Careers in Biochemistry and Genetics

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http://www.asbmb.org

Unlocking Life's Secrets

There's a quiet revolution going on.

It's a revolution in our understanding of the forces that give us life and conspire to produce illness and death.

Over the past few years, an ever-growing arsenal of techniques has helped researchers dissect the innermost secrets of the cell and develop new ways to detect and attack disease. The techniques also have been used to produce vast amounts of once rare drugs, trace the path of evolution, create instant tests for a host of illnesses, warm people when their offspring might inherit a deadly disease, and even identify criminals and victims of disasters.

The leaders in this revolution have been the geneticists, biochemists and molecular biologists who explore tiny realm inside cells, study the development of illness, and search for ways to improve life on Earth.

If cancer is to be cured, if the planet's pollution is to be cleaned up or if the aging process is ever to be slowed, it will probably be the geneticists, biochemists and molecular biologists who will provide the knowledge for these breakthroughs.

Few field are so interesting, so challenging and so potentially rewarding.

The 21st century is the era of the biological revolution! To become part of the revolution, it takes a willingness to learn, and a natural curiosity about how life works. It's an opportunity to be an explorer in a microscopic world that is as strange and breathtaking as any imaginable.

The Challenges

The molecular life sciences have grown to encompass virtually the entire spectrum of science, from physics and chemistry to biology and health care. Women and men in the field are studying life on every level from individual molecules to the interrelated web of Earth's organisms, and all the bacteria, yeast, plants, amphibians, and mammals in between.

At the molecular level, there's the quest to understand the information in DNA, to discover how portions of genetic material are turned "on" and "off," and to learn how the exact shape of a protein determines what it will do.

On a larger scale, scientists are struggling to see how different chemicals fit together to form cells, how those interact to build large organisms, and how seemingly subtle differences in the chemical instruction issued by DNA are able to sculpt Earth's vast array of life forms.

Because living things are always changing and adapting, there's an ongoing quest to understand the dynamics of life, from the secrets of cell-to-cell communication to the chemical changes in the brain that give us our memories.

Knowledge emerging from research in genetics and biochemistry will probably have a greater impact on our society than the splitting of the atom, as researchers in the field tackle a host of intriguing questions.

For example, biochemists and molecular biologists are:

- Creating genetically engineered crops that are more resistant to frost, drought, spoilage, disease and pests.
- Perfecting techniques for identifying criminals based on a single strand of hair of a tiny bloodstain left at the scene of a crime.
- Developing computerized portraits of enzymes and other important chemicals to see how they are made, how they are folded, and how they fit – both literally and figuratively – into the processes of life. That knowledge will help scientists design better vaccines, antibiotics, and anti-cancer drugs, and lead to pesticides that do less damage to human health and the environment.
- Comparing proteins from different species and recording the changes that have occurred through evolution. The result will be a family tree for life on Earth that is far more detailed than any developed from fossils.
- Mass producing life-saving chemicals that are usually found in the body in very tiny amounts. Some of those chemicals have been helping diabetics and heart attack victims for years.
- Learning how cells recognize one another and communicate with enough efficiency to assemble human beings composed of a hundred thousand billion cells
- Discovering how certain diseases such as AIDS and cancer escape detection by the immune system, devising ways to enhance immunity to combat these disease, and looking for ways to suppress the immune system to help people who have received a tissue transplant or have an immune system that has turned against them.
- Teasing out the chemical secrets of fertility. For infertile couples, that knowledge could improve the success in *in vitro* fertilization. For a woman who is not ready (or no longer willing) to bear children, it could eliminate the risk of pregnancy. Such knowledge may also help preserve endangered species.
- Trying to program bacteria to clean up the environment by "eating" toxic chemicals.
- Mining the data made available by the sequencing of the genomes of organisms ranging from microbes to man. Computational intensive comparisons of these genetic blueprints will reveal why humans have 40,000 genes and seemingly less complicated creatures like fruit flies and nematodes have almost half as many.

Early work using information from the human genome has pinpointed the genetic defects responsible for muscular dystrophy, hemophilia, cystic fibrosis and sickle cell anemia. Problems such as obesity, alcoholism, tooth decay, Alzheimer's disease, heart disease and some forms of mental illness involve heredity. Knowing the source of a genetic trait or defect can open the way to testing and treatment.

Cataloging humanity's genetic code may also lead to the identification of the instructions for the 10,000 or more proteins believed to be related to aging and longevity. With that knowledge, researchers may discover ways to extend the human life span.

The legal, ethical, social, medical and environmental impact of these discoveries will be immense. Safeguards must be developed, for example, to insure that the microorganisms designed to gobble up pollution are prevented from escaping to eat away natural resources. In another case, society must decide if it is okay for employers to discriminate against a job applicant whose genetic profile shows that he or she has an above-average risk of suffering a heart attack before retirement.

Thus, society will need scientists whose perspective extends beyond the laboratory, women and men able to provide the highest level of progress at the lowest level of risk. There is, for example, a need for science-related ethicists and for scientists able to deal with legal issues, patent applications and government regulations.

And these are only today's challenges.

Someday if extraterrestrial organisms are ever discovered, geneticists, biochemists and molecular biologists will be the ones asked to unlock the secrets of those alien life forms.

Careers in Genetics and Biochemistry

Career prospects seem bright for someone trained in the molecular life sciences. Projections for the next 20 years indicate that there will be thousands of unfulfilled science and engineering jobs. A large fraction of the shortage will be in the fields of genetics, biochemistry and molecular biology.

The demand for highly trained workers and scholars will be great. Scientists are rushing to use their new techniques to unravel the secrets of life, to tap that knowledge to create valuable products, and to develop a new generation of sophisticated techniques that will unlock new knowledge.

The greater a person's education, the greater the potential for rewards.

Over the next 10 years it is estimated that 47% of those entering the work force will be women and 31% will be members of minority groups. We need some of these people to be educated as scientists to assume positions that will be available. The government has recognized these circumstances. Opportunities for women, members of minority groups and disabled persons are especially promising because the federal government, including the National Science Foundation and the National Institutes of Health, offers a variety of special programs designed to bring them into the field.

College Graduates

A BS in genetics and biochemistry opens the door to graduate, medical, dental, veterinary, law or business school. Over 60% of our graduates go to professional school (most to study for an MD) or graduate school (to earn a masters – MS – or doctoral – PhD – degree). An increasing number are applying to law school. Because genetics and biochemistry are so closely tied to medicine, some PhD scientists also earn a medical degree (and some MDs complete a PhD). Such physician-researchers with an MD/PhD the broadest base possible for a career in medical research and are highly recruited by medical schools. Others use their training as a stepping stone to rewarding careers in biotechnology, toxicology, biomedical engineering, clinical chemistry, plant pathology, animal science or other fields.

Some graduates enter the job market directly. Many employers have jobs that require their talents:

- Government agencies, such as the National Institutes of Health, the U.S. Food and Drug Administration, the Environmental Protection Agency, the U.S. Department of Agriculture, and individual states have laboratories that employ skilled personnel in basic research programs and in the analyses of samples of food, drugs, air, water, wastes, or animal tissue.
- Drug companies have basic research programs on the causes of disease and applied programs to develop drugs to combat diseases.

- The FBI, state governments and private forensic laboratories require increasingly science-oriented individuals in order to take advantage of the powerful tools of DNA fingerprinting and other molecular analyses.
- Biotechnology companies, which have interests in the environment, energy, human health care, agriculture and animal health, hire genetics and biochemistry graduates for research, quality control, clinical research, manufacturing/production, and information systems.

In additions, our graduates have knowledge that can be valuable in the fields of management, sales, marketing, regulatory affairs, technical writing, or scientific journalism.

With additional courses in the education field, someone with a molecular life sciences degree is ideally suited to teach science in elementary, junior high and high school. An enthusiastic teacher can help inspire the next generation of scientists to tackle challenges that still, by today's standards, seem insurmountable. Careers that involve teaching in a college or directing scientific research in a university, a government laboratory or a commercial company requires at least the masters degree (MS) and, preferably, the doctorate (PhD) degree. It is typical in this field for students to bypass the MS degree and proceed directly to a PhD program. It is not uncommon for students to return to graduate school after working on a job that only required a lower degree. Having a doctorate allows you to design the research and direct others to carry out the experiments.

Preparing For a Career in Genetics, Biochemistry and Molecular Biology

Geneticists, biochemists and molecular biologists usually specialize in one of many areas in their field. But they also need to be familiar with several scientific disciplines. Their work requires an understanding of chemistry, physics, mathematics and computer science, and is often related to areas such as toxicology, physiology, microbiology and immunology.

The best way for a college student to prepare for a career in genetics, biochemistry and molecular biology is to earn a bachelors degree in one of these areas. Although many schools do not offer such a program, there are two ways for students to receive somewhat comparable training. Texas A&M offers degree programs in both biochemistry and genetics. It makes little difference which you complete. It's more important to choose your courses carefully, and to consult with a faculty advisor familiar with genetics and biochemistry during your freshman and sophomore years.

In addition to getting the bachelors degree, opportunities that provide on-the-job experience in a research laboratory are invaluable. Working one-on-one with a professor or senior researcher as you tackle your own research problem is crucial to your education in genetics and biochemistry. It is here that you learn to solve problems and think critically within the discipline. Medical schools, graduate schools and industry recognize such training as crucial to your education and future career no matter what you decide to do.

We strongly encourage all our majors in biochemistry and genetics to begin working a research lab during their freshman year. You are required to complete a hands-on laboratory research experience as part of your degree program in genetics and biochemistry, so you need to plan ahead so you have time in your junior and senior years for an independent project. The department offers a Senior Thesis and strongly encourages participation in the University Undergraduate Research Fellows program, both of which require a yearlong research project. Another way to acquire research experience and sample potential graduate schools is to take advantage of the many summer internships made available by diverse institutions some of which are sponsored by the National Science Foundation and the nation Institutes of Health.