Hello Students,

This resource packet includes a project that you can work on independently at home. You should also have project packets for some of the other courses you are enrolled in. These projects are standards-aligned and designed to meet the Remote Learning instructional minutes guidelines by grade band.

### High School Chemistry Project: Is aluminum in antiperspirant a cause of breast cancer?

<table>
<thead>
<tr>
<th>Estimated Time</th>
<th>~225 minutes</th>
</tr>
</thead>
</table>
| Grade Level Standard(s) | HS PS 1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.  
HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. |
| Caregiver Support Option | Caregivers can assist by supporting calculations in each of the investigations, by supporting reading of the texts and interpreting the data. |
| Materials Needed | Writing utensil, paper/notebook, and calculator |
| Question to Explore | Is aluminum in deodorant and antiperspirant a cause of breast cancer? |
| Student Directions | Follow the directions outlined in each section of the packet. |

**Task Materials Adapted From:**
- Introduction Article - [Teen Vogue](#)
- Investigation 2: The Bohr Model of the Atom - [Prep Scholar Blog](#)
- Investigation 3: Valence Electrons - [CK12](#)
- Investigation 3: Octet Rule - [CK12](#)
- Investigation 3: Genes and Cancer - [HBOC Society](#)
- Investigation 4: Evaluating Sources - [University of Georgia - Finding Reliable Sources: What is a Reliable Source?](#)
Introduction
Walk down the beauty or bath goods aisle in most stores, and you’ll see many deodorants and antiperspirants touting their aluminum-free status.

1. Take a moment to share your experiences with deodorant and/or antiperspirant. Do you use either of these? Do you know a friend or family member who does? Have you, your friends, or your family members ever thought of the significance of aluminum in deodorant or antiperspirant? Record your response on a separate sheet of paper.

So what’s the big deal with aluminum in deodorant, anyway? Why do manufacturers put this at the forefront of their labels? One article from Teen Vogue claims that aluminum in deodorant and antiperspirant is tied to breast cancer:

The concerns about the risk of breast cancer largely have to do with the proximity of the underarms to the breasts. Some studies have claimed that a majority of breast cancers develop in the upper outer quadrant of the breast because that section is closest to the underarms, where deodorants — which theoretically get absorbed by the skin or enter through razor nicks — are applied, the thinking being that the aluminum gets into the lymph nodes and then travels to the breasts.

Given the claim laid out in this excerpt from Teen Vogue, in this task, we will argue either for or against the driving question, “Is aluminum in deodorant and antiperspirants a cause of breast cancer?”

2. Take a moment to record your initial argument either for or against the driving question, and explain your reasoning. Record your response on a separate sheet of paper.

Task Overview
Over the course of this packet, you will investigate the reactivity of aluminum and how it may or may not be tied to breast cancer. You’ll investigate the chemical reactions of aluminum, both on the macroscopic and atomic scales, and then evaluate different sources of information on the health risks of aluminum for their validity. You will then synthesize all of this information to create an argument to answer the driving question for this task.
Investigation 1: How does aluminum react with other elements?

To help figure out if aluminum can be connected to breast cancer, it will help to start by investigating how reactive aluminum is. The data below are taken from the reactions of aluminum and five other elements with water and with hydrochloric acid.

<table>
<thead>
<tr>
<th></th>
<th>Lithium</th>
<th>Beryllium</th>
<th>Boron</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactivity With Water or Steam</strong></td>
<td>Vigorous reaction with cold water</td>
<td>Non-reactive</td>
<td>Non-reactive</td>
</tr>
<tr>
<td><strong>Reactivity With Hydrochloric Acid</strong></td>
<td>Explosively reacts with acids to make $\text{H}_2$ gas and hydroxides.</td>
<td>Slowly reacts with acids to make $\text{H}_2$ gas and hydroxides.</td>
<td>Very slowly reacts with hot and strong acids to make $\text{H}_2$ gas and hydroxides.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Sodium</th>
<th>Magnesium</th>
<th>Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactivity With Water or Steam</strong></td>
<td>Vigorous and sometimes explosive reaction with cold water</td>
<td>Slow reaction with cold water.</td>
<td>Non-reactive</td>
</tr>
<tr>
<td><strong>Reactivity With Acid</strong></td>
<td>Explosively reacts with acids to make $\text{H}_2$ gas and hydroxides.</td>
<td>Rapidly reacts with acids to make $\text{H}_2$ gas and hydroxides.</td>
<td>Slowly reacts with acids to make $\text{H}_2$ gas and hydroxides.</td>
</tr>
</tbody>
</table>

1. What patterns do you notice in the data regarding the reactivity of aluminum? Record your response on a separate sheet of paper.

2. Compare the reactivity pattern you found to the arrangement of atoms on the periodic table provided. What directional trends do you notice? Record your response on a separate sheet of paper.

3. Looking across the data and patterns you found in Investigation 1, what can you now conclude about how aluminum may be tied to breast cancer? Cite evidence to back up your claim. Record your response on a separate sheet of paper.

Investigation 2: Why does aluminum react in the way it does?

Now that you have seen how reactive aluminum is compared to other elements, it will help to figure out and why it undergoes these reactions. You can use this information to investigate the reactions aluminum might have in the body.

The internal structure of the atom will help us think about why aluminum might react with different elements. A model of the internal structure of the atom that we will use is called the Bohr Model, named after the man who first developed it, Niels Bohr. The Bohr Model has an atom with a positively-charged nucleus, composed of protons (red) and neutrons (green) surrounded by negatively-charged electrons (yellow) that have circular, planetary-like orbits. Today, we know that the Bohr Model has some
In the Bohr model, the electrons travel in defined circular orbits around the small positively-charged nucleus. The Bohr Model is known as a planetary model because these orbits look similar to that of planets orbiting the sun. According to Bohr, electron orbits could only hold a certain number of electrons. If an orbit was full, the remaining electrons would create a new orbit. That’s why, when you look at a Bohr diagram, you’ll sometimes see more than one electron orbit circling the nucleus. That happens when there are too many electrons to be housed in a single orbit.

In order to make a Bohr diagram, you need to know the number of protons, neutrons, and electrons the element has. You can see the principles outlined in the section above at work in the Bohr model for the boron atom. In the model for the boron atom, 5 negatively-charged electrons orbit a positively-charged nucleus with 5 protons and 5 neutrons. In heavier atoms, there are more protons in the nucleus than in the boron atom. Because of this, there are more electrons to cancel out the positive charge of the protons. That also means there will be more orbits around the nucleus.

3. On a separate sheet of paper, draw the Bohr models for the following different atoms: Lithium, Beryllium, Boron, Sodium, Magnesium, Aluminum, Oxygen, Hydrogen, and Nitrogen

Three additional factors will help us think about how aluminum reacts with different elements:

<table>
<thead>
<tr>
<th>Ionization Energy</th>
<th>Atomic Radius</th>
<th>Nucleus &amp; Electron Attraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>The reactivity of the atom depends in part on how easily the electrons can be removed from the atom. This quantity, called ionization energy, is the energy required to remove an electron from a specific atom. The higher the value, the harder it is to remove an electron. It is measured in kJ/mol, which is an energy unit, much like calories.</td>
<td>The size of atoms is important when trying to explain the behavior of atoms or compounds. One of the ways we can express the size of atoms is with the atomic radius. The size of an atom is defined by the distance from the edge of its orbital to the nucleus.</td>
<td>The nucleus of the atom, which has a positive charge, is attracted to the electrons of an atom, which have a negative charge. In contrast, the electrons in the atom, which all have a negative charge, repel one another.</td>
</tr>
</tbody>
</table>
Using the information above, consider the data on the next page on ionization energy and atomic radius for aluminum and five additional elements.
<table>
<thead>
<tr>
<th></th>
<th>Lithium</th>
<th>Beryllium</th>
<th>Boron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionization Energy (kJ/mol)</td>
<td>513</td>
<td>899</td>
<td>801</td>
</tr>
<tr>
<td>Atomic Radius (pm)</td>
<td><img src="167" alt="Li" /></td>
<td><img src="112" alt="Be" /></td>
<td><img src="87" alt="B" /></td>
</tr>
<tr>
<td>Reactivity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Sodium</th>
<th>Magnesium</th>
<th>Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionization Energy (kJ/mol)</td>
<td>496</td>
<td>738</td>
<td>577</td>
</tr>
<tr>
<td>Atomic Radius (pm)</td>
<td><img src="190" alt="Na" /></td>
<td><img src="145" alt="Mg" /></td>
<td><img src="118" alt="Al" /></td>
</tr>
<tr>
<td>Reactivity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. In the table above, record the relative reactivity of each element as you found in Investigation 1. You can simplify what you found by describing the reactivity as “high,” “medium,” “low,” or “none.”

4. What patterns or relationships did you find in the data above? Record your responses on a separate sheet of paper.

5. Use the patterns in the data - especially those relating to atomic radius and ionization energy - that you found to help you think about what causes the differences in reactivity that you see. Record any ideas you have. Record your responses on a separate sheet of paper.

6. Looking across the data and patterns you found in Investigation 2, what can you now conclude about how aluminum may be tied to breast cancer? Cite evidence to back up your claim. Record your response on a separate sheet of paper.
Investigation 3: How could aluminum be related to the cause of cancer?

Now that you have figured out how reactive aluminum is and why it undergoes reactions, we can use what you have uncovered to figure out if aluminum would theoretically be able to cause cancer.

In cancer, cells grow uncontrollably due to alterations of the genes that tell cells to grow and divide. These alterations can come from multiple sources, but we will focus on gene mutations and interactions with chemicals the body is not used to dealing with. When genes are disrupted, a cell may begin to divide without control, which is the hallmark of cancer. Mutations may be caused by aging, exposure to chemicals, radiation, hormones or other factors in the body and the environment. Sometimes, exposure to excessive amounts of heavy metals can result in chemical reactions with genes, which could lead to cancer.

To figure out if this is true for aluminum getting in the body from deodorants, it will help to start by looking more closely at a model of DNA.

7. What kinds of atoms do you see are most commonly found in a molecule of DNA. Note: carbon is not shown in this diagram, but we will ignore carbon as it is typically a structural atom and not often involved in chemical reactions with external atoms. Record your response on a separate sheet of paper.

With these atoms in DNA in mind, let’s take a look at how they might undergo chemical reactions with aluminum. To do so, it will help to see a new idea: valence electrons and the octet rule. Observe the Bohr atom models in the segment of the periodic table below:
8. What patterns do you see in how electrons are organized in these atoms? Remember to look across periods and up/down groups. Record your response on a separate sheet of paper.

These atoms models will help us figure out how aluminum can react with the atoms you found in a DNA molecule. When atoms react, their outer electron shell, also known as valence electrons, in most cases is most stable when it is filled with eight electrons. This is known as the octet rule. Atoms can satisfy the octet rule by transferring valence electrons from one atom to another. Atoms of metals tend to lose all of their valence electrons, which leaves them with an octet from the next lowest principal energy level. Atoms of nonmetals tend to gain electrons in order to fill their outermost principal energy level with an octet.

One example of this process is the reaction between sodium and chlorine. As you can see from the diagram on the right, sodium has one electron in its valence shell, and chlorine is missing one valence electron to make eight. When sodium gives away its one electron in the valence shell, that shell disappears and the next shell below that becomes the new valence shell, with eight electrons in it. In chlorine, the electron lost from sodium transfers to chlorine, filling up its valence shell with eight electrons. When atoms interact in this way, they form an ionic bond.
9. Using the elements that you found in DNA in Question 7 above, draw the atom shell models of each element, and what you think a reaction between that element and aluminum might look like.

<table>
<thead>
<tr>
<th>Draw the Atom Shell Model</th>
<th>Aluminum</th>
<th>DNA Element 1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Location &amp; Function</td>
<td>Enters the body through the skin or mouth and accumulates in nerve cells</td>
<td>Atom that is often found in important structures in DNA</td>
</tr>
<tr>
<td>Show how the valence electrons of aluminum would behave in a bond between aluminum and the element you chose.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Draw the atom shell model</th>
<th>Aluminum</th>
<th>DNA Element 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Location &amp; Function</td>
<td>Enters the body through the skin or mouth and accumulates in nerve cells</td>
<td>Atom that is often found in important structures in DNA</td>
</tr>
<tr>
<td>Show how the valence electrons of aluminum would behave in a bond between aluminum and nitrogen.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10. Looking across the data, models, and information from readings you found in Investigation 3, what can you now conclude about how aluminum may be tied to breast cancer? Cite evidence to back up your claim. Record your response on a separate sheet of paper.

Investigation 4: How does a chemical reaction with DNA and aluminum occur in a real-life context?

So far, we have figured out how and why aluminum reacts with different elements and how it creates bonds with other elements, which might have an effect on DNA and the formation of cancer. However, one important thing to understand about chemical reactions and toxicity is that just because certain chemical reactions are possible, that doesn’t mean they will happen, or that they will happen in the way one might expect. The truth is, the human body is exceptionally complex and what works in theory may not actually work in reality.

So to investigate if aluminum is truly able to undergo chemical reactions with DNA in the body, you will now evaluate the validity and reliability of multiple sources of information, and use them to find conclusions about how aluminum interacts with human DNA and genes. To help us get started with this process, it will be helpful to have some guidelines on how to evaluate the reliability and validity of a source in science.

Evaluating the Reliability And Validity Of Sources

A reliable source is one that provides a thorough, well-reasoned argument, discussion, or theory that is based on strong evidence. Not all sources of information are reliable. In fact, there is a large range of reliability of sources in our modern digital media world. The scale below gives some guidelines on how to evaluate the quality and reliability of a source.

⭐⭐⭐ Scholarly, peer-reviewed scientific articles or books that are written by scientific researchers for scholarly students and other researchers. These sources contain primary, original research with an extensive bibliography.

⭐⭐ Trade or professional articles or books that are written by practitioners in a field to impart practice-oriented information to professionals in the field. Beware of sources on the internet that look like trade/professional articles, but don’t have reliable content.

⭐☆☆ Magazine articles, books, websites, and newspaper articles from well-established sources that are written for a general audience by authors or journalists who have consulted reliable sources and were vetted through an editor.

• Newspapers and magazines often contain both researched news stories and editorial/opinion pieces that express the view of the writer. It is important to be able to distinguish between them.

• Beware of sources on the internet that look like reputable magazines, and newspapers, but don’t have reliable content.

• Note that these sources are secondary sources, meaning they are journalistic interpretations of a primary article. Beware of potential bias or spin in the interpretation of the original source.
Websites, blogs, and social media from unreliable sources. These sources can be reliable or unreliable, hoaxes or credible, and unintentional or deliberate misinformation. Researchers and other experts often use blogs and social media as a way to share their knowledge with the general public. However, anyone with computer access can post any idea they want to further any agenda they want. It’s up to you to evaluate the quality of what you find in these sources. These sources are particularly notorious for false information.

11. Read through the texts in Appendix A and annotate any information that you think will help you understand the role of aluminum in breast cancer.

12. After you read through the texts, rate how reliable you think they are. Assign them each a reliability rating based on the star system shown on the previous page and justify why you rated each source the way you did.

<table>
<thead>
<tr>
<th>Source</th>
<th>Reliability Rating</th>
<th>Justify Your Choice of Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. After reading all four articles, copy the following table onto a separate piece of paper, and fill it in with information from two articles you rated highly and two you rated lowly.

<table>
<thead>
<tr>
<th></th>
<th>High Rating Article 1</th>
<th>High Rating Article 2</th>
<th>Low Rating Article 3</th>
<th>Low Rating Article 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author &amp; Institution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What Biases May Be Present?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Claim The Author Makes Regarding 5G Safety

| Evidence 1          |                        |                      |                      |                      |
| Evidence 2          |                        |                      |                      |                      |

How does the author’s reasoning conflict with or confirm what you already know about how aluminum may contribute to breast cancer?

Is there anything else that you’re skeptical of or particularly resonated with you?

14. From the reliable sources that you identified, what new ideas can you conclude about aluminum may be tied to breast cancer? Record your response on a separate sheet of paper.

**Engaging in Argument From Evidence - Constructing Final Arguments**

Now that you have gathered multiple pieces of evidence, you will record a final scientific argument that answers the question, “Is aluminum safe to use in antiperspirants?”.

Complete the following on a separate sheet of paper:

15. **Claim:** Record whether or not you think the dangers of aluminum in antiperspirants are supported.
16. **Evidence:** Record at least three pieces of specific and appropriate evidence from the data sets analyzed.
17. **Reasoning:** Record how and why you think this claim is most supported, including how body fat is lost and where it goes when it is lost.
18. **Rebuttal:** Record one alternative claim from any of the texts in investigation four that you disagree with and provide one piece of evidence and reasoning that refutes this claim.
Reflection

1. What did you learn in this activity about how scientists evaluate health claims on consumer products? Record your response on a separate sheet of paper.
2. How will you think about claims on consumer products differently in the future?

Appendix A: Investigation 4 Texts

5 Things Wrong With Your Deodorant
Time Magazine. By Markham Heid, July 5, 2016 5:50 PM EDT

You wouldn’t swallow a spoonful of toxic cosmetic ingredients. But in some ways, smearing them under your arms in the form of deodorant or antiperspirant may be worse.

“When you eat something, it’s broken down by your liver and digestive system,” says Heather Patisaul, Ph.D., an associate professor of biology at North Carolina State University. “But when you put something on your skin, there are times when it can enter your bloodstream without being metabolized.”

Patisaul spends most of her time studying known and potential endocrine disruptors—chemicals that may mess with the function of your body’s reproductive and developmental hormones. She says rubbing something on your skin doesn’t mean all—or even any—of it will make its way into your bloodstream; it depends on the chemical. But blood tests show that many of the substances commonly included in deodorant products can, in fact, worm their way past the epidermis and into the body.

Experts like Harvey and Patisaul are worried certain compounds in antiperspirant and deodorant could cause or contribute to developmental or reproductive issues, as well as cancer.

Aluminum

Aluminum metal can cause “gene instability” in breast tissue, Darbre’s research shows. This instability can cause changes than may promote the growth of tumors or cancer cells, she explains. “Over 50% of breast cancers start in the upper outer quadrant of the breast local to the underarm region,” Darbre says. While that’s not proof aluminum is to blame, breast cancer incidence tends to align with use of products that contain the metal. Especially if you shave under your arms, applying a product containing aluminum to that broken skin could be bad news, Darbre says.

Still, as TIME has reported: According to the American Cancer Society’s website, there is no “clear” or “direct” link between aluminum and cancer. The National Cancer Institute site says “more research is needed.”
The Health Effects of Aluminum Exposure


Background

Aluminum is regularly taken up with the daily diet. It is also used in antiperspirants, as an adjuvant for vaccination, and in desensitization procedures. In this review of scientific research, we present the scientifically documented harmful effects of aluminum on health and the threshold values associated with them.

Aluminum in Antiperspirants: Aluminum compounds have been used commercially in antiperspirants since as early as 1903. Due to their antiperspirant effect, aluminum salts are used in dermatology at significantly higher concentrations (10–30% aluminum chlorohydrate) than in over-the-counter antiperspirants. The German Dermatological Society (Deutsche Dermatologische Gesellschaft) considers these to be a simple and suitable treatment option for hyperhidrosis with low side effects (2). Alternatives in the treatment of hyperhidrosis include tannin preparations with an astringent action, techniques such as tap water iontophoresis, chemical denervation with botulinum toxin A, systemic therapies with antihydrotic agents or psychotropic drugs, as well as surgical procedures (2).

Although aluminum is absorbed through the skin (11, 12), the penetration rate of aluminum chlorohydrate following the dermal application of antiperspirants is extremely low at around 0.01% (in two subjects [11]) and up to 0.06% in pre-damaged skin (in vitro [13]). To date, there are no epidemiological studies on internal exposure due to the use of antiperspirants following underarm shaving or the use of hair removal products.

The reference values for the internal aluminum load (<15 µg/L in urine, <5 µg/L in serum) are especially likely to be exceeded in persons with occupational exposure. The biological tolerance value for occupational exposure is 50 µg of aluminum per gram of creatinine in the urine. For aluminum welders and workers in the aluminum industry, declining performance in neuropsychological tests (attention, learning, memory) has been found only with aluminum concentrations exceeding 100 µg/g creatinine in the urine; manifest encephalopathy with dementia was not found. Elevated aluminum content has been found in the brains of persons with Alzheimer’s disease. It remains unclear whether this is a cause or an effect of the disease. There is conflicting evidence on carcinogenicity. The contention that the use of aluminum-containing antiperspirants promotes breast cancer is not supported by consistent scientific data.

Conclusion

The internal aluminum load is measured in terms of the concentration of aluminum in urine and blood. Keeping these concentrations below the tolerance values prevents the development of manifest and subclinical signs of aluminum toxicity.
Dangers of Aluminum in Deodorant
Nature Moms Blog, By Tiffany

Did you know that aluminum can be found in many popular antiperspirant deodorants? Did you know that the link between your deodorant and breast cancer may not be an urban legend?

A study was conducted by Dr. Kris McGrath, a Chicago allergist who claims to have found a connection between antiperspirants, underarm shaving and cancer. He believes the culprits in these antiperspirants are the toxins in aluminum salts such as aluminum chlorohydrate. He says they don’t normally penetrate the skin enough to cause a problem–unless the skin is shaven. If you disrupt the skin by shaving, it can open up the door, because just under the skin is the lymphatic system, which is connected to the breast.

In this study, more than 400 Chicago-area breast cancer survivors recalled their lifetime history of using antiperspirants and underarm shaving. He found that women who perform underarm shaving more aggressively had a diagnosis of breast cancer 22 years earlier than the non-users.

Now with the study above, British researchers have found traces of chemicals called parabens in tissue taken from women with breast cancer. These researchers also published a study last year in the Journal of Toxicology that suggested underarm cosmetics might be a cause of breast cancer. It is unclear how valid this proposed mechanism is, but it would sure seem safe to avoid all antiperspirants and deodorants just to be safe.

At the very least, if you are using a deodorant in order to avoid the aluminum in antiperspirant, you will also want to be certain that the deodorant you choose does not contain parabens.

In my own family we have given up antiperspirants all together, and when we select a deodorant we make sure it is preservative and paraben free.
Antiperspirants and Breast Cancer Risk

The American Cancer Society Website, October 14, 2014

For some time, an email rumor suggested that underarm antiperspirants cause breast cancer. Among its claims:

- Cancer-causing substances in antiperspirants are absorbed through razor nicks from underarm shaving. These substances are said to be deposited in the lymph nodes under the arm, which are not able to get rid of them by sweating because the antiperspirant keeps you from perspiring. This causes a high concentration of toxins, which leads to cells mutating into cancer.
- Most breast cancers develop in the upper outer quadrant of the breast because that area is closest to the lymph nodes exposed to antiperspirants. (Think of the breast as a circle divided by vertical and horizontal lines that cross at the nipple. Each of the 4 sectors you divide the breast into is called a quadrant. The upper outer quadrant of each breast is the part closest to the armpit.)
- Men have a lower risk of breast cancer because they do not shave their underarms, and their underarm hair keeps chemicals in antiperspirants from being absorbed.

All of these claims are largely untrue.

Do antiperspirants increase a person's risk of breast cancer?

There are no strong epidemiologic studies in the medical literature that link breast cancer risk and antiperspirant use, and very little scientific evidence to support this claim.

In fact, a carefully designed epidemiologic study of this issue published in 2002 compared 813 women with breast cancer and 793 women without the disease. The researchers found no link between breast cancer risk and antiperspirant use, deodorant use, or underarm shaving.

A study published in 2003 looked at responses from questionnaires sent out to women who had breast cancer. The researcher reported that women who were diagnosed with breast cancer at a younger age said they used antiperspirant and started shaving their underarms earlier and shaved more often than women who were diagnosed when they were older. But the study design did not include a control group of women without breast cancer and has been criticized by experts as not relevant to the safety of these underarm hygiene practices.

Probably, in general, younger women are more likely than older women to shave their underarms and use antiperspirants, whether or not they develop breast cancer later. For instance, most women born in the 1950s and 1960s might have started shaving earlier and using antiperspirants more often.
Does using antiperspirant after shaving allow chemicals to enter the body from the armpit and increase breast cancer risk?

Razor nicks may increase the risk of skin infection. If the underarm skin is already broken or infected, it is possible that some antiperspirants could cause slight irritation. But it is unlikely that this is a major source of carcinogens (cancer-causing substances) that get into the body and reach the breast cells.

Should I be concerned about aluminum in antiperspirants?

Aluminum-based compounds are the active ingredients in antiperspirants. They block the sweat glands to keep sweat from getting to the skin’s surface. Some research has suggested that these aluminum compounds may be absorbed by the skin and cause changes in estrogen receptors of breast cells. Because estrogen can promote the growth of both cancer and non-cancer breast cells, some scientists have suggested that using the aluminum-based compounds in antiperspirants may be a risk factor for the development of breast cancer.

But it isn’t clear that much aluminum is absorbed through the skin. One study that looked at the absorption of aluminum from antiperspirants containing aluminum chlorohydrate applied to the underarms found that only a tiny fraction (0.012%) was absorbed. The actual amount of aluminum absorbed would be much less than what would be expected to be absorbed from the foods a person eats during the same time.

It also doesn’t seem that breast cancer tissue contains more aluminum than normal breast tissue. A study that looked at women with breast cancer found no real difference in the concentration of aluminum between the cancer and the surrounding normal tissue.

At this point, no clear link has been made between antiperspirants containing aluminum and breast cancer.

How did the rumor about antiperspirants get started and spread?

We don’t know who started this rumor. Most people who forwarded the email did so with good intentions. We do know that this rumor has been posted on some websites that sell deodorants that are not antiperspirants, so some people might benefit financially from spread of this misinformation.

How can I learn more about breast cancer risk factors and ways to find breast cancer early, when treatment works best?

You can also talk to your doctor, nurse, or other health care providers. The American Cancer Society has information about all aspects of breast cancer, from causes and prevention, to diagnosis and treatment. Contact us at 1-800-227-2345 or visit our website, www.cancer.org.

**Direct DNA interaction and genotoxic impact of three metals: Cadmium, nickel and aluminum.**


**Abstract**

This study simultaneously investigates direct DNA interaction and genotoxic impact of three typical metals: aluminum, cadmium and nickel, which the high concentration in soils and which the industries use, result in a daily significant exposure to humans. The three of them are suspected to be involved in carcinogenesis which implies genomic lesions. We propose to first study their genotoxic impact in vivo on primary normal human dermal fibroblast (NHDF) cells with comet assay at pH 7 to measure DNA breaks occurrence. Then, to characterize the metal/DNA interaction by isothermal titration calorimetry (ITC).

Comet assay shows that Cd and Ni are genotoxic, they are responsible for DNA breaks starting from 1.10−4 mol.L−1 and 5.10−2 mol.L−1, respectively whereas Al has no effect (on DNA at pH7) as studied by ITC at pH 7. Cd and Ni present an electrostatic interaction with DNA phosphate groups. At high Cd concentration, a DNA condensation is observed by contrast. Al has no interaction with DNA phosphate groups, but at pH 4 the electrostatic interaction is strong and the same DNA condensation phenomenon is observed. Metal genotoxic effect seems linked to the electrostatic interaction on DNA phosphate groups. Genotoxic power evolves in parallel to DNA phosphate interaction strength as Cd > Ni > Al. If this study shows that metals ions do not directly break DNA, this binding could be a preferential site for damage due to reactive oxygen species.
Appendix B: Glossary

Valence electrons: An electron of an atom, located in the outermost shell (valence shell) of the atom, that can be transferred to or shared with another atom.

Ionization Energy: The ionization energy (IE) or ionization potential is the energy needed to remove an electron from an atom.

Electron shell/orbital: An electron shell is the outside part of an atom around the atomic nucleus. It is where the electrons are.

Electrostatic force: also known as the Coulomb force or Coulomb interaction. It's the attractive or repulsive force between two electrically charged objects.

Cation: Any positively charged atom or group of atoms (opposed to anion).

Anion: Any negatively charged atom or group of atoms (opposed to cation)

Ion: An atom or molecule with a net electric charge due to the loss or gain of one or more electrons.