Honors Biology Summer Assignment

Dear Prospective Honors Biology Student,

Welcome to Honors Biology! The honors biology course is a wonderful and rigorous course that will provide you with the background needed for additional science courses at Mark T. Sheehan High School and for preparation for college level study. It is important that you maintain serious study habits, time management skills, and balance in your life in order to perform at the level of excellence expected. To get the year off to a strong start, there are two summer assignments that include in-depth reading, analysis, and reflection. This work is a preparation for the themes and skills we will be working with during the school year.

- All assignments are due on the **first day of biology** and are to be completed **individually.**
- All assignments should be **typed** and **printed** well before the due date.

Honors Biology, Summer Assignments: An Overview

1. **Assignment 1**: Carefully read the articles: "All About Viruses" by the Yale Medical Group and "Scientists Move Closer to a Lasting Flu Vaccine" by Carl Zimmer. Thoughtfully and fully answer the questions that are in the packet.

2. **Assignment 2**: Read current newspapers and / or magazines. Complete the Current Event assignment in the packet.

We look forward to seeing you. Have a good summer!

Please read carefully and sign below.

I have read this document describing the Honors Biology summer work at Mark T. Sheehan High School and understand the commitment being made by enrolling in this course:

Print Student Name: _____ Date : _____

Student Signature: _____

Honors Biology Summer Assignment 1

Instructions: These two articles discuss one of the major themes we will be studying in biology: the virus. Read the articles carefully before beginning to answer the questions. Start early so that you do not have to rush.

- In your answers give evidence, reasons, and cite examples to demonstrate both your understanding of the articles and your insights.
- To fully explain your ideas, be sure to incorporate each question into its answer, so the reader does not have to go back to the question to understand what you are trying to say.
- Answer questions on a separate page. Answers should be typed.

All About Viruses – Yale Medical Group

Viruses are familiar from the common diseases they cause: colds and flu, for instance. But what are they, and how do they cause sickness?

A virus is a tiny, infectious particle made up of an outer layer called a capsid that's wrapped around a strand of DNA or RNA. DNA and RNA are chains of genetic material that contains instructions for the virus to reproduce. Some viruses also have a lipid (fatty) membrane surrounding their outer layer. Some have enzymes, a type of chemical that helps them reproduce inside a cell.

A virus can be thousands of times smaller than a bacterium, small enough to pass through most filters made to trap bacteria. Viruses are found everywhere in nature, even in harsh environments like deserts and polar seas, and thousands of feet underground. They also make up the bulk of organic matter in the sea. They infect plants, animals, bacteria, and humans.

Scientists estimate that there are millions of types of viruses, most not yet discovered. So far, each type of virus that has been discovered has its own unique

genetic makeup. This means that viruses may represent the largest reservoir of genetic material on earth. Viruses also may create new combinations of genetic material as they reproduce. This means that they create new or mutant versions of themselves.

Unlike living cells, viruses cannot on their own carry out the biochemical processes needed to reproduce. They must be inside a living cell to function and produce more viruses. But viruses are very specific about what type of cell they need.

How a virus infects a cell

Some viruses can remain outside a cell for a long time. Others can survive only in certain conditions. The virus's capsid protects the virus when it is outside a cell. Some viruses have capsids that are resilient and can withstand different environmental conditions. Others are fragile. The capsid also determines the path by which the virus enters a living organism. It also identifies the type of cell in the body that will host the virus.

Viruses usually infect only one type of cell. Once a virus finds the appropriate cell, it attaches itself to the cell wall. The virus then either enters the cell, or injects its genetic material (and enzymes, if it carries them) into the cell. Once inside the cell, the viral DNA or RNA and viral enzymes use the host cell’s own machinery to produce copies of the virus. These newly created copies leave their host cell by exploding out of it--killing the host cell--or breaking through the cell wall in a process called budding. The new viruses then find and infect other host cells.

Viruses can stay in the body area or organ they first infect, or they can spread. Viruses that cause hepatitis, for example, infect the liver and remain there. The measles virus and varicella-zoster virus enter through the respiratory tract and spread to lymph nodes, skin and other organs. Viral infections can damage body tissues in several ways. They can interfere with the normal processes of the host cell, kill the host cell by exploding out of it, or trigger the immune system's response.

In people with a healthy immune system, most common disease viruses produce infections that last from seven to 14 days. Some viruses, however, can cause chronic infections. Others lie undetected in the body and cause symptoms at a later time, called a latent infection. In a chronic infection, the virus reproduces and causes effects for an extended time, perhaps for a person's entire life. Hepatitis B and C viruses cause a chronic infection. In a latent viral infection, the virus's DNA or RNA rests harmlessly in the host cells and does not reproduce. If the virus is eventually activated, it begins to reproduce and damage body tissues. Varicella viruses are examples of viruses that cause latent infections. The varicella-zoster virus remains in the body after causing the initial infection known as chicken pox. After the initial infection, it enters the nerves and travels to base of the spine, where it remains dormant, not reproducing and not causing tissue damage. If it is re-activated, it travels through nerves to the skin, where it causes the blister-like lesions of shingles. The lesions appear along the route that the affected nerve follows underneath the skin. The virus then returns to its dormant state.

Treating infections

Outside the body, viruses can be killed by detergents, bleach, organic solvents such as ether or chloroform, and ultraviolet light.

Inside the body, the immune system provides defense by producing antibodies against specific viruses. Antibodies are made when the immune system first encounters a virus. The body builds an antibody specially designed to prevent that particular virus from attaching to new cells. Once an antibody is made for a specific virus, the immune system usually continues to make it, but in much smaller quantities, even if there is no current viral attack. If the immune system encounters that virus again, its response will be faster because it does not have to build a new antibody. It simply makes more of the ones it already has. This is called immunity.

You can develop immunity to fight a future viral infection in two ways. You can catch the virus or get a vaccination. Vaccines are made from a killed or inactivated form of

the virus or from harmless parts of a viral capsid grown in a laboratory. These substances contain just enough of the virus to trigger the immune system to build an antibody, but not enough to cause a serious infection. Vaccines exist for these viruses: chicken pox, shingles, measles, mumps, rubella, hepatitis A, hepatitis B, yellow fever, human papillomavirus, rabies, influenza, polio, Japanese encephalitis and rotavirus.

Another of the body's natural defenses against viral infections is a family of proteins called interferons. Interferons also fight bacterial infections and tumors. They do not kill viruses, but they activate other immune responses in the body, including processes in host cells that stop the virus's activity. Interferons can also be made commercially and injected into the body to boost the immune system response.

Antiviral medications

Once a virus is inside a host cell, it is difficult to kill or damage it without killing or damaging the cell. Because of this, scientists have developed drugs that interfere with a virus's functions rather than killing it outright. Antiviral drugs have been developed that prevent the virus from attaching to a host cell, entering the cell, reproducing within a cell, or releasing newly formed viruses. The drugs amantadine and rimantadine, for example, work by preventing the virus from entering the cell; the drug acyclovir blocks viral reproduction within the cell. Two newer drugs for the treatment of influenza, zanamivir and oseltamivir, block the release of newly formed viruses from the host cells, preventing their spread to other host cells. Protease inhibitors, used in treatment of HIV, work by blocking an enzyme the HIV virus uses to make copies of itself.

Antibiotics, which are prescribed for bacterial infections, don't work against viruses. This is because antibiotics are designed to interfere with biochemical reactions bacteria need to survive. Viruses don't have these same biochemical reactions.

The FDA has approved the use of two vaccines to help prevent infection with HPV, a major cause of cervical cancer. Several strains of HPV have been

identified. Both vaccines protect against strains 16 and 18, which cause about 70 percent of cervical and anal cancers. Only one vaccine protects against types 6 and 11, which cause about 90 percent of genital warts. The vaccine does not protect against HPV strains 31 or 45, which can also cause cervical cancer. The vaccines, which do not contain live virus, are approved for females ages 9 to 26. Recently, the use of one vaccine has been approved for males ages 9 to 26.

Scientists Move Closer to a Lasting Flu Vaccine

By CARL ZIMMER
Published: October 29, 2012

As this year's flu season gathers steam, doctors and pharmacists have a fresh stock of vaccines to offer their patients. The vaccines usually provide strong protection against the virus, but only for a while. Vaccines for other diseases typically work for years or decades. With the flu, though, next fall it will be time to get another dose.

"In the history of vaccinology, it's the only one we update year to year," said Gary J. Nabel, the director of the Vaccine Research Center at the National Institute of Allergy and Infectious Diseases.

That has been the case ever since the flu vaccine was introduced in the 1950s. But a flurry of recent studies on the virus has brought some hope for a change. Dr. Nabel and other flu experts foresee a time when seasonal flu shots are a thing of the past, replaced by long-lasting vaccines.

"That's the goal: two shots when you're young, and then boosters later in life. That's where we'd like to go," Dr. Nabel said. He predicted that scientists would reach that goal before long — "in our lifetime, for sure, unless you're 90 years old," he said.

Such a vaccine would be a great help in the fight against seasonal flu outbreaks, which kill an estimated 500,000 people a year. But in a review to be published in the journal "Influenza and Other Respiratory Viruses", Sarah Gilbert of Oxford University argues that they could potentially have an even greater benefit.

Periodically, a radically new type of flu has evolved and rapidly spread around the world. A pandemic in 1918 is estimated to have killed 50 million people.

With current technology, scientists would not have a vaccine for a new pandemic strain until the outbreak was well under way. An effective universal flu vaccine would already be able to fight it.

"Universal vaccination with universal vaccines would put an end to the threat of global disaster that pandemic influenza can cause," Dr. Gilbert wrote.

Vaccines work by enhancing the protection the immune system already provides. In the battle against the flu, two sets of immune cells do most of the work.

One set, called B cells, makes antibodies that can latch onto free-floating viruses. Burdened by these antibodies, the viruses cannot enter cells.

Once flu viruses get into cells, the body resorts to a second line of defense. Infected cells gather some of the virus proteins and stick them on their surface. Immune cells known as T cells crawl past, and if their receptors latch onto the virus proteins, they recognize that the cell is infected; the T cells then release molecules that rip open the cells and kill them.

This defense mechanism works fairly well, allowing many people to fight off the virus without ever feeling sick. But it also has a built-in flaw: The immune system has to encounter a particular kind of flu virus to develop an effective response against it.

It takes time for B cells to develop tightfitting antibodies. T cells also need time to adjust their biochemistry to make receptors that can lock quickly onto a particular flu protein. While the immune system educates itself, an unfamiliar flu virus can explode into full-blown disease.

Today's flu vaccines protect people from the virus by letting them make antibodies in advance. The vaccine contains fragments from the tip of a protein on the surface of the virus, called hemagglutinin. B cells that encounter the vaccine fragments learn how to make antibodies against them. When vaccinated people become infected, the B cells can quickly unleash their antibodies against the viruses.

Unfortunately, a traditional flu vaccine can protect against only flu viruses with a matching hemagglutinin protein. If a virus evolves a different shape, the antibodies cannot latch on, and it escapes destruction.

Influenza's relentless evolution forces scientists to reconfigure the vaccine every year. A few months before flu season, they have to guess which strains will be dominant. Vaccine producers then combine protein fragments from those strains to create a new vaccine.

Scientists have long wondered whether they could escape this evolutionary cycle with a vaccine that could work against any type of influenza. This so-called universal flu vaccine would have to attack a part of the virus that changes little from year to year.

Dr. Gilbert and her colleagues at Oxford are trying to build a T cell-based vaccine that could find such a target. When T cells learn to recognize proteins from one kind of virus, the scientists have found, they can attack many other kinds. It appears that the flu proteins that infected cells select to put on display evolve very little.

The scientists are testing a vaccine that prepares T cells to mount a strong attack against flu viruses. They engineered a virus that can infect cells but cannot replicate. As a result, infected cells put proteins on display, but people who receive the vaccine do not get sick.

In a clinical trial reported this summer, the scientists found that people who received the vaccine developed a strong response from their T cells. "We can bring them up to much higher levels with a single injection," said Dr. Gilbert, the lead author of the study.

Once the scientists had vaccinated 11 subjects, they exposed them to the flu. Meanwhile, they also exposed 11 unvaccinated volunteers. Two vaccinated people became ill, while five unvaccinated ones did.

While the Oxford researchers focus on T cell vaccines, others are developing vaccines that can generate antibodies that are effective against many flu viruses — or perhaps all of them.

The first hint that such antibodies exist emerged in 1993. Japanese researchers infected mice with the flu virus H1N1. They extracted antibodies from the mice and injected them into other mice. The animals that received the antibodies turned out to be protected against a different kind of flu, H2N2. In hindsight, that discovery was hugely important. But at the time no one made much of it.

"By and large, people just said, 'This is an oddity — so what?' " said Ian Wilson of the Scripps Research Institute.

Scientists did not appreciate its importance for more than 15 years, until Dr. Wilson and other researchers began isolating the antibodies that provided this kind of broad protection and showed how they worked.

The new antibodies turn out to attack different parts of the flu virus from the ones produced by today's vaccines. Today's vaccines cause B cells to make antibodies that clamp onto a broad

region of the tip of the hemagglutinin protein. Recently, Dr. Wilson and his colleagues discovered a new antibody with a slender tendril. It can snake into a groove in the hemagglutinin tip.

Dr. Wilson and his colleagues found that this tendriled antibody can attach to a wide range of flu viruses. The results hint that the groove — which flu viruses use to attach to host cells — cannot work if its shape changes much.

The antibody is also impressively powerful, the scientists found. They infected mice with a lethal dose of the flu and then, after three days, injected the new antibody into them. The antibody stopped the virus so effectively that the mice recovered.

The hemagglutinin groove is not the only promising target for antibodies. Dr. Wilson and other scientists are discovering antibodies that attack the base of the protein. Influenza viruses can be broadly categorized into three types — A, B and C. Until now, scientists have found only antibodies that attack different versions of influenza A. Dr. Wilson and colleagues at Scripps and the Crucell Vaccine Institute in the Netherlands recently found a stem-attacking antibody that blocks influenzas A and B.

“The whole field is invigorated,” Dr. Wilson said. “It’s a great time.”

Building on these discoveries, Dr. Nabel and other scientists have recently developed vaccines that generate some of the new antibodies in humans. Now they are trying to figure out how to get the body to make a lot of the antibodies.

“Once you have an antibody that has all the properties you desire, how do you coax the immune system to make that?” Dr. Nabel said. “That’s the classic problem in immunology.”

\

Instructions: These two articles discuss one of the major themes we will be studying in biology: the virus. Read the articles carefully before beginning to answer the questions. Start early so that you do not have to rush.

- In your answers give evidence, reasons, and cite examples to demonstrate both your understanding of the articles and your insights.
- To fully explain your ideas, be sure to incorporate each question into its answer, so the reader does not have to go back to the question to understand what you are trying to say.
- Answer questions on a separate page. Answers should be typed.

Questions:

1. Are viruses living? Why or why not? Be sure to use specific examples from the articles to support your answer.

2. What lines of defense do we have against viruses? Do antibiotics work against viruses? Why or why not?

3. Why and how are pathogens becoming resistant to medicines made by humans?

4. How does better technology/health care contribute to the spread of pathogens?

5. "In a very short time, we have doubled in number. A marvelous target for any organism that can adapt itself to invading us." Discuss this quotation. Why and how does the growth of the human population hurt the fight against pathogens? Explain. How does living in a highly populated area (as opposed to a rural area) affect living conditions, disease frequency, and overall quality of life?

6. How do vaccines protect you from getting a viral disease?

7. Why is the information and concepts presented in "Scientists Move Closer to a Lasting Flu Vaccine" so significant?

Honors Biology Summer Assignment 2

Current Event Articles

Read a daily newspaper, watch the news and read science magazines during the summer.

Look for articles that pertain to the issues raised in Honors Biology Summer Assignment 1.

Read and copy (or print) five articles. Then answer the provided questions.

NOTE: This is not an internet research assignment where you might put in key words and let the computer find articles for you. The intent is for you to regularly read magazines and newspapers during the summer. Many magazines are available at the public library if you do not have them where you are during the summer.

Examples of magazines with relevant articles:

Audubon
American Scientist
Discover
National Geographic
Natural History Magazine
Nature
The New Scientist
Science Illustrated
Scientific American
Sierra Club
Smithsonian
Science Magazine

Read and copy (or print) five articles.

Answer the questions below for ***each*** article.

You should have about 1 – 2 typed pages for each article.

QUESTIONS:

1. Explain how you found the article.

2. Explain why you picked the article.

3. Explain the main points of the article.

4. Explain how the ideas in the article demonstrate or are related to the points made by Zimmer.

5. Explain how or why your article is significant.

6. Attach the article or photocopy of the article. Be sure to include the name of the magazine or newspaper where it appeared, the author, the date of publication, and page numbers.

Be prepared to explain and discuss with the class the article you found.