The Immortal Life of Henrietta Lacks

Notes about Chapter 27: The Secret of Immortality and additional information about HPV, p53, and vaccine

MIT/HHMI Summer 2013 Teacher Institute
Lydia Breen
Rebecca Veilleux
HeLa Cell Immortality

• 1984- Dr. Harald zur Hausen discovered Human Papilloma Virus 18 (HPV 18) along with HPV-16 (1983) caused cervical cancer

• Tissue from Henrietta Lack’s original biopsy tested positive for multiple copies of HPV18

A papsmear with healthy cells (blue) and HPV-infected cells (pink). Photomicrograph by Ed Uthman, MD. Creative Commons.
HPV

- 100+ strains
- 13 strains of HPV cause cervical, anal, oral, labia, and penal cancers
- 90% of sexually active adults have been infected with at least one of the strains
- 1980’s HeLa used to study how HPV causes cancer and how if HPV DNA is blocked, cells stop being cancerous
- Leads to HPV vaccine
- Nobel prize for zur Hausen
More about HPV and Cancer
Slides 5-8 from NCI: Understanding Cancer
http://www.cancer.gov/cancertopics/understandingcancer
Many Types of HPVs

<table>
<thead>
<tr>
<th>Different HPVs–Different Infections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harmless</strong></td>
</tr>
<tr>
<td>No warts or cancer</td>
</tr>
<tr>
<td><strong>Warts-Linked</strong></td>
</tr>
<tr>
<td>Genital warts</td>
</tr>
<tr>
<td><strong>Cancer-Linked</strong></td>
</tr>
<tr>
<td>Most clear up</td>
</tr>
<tr>
<td>Some persist, but no abnormalities in cervix</td>
</tr>
<tr>
<td>Some persist, some abnormalities in cervix</td>
</tr>
<tr>
<td>A few persist and progress to <strong>cervical</strong> cancer</td>
</tr>
</tbody>
</table>

There are three groups of genital HPV strains: many no-risk types cause neither warts nor cancer; a few types cause genital warts; and 15 or so high-risk types can increase one’s risk of cancer. If left untreated, genital warts do not turn into cancer. High-risk HPV, on the other hand, may trigger an infection that leads to cervical cancer. The majority of infections with high-risk HPVs clear up on their own. Some infections persist without causing any additional abnormal cell changes. However, a few infections caused by high-risk HPVs end up triggering cervical cancer over many years.
Both harmless and cancer-linked human papillomaviruses pass by skin-to-skin contact. The high-risk types of HPVs need to penetrate deeply into the lining of the cervix to establish a chronic infection. A vaginal sore or sex, which can abrade the lining, may provide a point of entry for the papillomavirus. Once inside the cervical lining, the virus attaches to epithelial cells. As these cells take in nutrients and other molecules that are normally present in their environment, they also take in the virus. Over 99 percent of cervical cancer cases are linked to long-term infections with high-risk human papillomaviruses.
Virus Uncoats

The HPV sits inside the epithelial cells housed in a protective shell made of a viral protein called L1. After the virus enters the cell, the viral coat is degraded, leading to the release of the virus’ genetic material into the cell and its nucleus. From the nucleus, the genes of the virus are expressed, including two genes called E6 and E7, which instruct the cell to build viral proteins called E6 and E7.
Viral proteins E6 and E7 then disable the normal activities of the woman’s own suppressor genes, which make suppressor proteins that do “damage surveillance” in normal cells. These proteins usually stop cell growth when a serious level of unrepaired genetic damage exists. Even after suppressors are disabled in a woman’s cervical cells, it usually takes more than 10 years before the affected tissue becomes cancerous.
Henrietta’s cancer

- HPV DNA inserted into long arm of chromosome 11 (*chromosome 17)
- HPV DNA turned off p53 gene (tumor suppressor gene)
- Still unknown why Henrietta’s cancer cells were so virulent

What is the p53 Gene?

The **p53 gene** is responsible for proteins that can either repair damaged cells, or cause damaged cells to die, a process called **apoptosis**.

When the gene is **not** working due to a mutation, these proteins that repair cells or eliminate damaged cells are not produced, and abnormal cells are allowed to divide and grow.

By Lynne Eldridge MD, About.com Guide

Updated October 10, 2012

http://www.aschoonerofscience.com
Cell Cycle Checkpoints

- DNA in chromosomes can be damaged by a number of agents including radiation, toxic chemicals, and free radicals.
- At this checkpoint, a protein known as p53 will inspect the chromosomes’ DNA for damage.

* super website
http://lifesciences.envmed.rochester.edu/lessonsCancer.html
HeLa cells and HIV 1980’s

• 2004 Nobel Prize winner Richard Axel infected HeLa cells with HIV DNA sequence that made the cells susceptible to HIV infection and thus these cells could be used to study the virus in the lab.
• Led to law suit by activist Jeremy Rifkin to stop HIV HeLa research……later dismissed
• Brought about the discussion about the “evolution” of the HeLa cells and are HeLa cells a “new species”
HeLa Term Project

• Dr. Axel also used recombinant DNA technology to discover the molecule CD4, that is a surface protein on a T-cell - responsible for the transmission of HIV (Axel, 2004). A T-cell is a white blood cell which protects the body from infection, called lymphocytes (Medicine Net, 2010).

• He and Ellen Robey hypothesized that HIV’s glycoprotein, called gp120, is what that reacts to T-cell’s CD4. They worked on non-T-cells, including HeLa cells, by injecting them with CD4 to see if that made them susceptible to HIV. It did. They also isolated the gp120 and CD4 proteins, mixed them in solution and found that there was an affinity for the two to bind together (Robey & Axel, 1990). The hope is through this research there may be a treatment or vaccine found for HIV.

– http://helatermproject.blogspot.com/2012/03/richard-axel.html
Scientific Use of HeLa cells

• Well done interactive website for students to use when researching the use of HeLa cells in scientific research

http://whenintime.com/ShowEvents.aspx?tlurl=/tl/kelseypitts/HeLa_3a_Scientific_and_Medical_Breakthroughs_Through_the_Years/

HeLa: Scientific and Medical Breakthroughs Through the Years

– Created by Kelsey Pitts

Henrietta Lacks' immortal cells, known as HeLa, made many scientific and medical advances possible ever since they were harvested. This timeline details these advances and how HeLa was involved in each.
HeLa and Immortality

• Hayflick Limit- cells can only divide a finite number of times-
  1961 Leonard Hayflick cells reach their limit when they’ve doubled 50 times

• HeLa cells studied for their immortality

• Cancer cells have the enzyme telomerase that maintains the telomeres on each chromosome making them immortal

• “the day after the 58th anniversary of Henrietta Lacks’s death — the Nobel Prize in medicine has been awarded to Elizabeth Blackburn, Carol Greider, and Jack Szostak for the discovery of how telomeres and the enzyme telomerase protect chromosomes from degrading over time.” Rebecca Skloot’s blog 2009
Telomerase

The telomeres form caps at the ends of chromosomes. They contain a unique DNA sequence which is repeated several times.

The DNA sequence varies slightly between species. The one shown here is from *Tetrahymena*.

Telomere illustration. (Credit: Copyright The Nobel Committee for Physiology or Medicine 2009 / Illustration: Annika Röhl)
New study shows HPV vaccine helping lower HPV infection rates in teen girls

A new study looking at the prevalence of human papillomavirus (HPV) infections in girls and women before and after the introduction of the HPV vaccine shows a significant reduction in vaccine-type HPV in U.S. teens. The study, published in [the June issue of] The Journal of Infectious Diseases reveals that since the vaccine was introduced in 2006, vaccine-type HPV prevalence decreased 56 percent among female teenagers 14-19 years of age.

About 79 million Americans, most in their late teens and early 20s, are infected with HPV. Each year, about 14 million people become newly infected.

“This report shows that HPV vaccine works well, and the report should be a wake-up call to our nation to protect the next generation by increasing HPV vaccination rates,” said CDC Director Tom Frieden, M.D., M.P.H. “Unfortunately only one third of girls aged 13-17 have been fully vaccinated with HPV vaccine. Countries such as Rwanda have vaccinated more than 80 percent of their teen girls. Our low vaccination rates represent 50,000 preventable tragedies – 50,000 girls alive today will develop cervical cancer over their lifetime that would have been prevented if we reach 80 percent vaccination rates. For every year we delay in doing so, another 4,400 girls will develop cervical cancer in their lifetimes.”