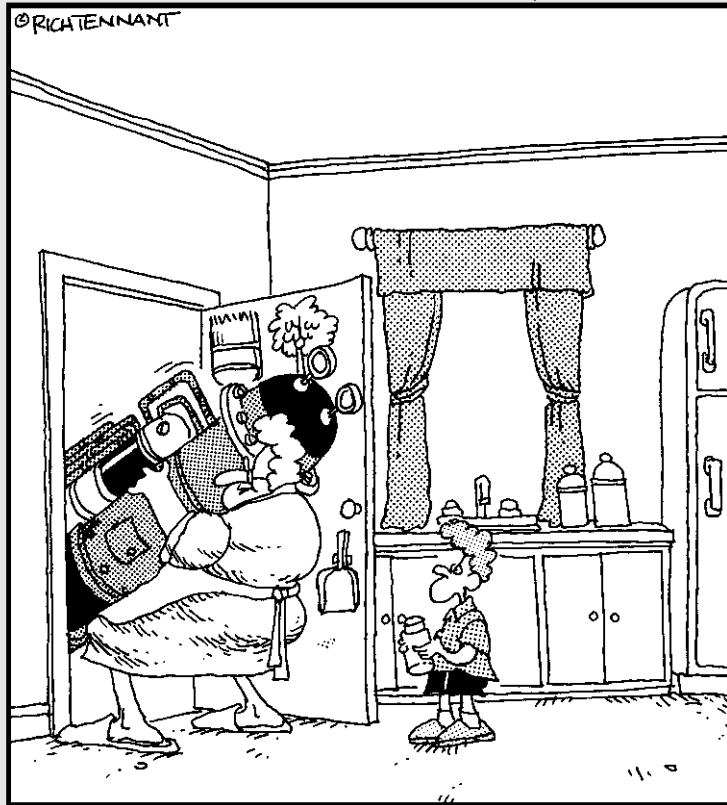


Part VI

The Part of Tens

The 5th Wave

By Rich Tennant



“You can take that old jar for your science project, I’m sure I have some baking soda you can borrow, and let’s see, where’s that old particle accelerator of mine...here it is in the pantry.”

In this part . . .

We wrap things up by zooming out a bit and looking at things we haven't covered yet. Here we compile two chapters' worth of short and sweet information about some of the lesser-known potential applications of biochemistry and some perhaps unexpected careers related to it.

Chapter 18

Ten Great Applications of Biochemistry

In This Chapter

- ▶ Examining tests
 - ▶ Checking out genetically modified foods
 - ▶ Considering cloning
-

In this chapter, we briefly look at some of the biochemical applications and tests that have changed our everyday lives. Although these are just a few of the hundreds of examples we could have chosen, we feel that all of these have made and continue to make a significant impact on society. And we hope you realize that more applications are being discovered almost daily.

Ames Test

The Ames test is a test that is used to determine whether a substance will affect (mutate) the structure of DNA. In this test salmonella bacteria is exposed to the chemical under question (food additives, for example), and changes in the way the bacteria grows are measured. Many substances that cause mutations in this bacteria also cause cancer in animals and humans. Indeed, this test is used today to screen chemicals for their potential ability to cause cancer in humans.

Pregnancy Testing

There are two types of pregnancy tests — one uses a urine sample and the other a blood sample. Both detect the presence of the hormone human chorionic gonadotropin (hCG). This hormone is produced by the placenta shortly after implantation of the embryo into the uterine walls and accumulates

rapidly in the body in the first few days after implantation. Home pregnancy tests, urine tests, are typically around 97 percent accurate if done two weeks after implantation. Blood tests, performed in a clinic, are more costly but can detect pregnancy as early as a week after implantation.

HIV Testing

Tests have been developed to screen for the presence of the human immunodeficiency virus. These tests may be done on urine, blood serum, or saliva and detect HIV antigens, antibodies, or nucleic acids (RNA). The nucleic acid tests (NAT) detect a 142-base sequence located on one of the HIV genes. Most blood banks use a combination of tests to ensure accuracy.

Breast Cancer Testing

Most breast cancer is not hereditary, but in 5–10 percent of cases, there is a heredity linkage. The vast majority of these cases is due to mutations in two genes: Breast Cancer-1 gene (BRCA1) and the Breast Cancer-2 gene (BRCA2), which were discovered in 1994 and 1995, respectively. Females who inherit a mutation in either one of these genes have a greatly increased chance of developing breast cancer over their lifetime. Postive tests for these mutations allow the individual to schedule increased screening tests at a more frequent rate than the general population.

Prenatal Genetic Testing

Prenatal genetic testing refers to testing the fetus for potential genetic defects. Tests commonly are performed on blood or tissue samples from the fetus. This may involve amniocentesis — collection of a sample of amniotic fluid that contains cells from the fetus — or collection of blood from the umbilical cord. Tests such as these are used to detect chromosomal abnormalities, such as Down syndrome or birth defects such as spina bifida.

PKU Screening

Phenylketonuria (PKU) is a metabolic disorder in which the individual is missing an enzyme called phenylalanine hydroxylase. Absence of this enzyme allows the buildup of phenylalanine, which can lead to mental retardation.

All states in the United States require PKU testing of all newborns. Infants who test positive are placed on a diet low in phenylalanine, allowing them to develop normally. Check out cans of soft drinks, and you will find a warning on many of them that they contain phenylalanine.

Genetically Modified Foods

Biochemists have developed the ability to transfer genes from one organism into other organisms, including plants and animals. This allows the creation of crops that are more pest and disease resistant and animals that are more disease resistant. Genetic modification can also be used to increase the yield of milk, eggs, or meat. In 1993, the first genetically modified food was given a license for human consumption from the U.S. Food and Drug Administration. It was a new tomato called Flavr Savr, which was resistant to rotting. However, the public has been slow to accept genetically altered foods and afraid of unforeseen effects on the population and environment.

Genetic Engineering

Genetic engineering involves taking a gene from one organism and placing it into another. The recipient may be a bacteria or a plant or an animal. One of the most well-known examples of genetic engineering involves the hormone insulin. Diabetes use to be treated with insulin derived from pigs or cows, and although very similar to human insulin, these animal-derived insulins were not identical and caused problems for some individuals. Biochemists solved this problem by inserting the gene for human insulin into bacteria. The bacteria, through the process of translation, created human insulin. (See Chapter 17 for much more on translation.)

Cloning

In 1996, Dolly the sheep was cloned — the first mammal ever cloned from adult animal cells. The cloned sheep was, of course, genetically identical to the original adult sheep. This clone was created by taking cells from the udder of a 6-year-old ewe and growing them in the lab. They then took unfertilized eggs and stripped the genetic material from them. Finally, they inserted the genetic material grown in the lab into these cells and implanted them into the uterus of another sheep. And Dolly was born. Since Dolly, many other animals have been successfully cloned. However, there is worldwide debate on the idea of cloning a human, which will surely continue for decades.

Gene-Replacement Therapy

In gene-replacement therapy, a modified or healthy gene is inserted into the organism to replace a disease-causing gene. Commonly a virus that has been altered to carry human DNA is used to deliver the healthy gene to the targeted cells of the patient. This process was first used successfully in 1990 on a 4-year-old patient who lacked an immune system due to a rare genetic disease called severe combined immunodeficiency (SCID). Individuals with SCID were prone to life-threatening infections. They lead isolated lives, avoiding people and commonly taking massive doses of antibiotics. Scientists removed white blood cells from the patient, grew them in the lab, and inserted the missing gene into the cells. They then inserted this genetically altered blood back into the patient. The process allowed the child to develop normally and even attend school, but the treatment must be repeated every few months.

Chapter 19

Ten Biochemistry Careers

In This Chapter

- ▶ Cruising careers
 - ▶ Finding out about professions
 - ▶ Juggling jobs
-

Because of recent advances in biochemistry and its related area biotechnology, many new professions have been created for the individual majoring in biochemistry. Those who stop at the B.S. degree often find themselves working as technicians in a variety of industries, but for those who go on for their M.S. or Ph.D. many more opportunities become possible.

Graduates at all levels find positions in a wide variety of career areas including forensics, industrial chemistry, molecular biology, pharmacology, technical sales, virology, horticulture, immunology, forestry, and so on. We have mentioned several careers throughout the book, so we are including here careers one might not normally associate with the field of biochemistry.

Research Assistant

A research assistant works in the area of biochemical research and development as part of a team. They may investigate new genetic tests, be involved in genetic engineering or cloning, or help with the development of new drugs or drug protocols. In addition to performing typical technical biochemical procedures, the research assistant analyzes data and prepares technical reports and summaries. Research assistants are often also involved in the search for inventions that can lead to patents. They may eventually head up their own research groups.

Plant Breeder

A plant breeder designs and implements plant breeding projects in conjunction with other research teams. They may be involved in the development of disease-resistant strains of crops or may search for ways to increase crop yields using biochemical and biotechnological techniques. They may also be involved in personnel management, public relations, and/or advising their company about future projects and plant-breeding goals.

Quality Control Analyst

The quality control analyst conducts analyses of raw materials and the finished products coming off the production line. They collect data concerning quality control test procedures and pinpoint sources of error. Along with quality control engineers, the analyst ensures that the quality of the product remains high. This is especially important, as you might imagine, when the product could be a genetically modified virus or a genetically altered food.

Clinical Research Associate

Clinical research associates design and implement clinical research projects such as a new drug protocol or the use of a new virus for gene therapy. They may travel to the various field sites where the clinical trials are being conducted to coordinate and/or supervise the trials. The clinical associate analyzes and evaluates data from the trials to ensure that clinical protocols were followed. A background in nursing or pharmacology is useful.

Technical Writer

Anyone who has ever read a poorly written set of directions or technical manual realizes the importance of a good technical writer. A technical writer in the biochemical world edits and writes operating procedures, laboratory manuals, clinical protocols, and so on. They ensure that these documents are written in a way that meets government regulations. They may develop professional development programs for staff members and write news releases. Part of their job is to take highly technical reports and edit them in such a way that they are understandable to the company's administration and the general public.

Biochemical Development Engineer

The biochemical development engineer takes the biochemical process developed in the laboratory and scales it up through the pilot plant stage to the full production plant. They help determine what instrumentation and equipment are needed and troubleshoot problems in the scale-up procedure. They work to develop more efficient manufacturing processes while maintaining a high degree of quality control. They may also be involved in technological advances from another area and apply them to their manufacturing process.

Market Research Analyst

Market research analysts analyze and research the company's market, the product mix, and the competition. They perform literature searches and make presentations on technical areas and new potential markets for the company. They predict future marketing trends based upon market research and may even be involved in the preparation of research proposals.

Patent Attorney

A patent attorney coordinates and prepares documentation for patent applications. They track the company's research studies and recommend the timing of patent filings. They collect supporting documentation and negotiate patent licenses and other legal agreements. They may become involved with interference and appeal hearings.

Pharmaceutical Sales

An individual with a degree in biochemistry becomes a natural for a career in pharmaceutical sales. These sales representatives spend much of their time on the road, talking to hospital personnel, physicians, pharmacists, and others. They are quite familiar with their company's products and try to be as persuasive as possible in touting their advantages over the competition. They have to be familiar with statistics and issues of concern in the medical community in order to successfully communicate with potential clients.

Biostatistician

Biostatisticians are statisticians who work in health-related fields. They design research studies and collect and analyze data on problems — such as how a disease progresses, how safe a new treatment or medication is, or the impact of certain risk factors associated with medical conditions. They may also design and analyze studies to determine health care costs and health care quality. They are instrumental in the designing stages of studies, providing expertise on experimental design, sample sizes, and other considerations.