

**December 2016/January 2017 Teacher's Guide for**

***Clearing the Way to Acne-Free Days***

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# About the Guide

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Articles from past issues of *ChemMatters* and related Teacher’s Guides can be accessed from a DVD that is available from the American Chemical Society for $42. The DVD contains the entire 30-year publication of *ChemMatters* issues, from February 1983 to April 2013, along with all the related Teacher’s Guides since they were first created with the February 1990 issue of *ChemMatters*.

The DVD also includes Article, Title, and Keyword Indexes that cover all issues from February 1983 to April 2013. A search function (similar to a Google search of keywords) is also available on the DVD.

The *ChemMatters* DVD can be purchased by calling 1-800-227-5558. Purchase information can also be found online at <http://tinyurl.com/o37s9x2>.

# Student Questions

**Clearing the Way to Acne-Free Days**

* 1. What percentage of teenagers experience episodes of acne?
  2. Describe the conditions that are required for *Propionibacterium acnes* to grow and spread.
  3. What is sebum and how does it keep water both inside and outside the skin?
  4. Explain the difference between the formation of a whitehead and the formation of a blackhead.
  5. How do androgen levels affect acne breakouts?
  6. What is IGF-1?
  7. Explain the relationship between diet, insulin, IGF-1, androgens, and acne.
  8. How does benzoyl peroxide work in treating acne?
  9. Salicylic acid is another compound that is used to treat acne. What does salicylic acid do in the treatment of acne?
  10. Why must doctors be cautious about prescribing antibiotics to treat acne?
  11. Retinoids can be prescribed for moderate to severe acne that doesn’t respond to other treatments. How is the action of retinoids different from that of benzoyl peroxide and salicylic acid?
  12. Why would spironolactone be prescribed to treat acne?

# Answers to Student Questions

**(taken from the article)**

**Clearing the Way to Acne-Free Days**

* + 1. **What percentage of teenagers experience episodes of acne?**

*80% to 90% of teenagers experience episodes of acne.*

* + 1. **Describe the conditions that are required for *Propionibacterium acnes* to grow and spread.**

Propionibacterium acnes *require an environment that has an excess of oil and an overgrowth of skin cells.*

* + 1. **What is sebum and how does it keep water both inside and outside the skin?**

*Sebum is the oil that is produced in the sebaceous glands located inside hair follicles. Because sebum is composed of fats which do not dissolve in water, sebum can keep water outside the skin from getting in and the water underneath the sebum from getting out.*

* + 1. **Explain the difference between the formation of a whitehead and the formation of a blackhead.**

*Dead skin cells and oils collect in the opening to the hair follicle producing a bump. If the skin over the bump stays closed, the bump is called a whitehead. When the skin over the bump opens, exposure to the air causes it to look black due to oxidation, and a blackhead forms.*

* + 1. **How do androgen levels affect acne breakouts?**

*Androgen levels affect acne breakouts by stimulating the sebaceous gland cells to produce more sebum. An increase in sebum supports the growth and spread of the bacteria that can cause acne. Therefore, higher levels of androgens encourage bigger breakouts.*

* + 1. **What is IGF-1?**

*IGF-1 stands for insulin-like growth factor-1. It is a growth hormone that stimulates sebum-producing cells to increase sebum production. IGF-1 also makes skin cells grow faster and stimulates the production of more androgens.*

* + 1. **Explain the relationship between diet, insulin, IGF-1, androgens, and acne.**

*Anytime insulin increases in response to eating carbohydrates, IGF-1 increases. This causes an increase in sebum production, increased cell growth, and the production of more androgens. These three factors provide the fuel for acne breakouts. Therefore, a diet that requires less insulin could be considered to help curb acne breakouts.*

* + 1. **How does benzoyl peroxide work in treating acne?**

*Benzoyl peroxide is a lipophilic antimicrobial agent that kills* P. acnes *by penetrating deep into the pimples and preventing the organism from reproducing.*

* + 1. **Salicylic acid is another compound that is used to treat acne. What does salicylic acid do in the treatment of acne?**

*Salicylic acid helps in the treatment of acne by loosening and removing (exfoliating) the outermost layer of skin and unclogging hair follicles.*

* + 1. **Why must doctors be cautious about prescribing antibiotics to treat acne?**

*Doctors must be cautious about prescribing antibiotics because the bacteria may become resistant to the drugs, making them useless.*

* + 1. **Retinoids can be prescribed for moderate to severe acne that doesn’t respond to other treatments. How is the action of retinoids different from that of benzoyl peroxide and salicylic acid?**

*Retinoids are similar to salicylic acid in that they help exfoliate the skin cells but they also have an anti-inflammatory effect. Retinoids do not kill the bacteria like benzoyl peroxide does.*

* + 1. **Why would spironolactone be prescribed to treat acne?**

*Spironolactone is used to treat acne due to its ability to block “the influence of androgens on the sebaceous glands, reducing oil production and improving acne.”*

# Anticipation Guide

Anticipation guides help engage students by activating prior knowledge and stimulating student interest before reading. If class time permits, discuss students’ responses to each statement before reading each article. As they read, students should look for evidence supporting or refuting their initial responses.

**Directions:**  *Before reading*, in the first column, write “A” or “D,” indicating your agreement or disagreement with each statement. As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Almost everyone’s skin contains acne-causing bacteria. |
|  |  | 1. The bacteria that cause acne are anaerobic. |
|  |  | 1. Acne-causing bacteria require an excess of oil. |
|  |  | 1. Sebum is an oil that controls the amount of water entering and leaving our skin. |
|  |  | 1. A blackhead is caused when a pimple is not exposed to air. |
|  |  | 1. Higher levels of sex hormones (androgens) are related to fewer acne breakouts. |
|  |  | 1. There is a definite link between eating chocolate and increased acne breakouts. |
|  |  | 1. Benzoyl peroxide and salicylic acid, both used to treat acne, contain only hydrogen, carbon, and oxygen. |
|  |  | 1. All prescription medications for acne work the same way. |
|  |  | 1. Eating fewer processed carbohydrates may help lower acne development. |

# Reading Strategies

These graphic organizers are provided to help students locate and analyze information from the articles. Student understanding will be enhanced when they explore and evaluate the information themselves, with input from the teacher if students are struggling. Encourage students to use their own words and avoid copying entire sentences from the articles. The use of bullets helps them do this. If you use these reading and writing strategies to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

***Teaching Strategies:***

1. Links to **Common Core Standards for Reading**:

* ELA-Literacy.RST.9-10.1:Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
* ELA-Literacy.RST.9-10.5: Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
* ELA-Literacy.RST.11-12.1:Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
* ELA-Literacy.RST.11-12.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

1. Links to **Common Core Standards for Writing**:

* ELA-Literacy.WHST.9-10.2F: Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
* ELA-Literacy.WHST.11-12.1E: Provide a concluding statement or section that follows from or supports the argument presented.

1. **Vocabulary** and **concepts** that are reinforced in this issue:

* Chemical reactions
* Redox reactions
* Solubility
* Equilibrium
* Le Chatelier’s Principle
* Vitrification
* Hydrogen bonding
* Molecular structures
* Personal and community health
* Rare-earth metals
* Endothermic and exothermic reactions
* Conservation of energy

1. Some of the articles in this issue provide opportunities for students to consider how understanding chemistry can help them make informed choices as citizens and consumers.
2. Engagement suggestions:

* Prior to giving students the article “The Flint Water Crisis: What’s Really Going On?” use a Think-Pair-Share to find out what students already know about the Flint water crisis. During reading, students will reflect on what they thought and how the evidence from the article supports their original ideas (or not).
* Avoid telling students the title of the article, “No Smartphones, No TV, No Computers: Life without Rare-Earth Metals.” Instead, ask them where in their everyday lives they would find rare-earth metals and why they are used. After a short class discussion, give them the article to read.

1. To help students engage with the text, ask students which article **engaged** them most and why, or what **questions** they still have about the articles. The Background Information in the *ChemMatters* Teacher’s Guide has suggestions for further research and activities.

***Directions*:** As you read the article, complete the graphic organizer below to describe the causes of acne breakouts and possible solutions to an acne problem. Use bullets for each idea.

|  |  |  |
| --- | --- | --- |
|  | **Description** | **Chemicals involved** |
| **Cause(s) of acne** |  |  |
| **Effect of diet on acne** |  |  |
| **Over-the counter medication for acne** |  |  |
| **Prescription medication for acne** |  |  |

**Summary:** On the back of this paper, write a short (3-5 sentence) email describing what you learned to a friend who has problems with acne breakouts.

# Connections to Chemistry Concepts

**(for correlation to course curriculum)**

1. **Polar and nonpolar solubility**—Sebum, being an oil, keeps water both inside and outside the skin. Also, benzoyl peroxide and salicylic acid are lipophilic, as they can dissolve in oil. The solubility of the different drugs is a factor in their ability to be used to treat acne.
2. **Oxidation reduction**—When the collection of dead skin cells and sebum is exposed to air the mixture is oxidized, resulting in a change in color to black.
3. **Biochemistry**—The activity of the androgen hormones and insulin play a part in acne breakouts.
4. **Biochemistry**—Diets composed of complex carbohydrates and other low-glycemic foods help manage acne breakouts.
5. **Chemical compounds and formulas**—Compounds such as retinoids, salicylic acid, benzoyl peroxide, and spironolactone are mentioned and their structural formulas illustrated. This could tie into the unit on chemical compounds and nomenclature.
6. **Acids and bases**—Salicylic acid and some other organic acids such as azelaic acid are used to treat acne. The pH of the skin is a factor in controlling acne. Higher pH levels will favor *P. acnes* growth.
7. **Organic chemistry**—α- and β-hydroxyacids can be used as examples in organic nomenclature.

# Possible Student Misconceptions

**(to aid teacher in addressing misconceptions)**

1. **“Acne is caused by clogged pores.”** *This is primarily a technical misunderstanding of the structure of the skin. Not all openings in the skin are pores. Pores are the opening to sweat glands. Acne is caused by clogged hair follicles.*
2. **“Acne is caused by eating chocolate, chips, and drinking pop.”** *Some research was done specifically with chocolate, but it was never proven to have an effect on acne. The research concerning diet and acne has been difficult to design and control. What has recently been shown to have some correlation is the overall diet. A low glycemic diet has been shown to have a positive effect in acne treatment.*
3. **“Dirty skin causes acne.”** *Students who feel that dirty skin causes acne may be prone to wash or scrub their skin often thinking that this will clear up the acne. Actually, vigorous scrubbing may irritate the skin and make acne worse. Students trying to control acne should gently wash the affected areas only once or twice daily and after sweating, with a mild, nondrying cleanser. The bacteria that is responsible for acne resides deep within the sebaceous glands and cannot be washed off.*
4. **“Only teenagers get acne.”** *Acne can occur at all times of life, though it is most common among teens. Neonatal acne is common among most newborns and occurs in the first four weeks of life. Sebum production is increased due to stimulation by maternal or neonatal androgens. After six months, sebum production decreases. Adults may also have trouble with acne as well.*
5. **“Acne will eventually go away on its own.”** *While acne will usually subside as a person gets older, not treating acne can lead to scarring. Also, if acne is not treated, it could become worse and lead to greater scarring.*
6. **“Sweating helps acne by getting the toxins out.”** *Sweating actually makes acne worse.*

*Sweating from a hot and humid climate or from exercising and working your body hard can cause a type of acne called****pityrosporum folliculitis.*** *Pityrosporum folliculitis is a tough and stubborn form of acne to treat because some people’s skin is just prone to it.****What happens is that a normal skin yeast that grows on most everybody's skin******(Malassezia)******starts to overgrow in the pores.*** *For some people, their pores don’t fight the yeast very well and so it easily takes off. A little heat and sweat and -*poof*, the yeast ‘parties on’, causing pimples.*

(<https://www.drbaileyskincare.com/info/blog/can-sweat-cause-pimples-and-acne>)

1. **“Sunlight can help get rid of acne.”** *Tanning does help hide acne, but the UV rays ultimately dry the skin and can make the skin condition worse. Also, tanning causes premature aging, not to mention, skin cancer.*

# Anticipating Student Questions

**(answers to questions students might ask in class)**

1. **“Do doctors prescribe spironolactone to males? What would happen if they did?”** *Spironolactone is usually not prescribed for males because of its anti-androgen effects on male hormones. Males who take spironolactone start losing muscle mass and start developing feminine characteristics such as breasts with developed nipples, less body hair, and shrinking of the testes (hypogonadism). Due to these effects, spironolactone is used to aid in the feminization of transgender men, as it depresses the testosterone level to that of a female.*
2. **“What are low-glycemic foods?”**

*The Mork article concludes by recommending that students eat more low-glycemic foods. The low-glycemic foods are those foods that are less likely to cause large increases in glucose levels. They provide a steadier rise in blood sugar and generally have more fiber, which makes you feel full. Examples of low-glycemic index foods are oatmeal, peanuts, peas, carrots, beans, hummus, skim milk, and most fruits. High-glycemic foods, such as white bread, cookies, crackers, white potatoes, white rice, pretzels, and sugar-sweetened beverages should be avoided. More information on low-glycemic diets can be found at the Mayo Clinic Web site. (*[*www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/glycemic-index-diet/art-20048478*](http://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/glycemic-index-diet/art-20048478)*)*

1. **“What would happen if I used benzoyl peroxide and salicylic acid together?”**

*Benzoyl peroxide has antibiotic properties and salicylic acid has exfoliating and anti-inflammatory properties. The two compounds actually complement each other in treating the causes of acne. Some acne treatments have now combined the two compounds in a single acne treatment gel or solution. Students could examine the ingredients of the acne treatments at the store (or at home) to report back which ones carry both salicylic acid and benzoyl peroxide.*

# Activities

**Labs and Demos**

1. **Lab project to test the effectiveness of different acne medications:** Which acne medication can really “Zap that Zit”? This is a science project requiring 2–4 weeks. It involves growing *E. coli* and testing various acne products on it. The procedure is provided, complete with a list of required materials. Agar plates and antibiotic discs are required for this lab. This is suggested as a science fair project but it could be adapted to classroom use. ([www.sciencebuddies.org/science-fair-projects/project\_ideas/MicroBio\_p019.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/MicroBio_p019.shtml))
2. **Synthesis of Aspirin Lab:** If you discuss the function and structure of salicylic acid you could complement this with a synthesis of aspirin lab. This would be even more appropriate if you are studying a unit on organic chemistry at the time. A procedure for the lab experiment can be found here: <http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/045/Aspirin.pdf>.

A separate YouTube video of the experiment can be found here: <https://www.youtube.com/watch?v=Y4NMpO1xI8U>.

1. **Polar and Nonpolar Solubility Lab:** You can find a lab that explores the solubility difference in polar and nonpolar solutes and solvents in *Chemistry in the Community* 4th, 5th, and 6th editions. In the 4th and 5th editions it is in Unit 1, section C, and in the 6th edition it is in Unit 4, section B. Given a variety of different solutes, students discover the patterns of polar and nonpolar solubility. This relates to the solubility of some medications in the sebum in the skin as well as helps demonstrate skin’s properties. The lab as it appears in the 5th edition student’s book is here: <https://books.google.com/books?id=vWa4V3mhZ0sC&pg=PA72&lpg=PA72&dq=chemistry+in+the+community+polar+and+nonpolar+lab&source=bl&ots=1PJB9o3cJh&sig=qzk5QaSKMdaUOxfHP4tocRTWWYM&hl=en&sa=X&ved=0ahUKEwjSk4_ewP7PAhULs1QKHRnwCOQQ6AEIMjAE#v=onepage&q=chemistry%20in%20the%20community%20polar%20and%20nonpolar%20lab&f=false>.

**Simulations**

1. **Progression of skin cells through the different layers:** This animation shows the movement of the skin cells from the basal layer to the stratum corneum where they are shed. (<http://www.abpischools.org.uk/topic/skin-structure-and-function/2/1>)
2. **Skin’s response to change in temperature:** Students, or the teacher, using a smartboard, can adjust the temperature from hot to cold and watch the animated skin adjust. (<http://www.abpischools.org.uk/topic/skin-structure-and-function/3/1>)

**Media**

1. **The chemistry of acne:** This is a short (3:58) animation made for *ChemMatters* that explains acne and the action of benzoyl peroxide on *P. acnes*. You definitely want to show this, especially for the chemistry!

(<https://www.tes.com/teaching-resource/chemmatters-the-chemistry-of-acne-6265815>)

1. **“How to Get Rid of Pimples”:** This video (2:38) is a fun introduction to home remedies for treating a pimple. A high school girl is the principle actress. After showing the video it would be interesting to assign the home remedies to students to research and report back what makes them work. Common household items such as oatmeal, honey, lemon juice, toothpaste, and aspirins are used to treat the pimple in the video. (<http://www.sciencekids.co.nz/videos/howto/acneremedies.html>)
2. **PowerPoint presentation on skin, acne, and more:** This is an extensive PowerPoint presentation about skin. Lots of useful information is presented. The slides related specifically to acne begin at slide152, with the sebaceous glands as a precursor to the acne vulgaris presentation, beginning at slide 158. If you teach anatomy and physiology, the entire slide show could be used. There are excellent slides before 152 containing diagrams of cross sections of skin that could be used when you discuss the Mork *ChemMatters* article.

(<http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCUQFjAA&url=http%3A%2F%2Fdrmagrann.com%2FAnatomy%2F4%2520skin.ppt&ei=_PfvUvSzCdSssAT4u4HYCQ&usg=AFQjCNHCKPXrUx0GdykN8Bc7CnvdGWuavg&sig2=1QNzdckrNxfvp_ZWaCT7ng&bvm=bv.60444564,d.cWc>)

1. **Kids video, teaching about acne:** If your school or district has a subscription to Brain Pop, there is a video and lesson about acne that can be found here: <https://educators.brainpop.com/search/?q=acne>.

**Lessons and Lesson Plans**

1. **Computer tutorial about skin and acne:** If you have access to classroom computers, this tutorial about skin has good information accompanied by simulations, questions to answer as students work through the tutorial, and a final assessment activity at the end. (<http://www.abpischools.org.uk/topic/skin-structure-and-function/>)
2. **Skin knowledge lesson plans:** This is a library of lesson plans developed by the American Academy of Dermatology. While most of these are for younger students (ages 11–13), some can be easily adapted for older students. The game “2 Myths and a Truth” in lesson three would be very good to assess student misconceptions and prompt discussion about acne. ([www.aad.org/public/kids/good-skin-knowledge-lesson-plans-and-activities](http://www.aad.org/public/kids/good-skin-knowledge-lesson-plans-and-activities))
3. **“The Skin You’re In” teaching guide:** There are three short lessons about skin in this packet. The lesson topics are acne, sun protection for skin, and dermatitis. The acne lesson involves reading a story and answering questions provided on a worksheet. ([www.americanskin.org/education/the\_skin\_youre\_in/pdf/teaching\_guide.pdf](http://www.americanskin.org/education/the_skin_youre_in/pdf/teaching_guide.pdf) )

**Projects and Extension Activities**

1. **Acne product comparison and market research activity:** Students could go to a local drug store and examine the various over-the-counter products designed to treat acne. The names under which the various products are sold can be somewhat confusing, and at times perhaps misleading. Words and phrases like “maximum,” “maximum strength”, and “ultra” often appear, but do not seem to have any specific meaning. For example, one product from the same company is labeled “ultra,” and contains 10% salicylic acid, while another product is labeled “maximum strength,” but still only contains the same 10% formulation. An interesting and educational project might be to examine the labels on several over-the-counter medications and then compare the actual ingredients to the suggestive words on the label. Products could be compared for similarity in composition. Students could look to see which products contain the new formulation of a benzoyl peroxide and salicylic acid mixture. The project could also involve comparing the cost per given amount of active ingredient for various brand name products and non-brand name products.
2. **Design an acne research study**: If you are teaching experimental design with your students, acne research is loaded with questions that are demanding better studies in order to supply physicians the proof necessary to make good decisions, with respect to patient treatment. Students could choose a question and, using good experimental design, formulate an experiment or study that would help answer that question.

# References

**(non-Web-based information sources)**

**The references below can be found on the *ChemMatters* 30-year DVD, which includes all articles   
published from the magazine’s inception in October 1983 through April 2013; all available Teacher’s Guides, beginning February 1990; and 12 *ChemMatters* videos. The DVD is available from the American Chemical Society for $42 (or $135 for a site/school license) at this site:** [**http://ww.acs.org/chemmatters**](http://www.acs.org/chemmatters)**. Click on the “Teacher’s Guide” tab to the left, directly under the “*ChemMatters Online"* logo and, on the new page, click on “Get the past 30 Years of *ChemMatters* on DVD!” (the icon on the right of the screen).**

**Selected articles and the complete set of   
Teacher’s Guides for all issues from the past three   
years are available free online at the same Web site, above. Click on the “Issues” tab just below the logo, *“ChemMatters Online”*.**



***30* Years of *ChemMatters !***

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Author Smith discusses the function of the skin, why we need moisturizers and cleansers, cleansing creams, soap and cold cream, as well as the simple causes of acne. The action of benzoyl peroxide is explained in terms of free radical reactions. (Smith, W. Skin Deep. *ChemMatters*, 1987, *5* (4), pp 4–7)

Author Baxter spends little time discussing the cause of zits, and she gets right to the cures, including recent developments with vitamin A and lasers. She mentions Accutane which was the formula for isotretinoin manufactured by Roche. Roche no longer markets this drug. (Baxter, R. Battling Zits! *ChemMatters*, 2005, *23* (2), pp 4–6)

The Teacher’s Guide for the April 2005 *ChemMatters* article above contains additional information about acne treatments Accutane and the alpha- and beta-hydroxy acids. There is also a discussion of the term “like dissolves like” in terms of entropy and enthalpy.

Soaps, skin cleansers, body odor, bad breath, acne and flatulence are the subjects of this article. (Rohrig B. Demystifying Gross Stuff. *ChemMatters,* 2011, *29* (3) pp 12–14)

The evolution of skin color and its respective chemistry is discussed in this issue of *ChemMatters*. (Harper, K. Skin Color: A Question of Chemistry. *ChemMatters*, 2014, *32* (2), pp 12–14)

The Teacher’s Guide to the April 2014 *ChemMatters* issue above contains more information on the anatomy of skin and its functions. The guide also contains a discussion of recent developments in artificial skin.

# Web Sites for Additional Information

**(Web-based information sources)**

**Skin**

For a good, labeled cross section of the skin that could be projected on a smart or Promethean board, use this Wikipedia drawing: <https://en.wikipedia.org/wiki/Human_skin#/media/File:Skin.png>.

**Acne**

Photographs of the various stages of acne can be found at the MedlinePlus Web site. These could be made into power point slide or projected as they are. (<https://medlineplus.gov/ency/article/003236.htm>)

Medline’s home page for acne includes an index for the information contained in this teacher’s guide, ranging from basic description to treatments and research. There is lots of information in Spanish, if you have students who need lessons in Spanish. (<http://medlineplus.gov/acne.html>)

In this article published by the American Academy of Dermatology the information is presented in easy to read bullet points. Some statistical information concerning incidence of acne and cost is located here, also. (<https://www.aad.org/media/stats/conditions>)

Lots of basic information about acne can be found at this site. An easy-to-access menu helps locate the different topics. There are translation options at the top of the page, which make reading possible in several different languages. (<http://emedicine.medscape.com/article/1069804-overview>)

This site contains information about Propionibacterium species and the infections they cause: <http://emedicine.medscape.com/article/226337-overview>.

**Acne treatment**

The *Journal of Clinical and Aesthetic Dermatology* is the source of the article found at this link. It contains extensive information about over-the-counter (OTC) treatments for acne. A comparison of the effectiveness of benzoyl peroxide, compared with antibiotics, is presented with nice graphs. This would be a good site to use to get some discussion going on designing an experiment that answers some of the questions about the performance of many of the products discussed. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3366450/>)

What’s new and what’s still true is the theme of this 2015 article about the current status of many acne treatments. The segment on what’s new is very informative. (<http://www.scopemed.org/fulltextpdf.php?mno=165508>)

More information on the chemistry of salicylic acid and how it works in acne treatments can be found at this Web site: <http://www.kaviskin.com/info/salicylicacid.html>.

Descriptions of several treatment options for acne are located at this Web site: <http://emedicine.medscape.com/article/1069804-treatment>.

Considerable information on how salicylic acid works, compared to benzoyl peroxide, can be found here. The benzoyl peroxide information and a guide for choosing acne treatments are on other tabs at this site. (<https://www.verywell.com/salicylic-acid-15632>)

A comprehensive table of acne treatments can be found here. The amount of information is staggering, as each entry is a link to the names of the commercial products containing that compound. (<http://www.skinacea.com/acne/acne-treatment-list.html#.WBVdDvorLDc>)

“Evidence based update on the management of acne” is the title of this report. Treatment of acne is presented through several case studies, each for acne in a different stage. (<http://ep.bmj.com/content/90/4/ep98.full#content-block>)

**Diet and acne**

An article about recent acne research exploring the use of probiotics to enhance the treatment of acne can be found here: <https://www.aad.org/media/news-releases/could-probiotics-be-the-next-big-thing-in-acne-and-rosacea-treatments>.

The relationship between acne and diet is the topic of this extensive review of the literature for recent research studies. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2836431/>)

The research paper “A low-glycemic-load diet improves symptoms in acne vulgaris patients” can be found here as it appears in the *American Journal of Clinical Nutrition*. This is a landmark study. There are charts and pictures that have links to PowerPoint slides for use in presentations. This article would be good to use in a discussion on experimental design. (<http://ajcn.nutrition.org/content/86/1/107.long>)

“High glycemic load diet, milk and ice cream consumption are related to acne vulgaris in Malaysian young adults: a case control study” is the name of the research report that can be found at this site:

<https://bmcdermatol.biomedcentral.com/articles/10.1186/1471-5945-12-13>.

The history of the debate about chocolate’s effect on acne can be found at this Web site, as well as the research into several other diet claims concerning acne. (<http://www.acne.org/diet.html>)

A low glycemic load diet is discussed on this web site: <http://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/glycemic-index-diet/art-20048478>.

**Retinoids**

Wikipedia has a very good section on the history of isotretinoin. This highly restricted drug has had many confrontations with the FDA and legislature in order to remain available for doctors to prescribe it. (<https://en.wikipedia.org/wiki/Isotretinoin>)

For a list of commercial retinoid creams, listed from mildest to strongest, and the pros and cons of each, visit the following web site: <http://www.skinacea.com/retinoids/types-of-retinoids.html#.WBVFcforLDc>.

A discussion of natural retinoids versus synthetic retinoids is covered in depth here: <http://www.skinacea.com/retinoids/natural-vs-synthetic-retinoids.html#WBUygoWcGWw>.

Downloads from the FDA for the iPLEDGE program for those who want to take isotretinoin can be found on this site. The brightly colored yellow and black contracts and patient agreements are located further in the packet. This is the most recent document published in 2012. Others on the Web are shorter but are not up to date. (<http://www.fda.gov/downloads/drugs/drugsafety/postmarketdrugsafetyinformationforpatientsandproviders/ucm234639.pdf>)

**Hormone treatments and** **spironolactone**

A recent article reviews patient studies and research that have been reported for spironolactone as it is used for the treatment of acne. The results of several studies are used to support the use of spironolactone. (<http://www.medpagetoday.com/meetingcoverage/aad/53310>)

The scholarly article “Hormonal Treatment of Acne in Women” that occurred in the December 2009 issue of the *Journal of Clinical and Aesthetic Dermatology* provides a thorough explanation of the hormonal pathogenicity of acne. The authors explain the biochemical pathways involved in the production of androgens in the skin. Treatment of acne with oral contraceptives and spironolactone is explained. If you are teaching an upper level chemistry class and are covering a unit on biochemistry, this would be an excellent article to assign as outside reading. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2923944/>)

General information about spironolactone and its formula and that of its derivative can be found here: <https://en.wikipedia.org/wiki/spironolactone>.

**Acne research**

“Strain of acne-causing bacteria found to actually preserve the skin” is the title of the article featured at this medical news site. Reports about a study that compared the *P. acnes* strains found on people with acne to those found on people without acne revealed strains of *P. acnes* on the acne-free participants that were not present on the participants with acne. (<http://www.medicalnewstoday.com/articles/257040.php>)

**Laser treatments**

The results of a study done to compare laser treatments with salicylic acid peels can be found at this Web site. The study treated half of the face of participants with lasers and then applied salicylic acid peels to the entire face for a comparison of the efficacy of laser therapy. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4688384/>)