Investigation 3.14

3.14A: Final Case
3.14B: Circle of Life

Investigation

3.14A: Final Case

Introduction:

As you study American History the will find the name Dewey pops up again and again. For example, Admiral George Dewey won the Battle of Manila Bay in the Spanish-American War. Melvil Dewey invented the Dewey Decimal System to organize books on library shelves. Thomas Dewey prosecuted infamous gangsters, won election to the office of Governor in the State of New York, but then failed twice to win election to the Presidency of the United States. But focus here for a moment on John Dewey (1859-1982), a college professor, philosopher, psychologist, and educational reformer. John Dewey made his mark in history by challenging teachers not to just teach what they knew, but to provide students with experiences that enable them to teach themselves skills and concepts they will need in their own future. What a challenge!

This workbook has sought to introduce you to some of the current concepts in medical science, but it has not tried to predict the future of this field of science. To stimulate your interest in medical science as a potential career, we do need to ask about the future. How will medical science change in the coming decades?

Everyone would love to predict the future accurately, but the future has a way of taking turns no one foresees. For workbook readers who indeed are considering healthcare as a potential career choice, gauging the direction of change for the future healthcare has great importance. We do know with great certainty that the future will differ from the present.

Let's try to predict. Let your imagination go wild. If you were to fall ill twenty years in the future, how might healthcare approach your illness? Imagine what that process might involve and jot down some key points?

I feel that medical treatment twenty years from now might be different than today in the following ways:

1. _____
2. _____
3. _____

Did you feel like a science fiction writer? The science fiction stories written years in the past quite often suggested inventions that actually exist today. The comic book character Dick Tracy created many years ago had a ridiculous communicator inside his wristwatch, not too different from the cell phones we find perfectly normal today.

We often foresee the future by looking at **trends** in progress going on today. An example might be found in the treatment of cancer (**oncology**). The term **cancer** refers to diseases in which human cells begin to divide and grow abnormally in numbers and in function. Normal cells have very strong attachments to the cells that surround them, but cancer cells lack that feature, so that they readily spread about the body, a feature

we refer to as **metastatic**. Many years ago no treatment existed for cancer. Then mankind learned how to perform surgery and surgeons could remove cancers, but the cancer often **recurred**. Next physicians and medical scientists learned how to attack rapidly growing cancer cells with poisons (**chemotherapy**) and **radiation** (radiation oncology). Since the poisons and radiation they used to attack cancer cells were known also to cause cancer, everyone knew from the beginning those modes of treatment could not possibly prove the optimal therapy in our fight against cancer. We used these treatments because no one had a better solution at the time.

Scientists who studied the biology of human life discovered in the 1950's the molecular structure of our genetic make-up we now all know as DNA. We can find **deoxyribonucleic acid** or DNA in almost every living-cell on earth (the red cells in our blood do not contain DNA). DNA codes direct the manufacturing of **proteins** inside cells (even bacteria). Proteins consist of chains made from 20 **amino acids** and form the complex molecules that make life as we know it possible. The DNA allows living organisms, large and small, to reproduce by making exact copies of their DNA for their offspring. A mistake in copying or an induced defect in a strand of DNA causes both genetic diseases and cancer, and perhaps may also control aging as well.

We know that toxic materials in our environment can create DNA mistakes or defects, as can viral infections, as can radiation to include cosmic rays that travel through space, enter our atmosphere, and pass through our bodies constantly. Mankind has tried to figure out how to eliminate from our environment as many things as possible that can cause cancer, but that effort has provided very limited success. Recently molecular biologists have learned how to modify DNA to allow our body's **immune system** to recognize and kill specific cancer cells without damaging normal cells. They do this by inserting short pieces of DNA into the long DNA strands inside the human cells that fight infections. To do this insertion they use a **modified virus** as the implanting agent. That implanted gene gives the cells of the cancer victim the ability to find and then eliminate the cancer cells that the victim did not previously see as an enemy.

Even more recently scientists working collaboratively in molecular genetics laboratories in the United States and France have discovered a new, simpler method for precisely placing a **genome** into a double stranded DNA molecule. They learned this method by studying the way bacteria acquire immunity to a virus that has infected them. This new method is called CRISPRS/Cas9, which stands for Clusters of Regularly Interspaced Short Palindromic Repeats with the Cas9 referring to an associated protein that **cleaves** the DNA at a point programmed by a length of RNA **synthesized** to match the DNA of the target site. Could you make any sense of all those strange words?

While the description of this process sounds complicated a video you can watch on the internet (referenced below) provides a visual image that makes the concept easy to understand. Dr. Jennifer Doudna, who led the development of this remarkable biologic tool, says they have trained high school students in two weeks to successfully **splice** new genes at specified spots inside the DNA of living cells. While gene splicing has been done previously, the CRISPRS approach makes the process much easier and more precise. This advance suggests that the ability of medical science to treat diseases with a genetic basis, to include cancer and even infections, will advance now more rapidly than we would previously have predicted. The scientists involved in this work caution the public that making certain that new treatments can do no harm will require years of research. Recently scientists began using CRISPRS to modify mosquitos in Brazil in an attempt to reduce their ability to spread diseases such as

malaria. Although it will require years to realize the full potential of this technology, knowing of this breakthrough probably helps us view the future of healthcare with more certainty and with great excitement.

Progress in the laboratory of the sort represented by **CRISPRS** allows us to also recognize that the list of healthcare providers we have classically considered to include physicians, physician assistants, nurses and nurse practitioners, pharmacists, plus a variety of clinical technicians and technologists, needs alteration. We must include laboratory scientists involved in a **spectrum** of fields that are unlocking the secrets of biology, especially at the molecular level. Indeed one can argue that molecular science, not clinical practice, will drive the major advances in medical science in the coming decades.

Take a look at Dr. Jennifer Doudna's presentation on www.ted.com to gain a visual insight into the amazing mechanisms that make this new medical science pathway possible. Direct hands-on clinical care of patients will certainly continue to provide bright minds with highly rewarding careers that combine problem solving based in science with skills in human interaction. But we also want you to appreciate the remarkable discoveries in the laboratory sciences that support the progress in medical practice. These laboratory sciences will likely attract the best and brightest in the years ahead as the frontiers of medical science continue to shift into the domain of molecular biology and chemistry.

Are you surprised to learn that the genetic coding and molecular mechanisms inside a germ are exactly the same as those inside the cells in your body? As you hear Dr. Doudna's presentation jot down other things that surprise you or excite you.

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Who would have thought the future of medical science could prove so amazing! Imagine yourself treating patients in what was the future, but is now the present. You might find yourself with a whole new arsenal of treatment options that can even cure genetic defects that were untreatable when you were in middle school. Imagine yourself as the treating physician in the following case study.

Case Study

It is quite impressive to look back at the progress humankind has made in the treatment of medical conditions over the past 200 years following many millennia with barely any progress. But looking ahead to the rapid progress that current technology lends to our future medical treatments is even more exiting. The greater the advances we make in technology, the more rapid the advances we make in medical science. Remember the actual definition of technology, "the techniques, methods and processes used in the

production of goods or in the accomplishment of scientific objectives." We might view the changes in our Earth itself as moving in the opposite direction. Before man started burning fossil fuels, the atmosphere maintained a consistent composition which comfortably sustained the evolution of life. But the more the planet's population grew, and the more that population burned fossil fuels, the more rapidly changes occurred in our atmosphere. We can only hope that further advances in fuel technology can reverse the rapid changes to our atmosphere that now appear to endanger the very existence of life on our planet.

If you by chance, because of your excitement about this new technology, don't wish to wait until your university molecular biology class to learn more about CRISP-R, we recommend you visit the following website:

http://www.yourgenome.org/facts/what-is-crispr-cas9