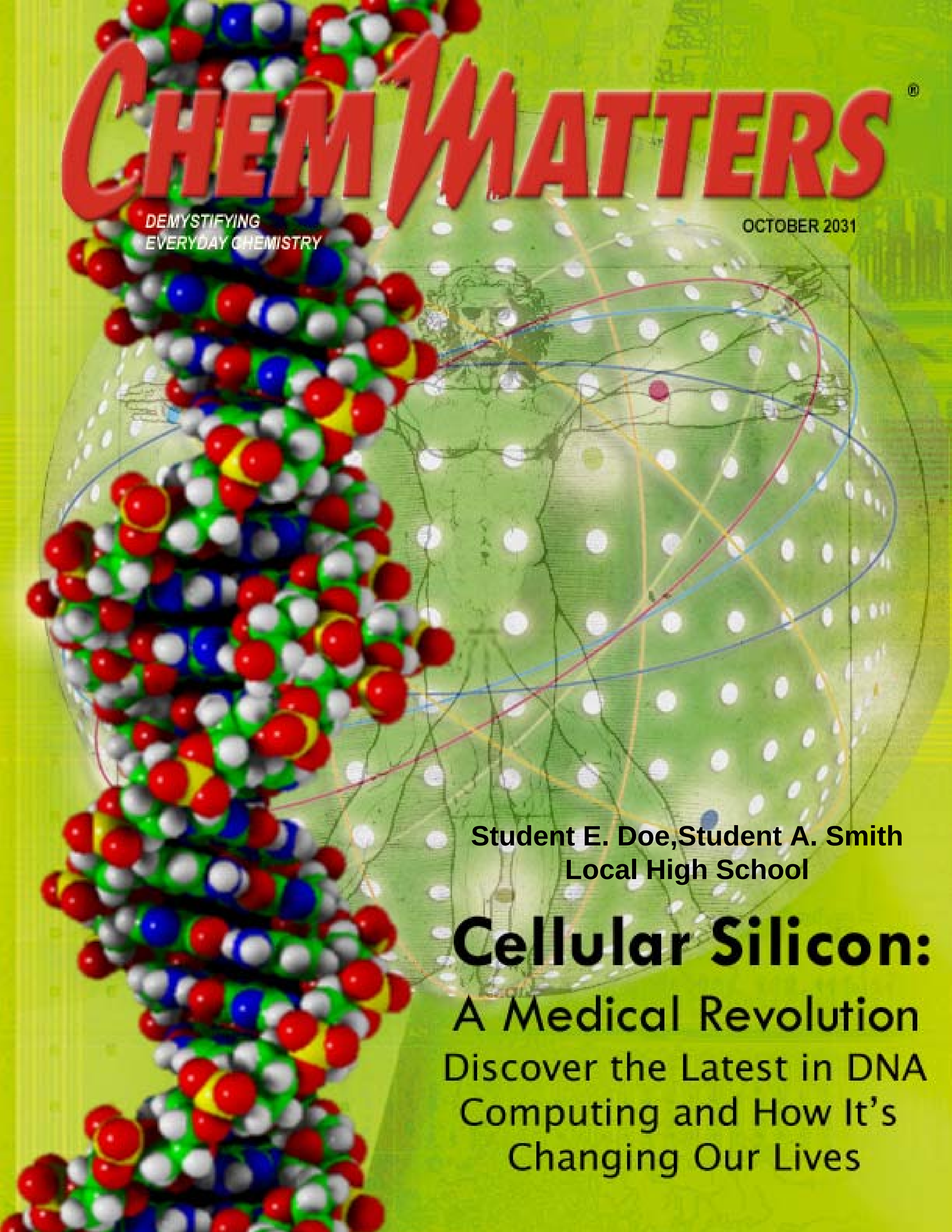

ChemMatters®

DEMYSTIFYING EVERYDAY CHEMISTRY

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Local High School

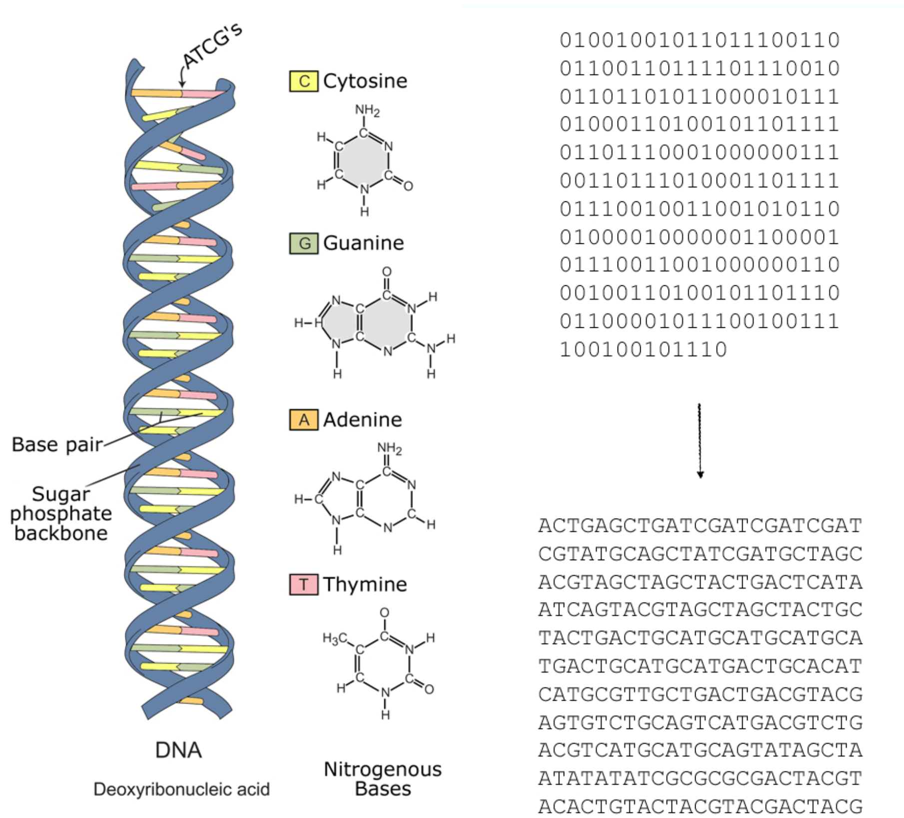
Cellular Silicon:

A Medical Revolution

Discover the Latest in DNA Computing and How It's Changing Our Lives

Cellular Silicon

Today it is hard to imagine a world without implanted computers to monitor our health and diagnose our illnesses. But a little over 25 years ago, the face of medicine was drastically different. Gone now are the invasive medical tests, bulky hospital equipment, inaccurate and incomplete patient medical histories, and life-threatening misdiagnoses which used to plague medicine. With the progress made everyday in DNA computing, doctors may one day be on that list. But what about these fascinating computers have made this all possible?



In DNA computing the four bases of DNA, AGCT, replace the 1s and 0s of binary computing.

1s and 0s

The secret lies in the advent of parallel DNA computing. DNA computing was born in 1994 when computer scientist Leonard M. Aldeman of the University of Southern California manipulated DNA, deoxyribonucleic acid, to solve a math problem. Further breakthroughs came in 2001 from Ehud Shapiro of the Weizmann Institute of Science in Israel when he was able to use DNA molecules as biomolecular nanocomputers in rudimentary ways; such as to diagnose cancers, based on varying provided symptoms.

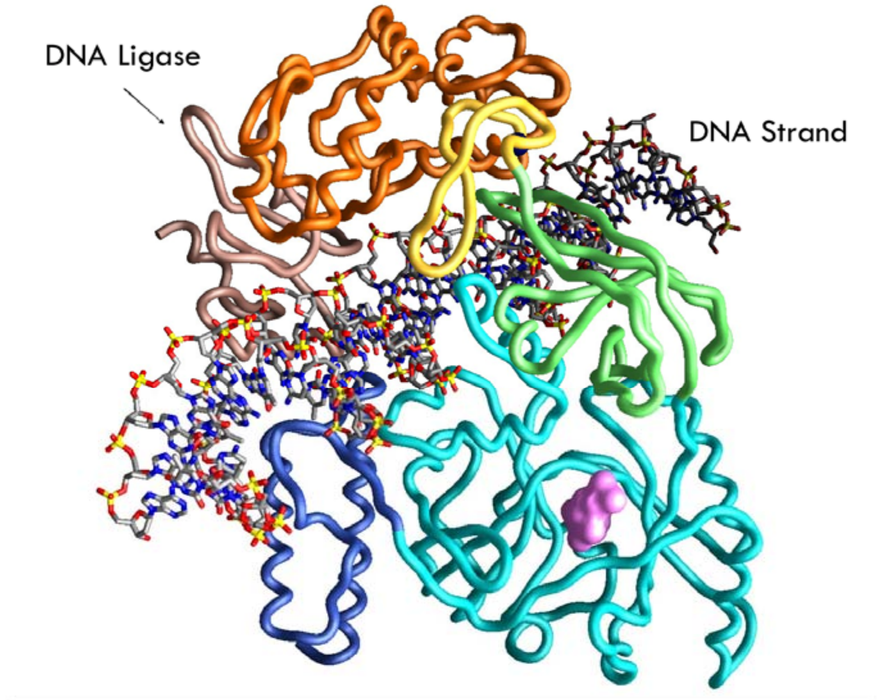
Fundamentally, DNA computing realizes that human cells and computers have the capacity to store and process information in similar ways. Just as computers store data in series of 1s and 0s, DNA can hold information in the arrangement of its bases; adenine, guanine, thymine, and cytosine.

Excuse me, there are 15 thousand trillion computers in my soup

One of the most important reasons DNA computers are the most successful internal computers are the advanced capabilities of DNA. DNA can replicate extremely quickly and efficiently, giving biocomputers great capacities for transferring large amounts of data and also an immense memory capacity, roughly 100 times larger than the computers of two decades ago. Moreover, these vast repositories of information can fit into a very small volume, where 1 spoonful can hold 15 thousand trillion computers. Finally, DNA computers have a great ability to process many calculations in parallel, nearly 10^9 calculations per mL of DNA per second, in a highly energy efficient way, more than a million times more efficient than the computers of yesteryear.

Health through Technology

The most commonly used function of the nanocomputer is to monitor various functions of the body. Some of its capacities include measuring the heart rate, through electrode monitors of the electrical voltage in the heart, blood pressure, with the incorporation of an arterial pressure sensor, blood sugar level, by tracking the glucose level, and body temperature. More recently, advances in biocomputer technology have added features to track blood composition, by measuring the number of blood cells and other cells per million parts, and oxygen and carbon dioxide levels in a similar manner. The DNA nanocomputer is also able to track the deterioration of organs and the spreading of cancer, both through the monitoring of the cells and the presence of specific cancer-relating strains of mRNA in the area. All of these conditions must be regulated to guarantee a healthy life, and must be especially monitored in the infirm and elderly. Only 25 years ago diabetics had to test themselves often to track blood sugar levels; the biocomputer not only increases the accuracy of testing procedures but also tracks



DNA Ligase, when stimulated by miniaturized mRNA sensors, cuts the DNA strand into a length of data which indicates the presence of cancer.

glucose continuously without the hassle of a needle.

As the sensors record data in the body they transfer the data into the main body of the computer, located in the chest, where it diagnoses any possible bodily irregularities. Thanks to the memory capabilities of DNA computers, a database of illnesses and health issues can be held in less space than a drop of water. This memory capacity, more than 10 terabytes of data per cubic centimeter of DNA, is something we now take for granted; but, was almost impossible 25 years ago. Once the sensors have transferred data into the computer, it is simple work for the computer to cross reference the recorded symptoms with all known medical irregularities, and come up with a diagnosis of any illnesses or disease. Modern advances in the speed of calculation have made this possible; two decades ago it would have taken at least several hours to perform this cross-referencing, with parallel DNA computing the diagnosis occurs in a matter of seconds.

Once a diagnosis is made, it is transferred to a central hub, located in a wrist watch. Not long ago this transfer would have been impossible, but recent miniaturization breakthroughs have made it not only possible, but quick and safe. First, in the computer, DNA is cut by different enzymes into a code, which reflects the recorded bodily symptoms, and diagnosis. This code was created in 2003 by Dr. Shapiro, who first used enzymes Fok-I and Ligase to cut DNA into different lengths, depending on the presence of different chemicals. This technology has since been adapted to cut DNA into different lengths depending on different symptoms and diagnoses. Once the DNA is encoded, the computer transmits the diagnosis information through the body to the site of the watch. The watch then collects cells from the surface of the body which contain the information DNA. Within the watch, the DNA code is read, and converted into a readable human form Once the information reaches the watch, internal body conditions can be displayed on the watch, as well as warnings when homeostasis is disrupted, or an illness is diagnosed. More recent models of the wrist watch component have the capability to wirelessly contact EMS services if an individual is in severe medical danger. Moreover, the individual's entire medical history can be recorded and stored on the watch for access by hospitals and physicians, forever banishing inaccurate and incomplete patient histories from medicine.

A Medical Renaissance

The degree by which our nanocomputers have improved our lives is astounding. Life is safer for not only the sick, but every human. No longer are time consuming, inconvenient, and medically unsafe tests used, now that unfathomable amounts of medical information are available at the press of a watch button. No longer is anyone abandoned, unable to call for help during a time of emergency. No longer are doctors forced to make life changing decisions with inaccurate medical information. Never again will cancers be able to lurk in the body, undetected and untreated. DNA computers have revolutionized medicine, and are perhaps the single most life-altering development since the modern computer.

1994
Leonard Aldeman invents a DNA computer capable of solving basic math problems.

2003
Ehud Shapiro develops a process by which Fok-I and Ligase cut DNA into different lengths based on the presence of different chemicals.

2010 - 2016
Advances in invasive, implantable, efficient, miniaturized sensors for monitoring vital signs and health.

2020
Ubiquitous 4th Generation Mobile Wireless Information Network allows for computer to wirelessly transfer health information to EMS and hospitals.

2021
Early mRNA presence based cancer detection methods allows for more effective application of pervious cancer treatment techniques.

2027
Development of mechanized automated cellular DNA extraction device

2029
Miniaturization and perfection of computers with sufficient processing capacity to decode and process strands of DNA

2031
DNA Biocomputers

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