollege graduates has also increased, but not as fast as the job offerings. The unemployment rate for people trained in biology has always been significantly below that of the nation.

Figure 3 A comparison of biologically oriented jobs advertised in

1973 and 1997 in the journal Science, by category of workplace.

Traditionally, jobs for biologists have been found in 3 sectors: academics (secondary and postsecondary schools), government (e.g., NIH and the military), and business (for-profit). Of the 3, academia has been the largest market and business the smallest for biology (as opposed to chemistry, which has always had a large industrial base). A survey of job offerings for biologists in the journal *Science* indicates that this is changing. Figure 3 shows that, although academia still comprises the largest category for new jobs, it now holds that rank by the slimmest margin. The growth area is in for-profit companies, particularly those engaged in pharmaceutical and genetic engineering activities. Even researchers working primarily in universities often form alliances with companies outside of academia. Inform students of this major change in where the jobs will be when they are ready to take them.

The trend has also been toward the molecular and cellular levels. Of the jobs offered in 1996, 71% were in those areas, whereas only 45% had been there in 1973. Students with the aptitude and training to work on the cellular level have more jobs available to them. In addition, there is some evidence, from statements by executives of biotechnology and pharmaceutical companies, that a person trained in physiology, anatomy, and ecology will be valued more highly if he or she is also able to work on the cellular and molecular level. A broad base of training is highly regarded. A person wishing to work only at the whole-organism level or above will still have job opportunities, but will have to look harder and longer and will need excellent skills to compete in an arena with fewer opportunities.

Traditionally, jobs in *ecology, wildlife conservation, resource management,* etc. have depended a great deal on government funding. That has meant, and will probably continue to mean, that the job market is changeable, following the perceptions of politicians. They, of course, get their cues from the population as a whole; when we decide that preserving our environment is a high priority, scientists in these areas will be adequately funded.

In the area of human health, the trend has been ever upward, with the number of physicians, other deliverers of direct health care, and supporting personnel (including research workers) increasing spectacularly in the past several decades. There are indications that we are approaching a point where this spending trend cannot continue indefinitely. Some medical schools are contemplating reducing their admissions for the MD program, as dental schools have already done.

Hospitals are cutting nurses and support personnel to contain costs. Academic support of biomedical research is softening. What of the future?

It is safe to say that the need for health delivery will continue and perhaps accelerate as our population ages and as infectious diseases stage a comeback. Historically, health care and research in biomedicine have been highly supported activities, and our society will probably find a way to continue them---although growth of this area may moderate in the early 21st century.

Careers: The Hot Ones

When a student asks, "What areas of biology will really take off when I'm ready to find a job?" you will pull out the crystal ball and hope you are right. Here are some fields that seem to be good bets.

The pharmaceutical industry will continue to scour the graduating classes for people who can help them in *drug development.* They will be particularly interested in those who can work with *antimicrobial agents,* as we experience the increasing ability of bacteria and other parasites to resist currently available antibiotics. They will want to find people who know about *animal physiology* as well as molecules.

Biotechnology labs will continue to grow, branching out into areas such as large-scale *genetic screening, immunology, and developmental biology.* They will develop genetically altered plants to increase yield and resist herbivores. They will seek people who can work with microbes and plants that reclaim polluted land *(bioremediation)*. Farm animals will be genetically altered for greater productivity.

On the medical front, it seems inevitable that more people will be needed in the field of gerontology as our population ages. In medical research gene therapy, transplanting animal tissues, inducing regeneration of damaged organs, and repairing ineffective immune systems are among many hot areas. Cancer research should yield cures and preventions during the next several decades.

Figure 5 Trends indicate substantial growth in career areas like medical research, gerontology, surgery, and the neurosciences.

Other areas will see growth as well. The *neurosciences* are already experiencing spectacular growth in knowledge and will attract many researchers in the future. To make available the huge volume of information coming from all of these fields, experts in *bioinformatics* (using computers to analyze complex biological data) may become highly prized. In biochemistry, a hot topic is structural biology: predicting what protein or nucleic acid structure would be necessary to accomplish a task, then producing that structure. *Agricultural research* above the gene level will become more important as the world faces food shortages. *Epidemiologists* will be needed in larger numbers as disease agents are transferred from animal populations to humans encroaching on their territory. The saving of pristine habitats such as rain forests and wetlands will provide job opportunities for *ecologists, conservation biologists,* and *taxonomists.* The task of directing such large-scale efforts and of allocating resources will be carried out by science policy analysts. Last, but far from least, the outlook for jobs in teaching at the secondary school level appears to be healthy.

Challenges for Biology Instructors

Where do biology educators fit in? We should continue our own education in order to teach accurately the modern view of life. At the college level, we should insist that budding physicians take ecology courses and that wildlife conservation students take cell biology. We must consider revisions of courses and curricula to include new materials and especially to help students make connections with fields outside the traditional boundaries of biology. We should take advantage of the human resources in our neighborhoods, by inviting professional biologists of all sorts onto our campuses to talk about their career tracks as well as their professional interests.

Finally, we should become aware of new information sources for careers in biology, including the rich lodes to be tapped via the Internet. Many college and university life science departments now include career information on their Web pages. For instance, on my university's Biology Department home page there is much career information available (see Further Resources).

The educator's job is perhaps the most important of all: By working diligently and welcoming new sources of information, we can prepare and guide young students in

their career choices.

Further Resources

Web Sites

The Biology Careers Page

Science's Next Wave, An Electronic Network for the Next Generation of Scientists

Books

Janovy, John Jr. 1985. *On Becoming a Biologist.* Harper & Row Publishers, New York.

Occupational Outlook Handbook. 1996. Bureau of Labor Statistics,

U. S. Department of Labor. (Also available on the Web: **http://stats.bls.gov:80/ocohome.htm**)

Statistical Abstract of the U. S. Bureau of the Census. U. S. Department of Commerce.

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