



**Got Vitamin D?**

*December 2017/January 2018*

<http://www.acs.org/chemmatters>

**Teacher’s Guide**



**Teacher's Guide for**

***Got Vitamin D?***

**December 2017/January 2018**

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# Connections to Chemistry Concepts

|  |  |
| --- | --- |
| **Chemistry Concept** | **Connection to Chemistry Curriculum** |
| **Biochemistry** | The chemistry of vitamin D could be included in a unit on biochemistry when vitamins are discussed.  |
| **Chemical reactions** | The conversion of 7- dehydrocholesterol to vitamin D3 can be used as an example of a photochemical (light-initiated) reaction during lessons on chemical reactions. If teaching organic reactions, it can be used as an example of an organic fission reaction.  |
| **Organic chemistry** | The comparison of the structures of vitamins D2 and D3 can be used when talking about organic structures and substitution groups like the methyl groups on the compound. The hydroxyl groups on the compounds are examples of a functional group the students could identify.  |

# Teaching Strategies and Tools

## Standards

* 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, and 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.

* 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.

* In addition to the writing standards above, consider asking students to debate issues addressed in some of the articles. Standards addressed:

**ELA-Literacy.WHST.9-10.1B.** Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and **counterclaims** in a discipline-appropriate form and in a manner that anticipates the audience’s knowledge level and concerns.

**ELA-Literacy.WHST.11-12.1.A.** Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

* Links to **Next Generation Science Standards**:

**HS-LS1-4:** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

* **Disciplinary Core Ideas:**
	+ LS1.A: Structure and Function
* **Crosscutting Concepts:**
* Cause and effect: Mechanism and explanation
* Systems and system models
* Structure and function
* **Science and Engineering Practices:**
* Constructing explanations and designing solutions
* Obtaining, evaluating, and communicating information
* **Nature of Science:**
* Scientific knowledge assumes an order and consistency in natural systems

## VocabularyVocabulary and concepts that are reinforced in the December 2017/January 2018 issue:

* Metric units
* Structural Formulas
* Fermentation
* pH
* Electrochemistry
* Oxidation & Reduction
* Amines
* Allotropes
* Physical properties
* London dispersion forces

# Reading Supports for Students

The pages that follow include reading supports in the form of an Anticipation Guide, a Graphic Organizer, and Student Reading Comprehension Questions. These resources are provided to help students as they prepare to read and in locating and analyzing information from the article.

The borders on these pages distinguish them from the rest of the pages in this Teacher’s Guide—they have been formatted for ease of photocopying for student use.

* **Anticipation Guide (p. 8):** The Anticipation Guide helps to 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.
* **Graphic Organizer (p. 9):** The Graphic Organizer is provided to help students locate and analyze information from the article. 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 article. The use of bullets helps them do this.

If you use the aforementioned organizers 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 |

* **Student Reading Comprehension Questions (p. 10):** The Student Reading Comprehension Questions are designed: to encourage students to read the article (and graphics) for comprehension and attention to detail; to provide the teacher with a mechanism for assessing how well students understand the article and/or whether they have read the assignment; and, possibly, to help direct follow-up, in-class discussion, or additional, deeper assignments.
* Most of the articles in this issue provide opportunities for students to consider how understanding chemistry can help them make decisions in their personal lives.
* Consider asking students to read “Open for Discussion: Are Vitamin Supplements Necessary?” on page 4 to extend the information in “Got Vitamin D?” on pages 5-6.
* 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.
* You might also ask them how information in the articles might affect their health and/or consumer choices. Also ask them if they have questions about some of the issues discussed in the articles.

“Got Vitamin D?” *ChemMatters*, December 2017/January 2018 Issue

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Anticipation Guide

“A Close-up Look at the Quality of Indoor Air” (*ChemMatters*, April/May 2016 Issue)

**Directions: *Before reading the article*,** 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. Our bodies can produce both vitamin D2 and vitamin D3 when we are in sunlight.
 |
|  |  | 1. Vitamin D produced by our bodies is derived from cholesterol.
 |
|  |  | 1. Fatty fish are good sources of Vitamin D.
 |
|  |  | 1. The FDA (Food and Drug Administration) regulates foods that are fortified with vitamin D.
 |
|  |  | 1. In the U. S., vitamin D fortification of infant formula is required.
 |
|  |  | 1. Less than 25% of the adult population takes supplemental vitamins.
 |
|  |  | 1. Vitamin D helps produce strong bones even if we do not eat enough calcium.
 |
|  |  | 1. People over 70 years old do not need as much vitamin D as younger people.
 |
|  |  | 1. Research suggests that daily sun exposure is required to produce adequate levels of vitamin D.
 |
|  |  | 1. It is possible to overdose on vitamin D from supplements.
 |

## Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

“Got Vitamin D?” *ChemMatters*, December 2017/January 2018 Issue

**Directions**: ***As you read***, complete the graphic organizer below to describe where we obtain vitamin D and why we need it.

|  |  |
| --- | --- |
| **Vitamin D** |  |
| **Sources**  |  |
| **How our bones use it** |  |
| **Effects of overdose** |  |

**Summary:** On the back of this paper, use information from the article to write a tweet (280 characters or less) about vitamin D.

## Student Reading Comprehension Questions

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name

**Directions**: Use the article to answer the questions below.

* 1. When does the body produce vitamin D?
	2. What are the best dietary sources of vitamins D2 and D3?
	3. Give several examples of foods that are vitamin D fortified.
	4. For what food does the U.S. Food and Drug Administration mandate the addition of
	vitamin D?
	5. What disease is caused by a vitamin D deficiency?
	6. What is the composition of the outer layers of bones?

**Student Reading Comprehension Questions, cont.**

“Got Vitamin D?” *ChemMatters*, December 2017/January 2018 Issue

* 1. How does vitamin D affect the supply of calcium ions (Ca2+) and phosphate ions (PO43–) in the blood?
	2. What causes the bones to become soft, and why is this a problem?
	3. How much sun exposure is recommended to produce adequate levels of vitamin D?
	4. What are the symptoms of vitamin D toxicity or hypervitaminosis D?
	5. What level of vitamin D causes toxicity?
	6. What is the recommended daily dose of vitamin D for the average high school student?

## Answers to Student Reading Comprehension Questions

1. **When does the body produce vitamin D?**

*The body only produces vitamin D when the skin is exposed to ultra-violet (UV) light from the sun.*

1. **What are the best dietary sources of (a) vitamin D2, and (b) vitamin D3?**
	1. *The dietary sources of vitamin D2 are vegetables such as mushrooms and alfalfa.*
	2. *The dietary sources of vitamin D3 are the flesh of fatty fish such as salmon, tuna, and mackerel as well as fish liver oils.*
2. **Give at least four examples of foods that are vitamin D fortified.**

*Some examples of vitamin D fortified foods are*

1. *milk*
2. *milk substitutes*
3. *breakfast cereals*
4. *pastas*
5. *yogurts*
6. *some cheeses*
7. *some juices*
8. *margarine spreads.*
9. **For what food does the U.S. Food and Drug Administration mandate the addition of vitamin D?**

*In the U.S., the Food and Drug Administration mandates that infant formula is fortified with vitamin D due to the importance of vitamin D in young children.*

1. **What disease is caused by a vitamin D deficiency?**

*Vitamin D deficiency can result in a disease called rickets, which causes bones to be too soft.*

1. **What is the composition of the outer layers of bones?**

*The outer layers of bones are composed of collagen and hydroxyapatite, a calcium phosphate salt [Ca10(PO4)6(OH)2].*

1. **How does vitamin D affect the supply of calcium ions (Ca2+) and phosphate ions (PO43–) in the blood?**

*Vitamin D helps increase the levels of calcium and phosphate ions in the blood by aiding in the absorption of these ions in the intestines, as well as increasing the reabsorption of calcium ions in the kidneys.*

1. **What causes the bones to become soft, and why is this a problem?**

*“When vitamin D levels are low, there is relatively little hydroxyapatite compared with collagen, so bones become soft.” Soft bones are pliable, so their shape can change under a person’s weight. Bowed legs may result from vitamin D deficiency. Note that students may also answer that low vitamin D levels reduce the deposit of calcium ions on the outer layer of bones, making them soft, which can be inferred from the diagram at the top of page 6 in the article.*

1. **How much sun exposure is recommended to produce adequate levels of vitamin D?**

*According to the results of research reported in this article, adequate levels of vitamin D can be produced by approximately 5–30 minutes of sun exposure between 10 am and 3 pm at least twice a week*

*.*

1. **What are the symptoms of vitamin D toxicity or hypervitaminosis D?**

*According to the author, “Symptoms of vitamin D toxicity, or hypervitaminosis D, include feeling tired: nausea, vomiting, and dizziness; increased blood pressure; and/or an irregular heartbeat.”*

1. **What level of vitamin D intake has been reported to cause~~s~~ toxicity?**

*Vitamin D toxicity has been shown to result from taking 50,000 international units (IU) a day of vitamin D for several months. This is about 100 times the recommended daily allowance.*

1. **What is the recommended daily vitamin D dose for the average high school student?**

*The recommended daily vitamin D dose for an average high school student is 600 IU, or 15 µg/day.*

# Possible Student Misconceptions

1. **“I’ve always heard that sunlight contains vitamin D.”** *Sunlight is radiant energy and does not contain any chemical compounds. The reaction of 7-dehydrocholesterol in your skin with the sunlight is what produces the vitamin D.*
2. **“I should go without sunscreen in order to get my vitamin D.”** *While it is true that you will produce more vitamin D if you are not wearing sunscreen*, *sunscreen is important in protecting your skin from the damaging effects of the sun. Sunscreen generally does not block all the UV— just 93–98% of it—depending on the sun protection factor (SPF). Plus, this advertised percentage of blockage relies on proper application and usage. Your skin will still be able to produce some vitamin D, even while wearing sunscreen, but probably not an adequate amount—unless you are spending a lot of time outdoors. While some professionals say spending only 15–30 minutes in the sun twice a week without sunscreen is enough to produce an adequate amount of vitamin D, you should be careful about the amount of time you spend in the sun without sunscreen, protective clothing, and sunglasses. Overexposure to the sun causes the skin to toughen and age prematurely and increases the risk of developing skin cancer. Also, overexposure of the eyes to sunlight can cause cataracts to develop. The American Academy of Dermatology’s 2009 “Position Statement on vitamin D” concluded that “there is no scientifically validated, safe threshold level of UV exposure from the sun that allows for maximal vitamin D synthesis without increasing skin cancer risk.”* *The Skin Cancer Foundation recommends that one get vitamin D from diet and supplements rather than to rely on sun exposure, which can lead to skin cancers*. ([*http://www.skincancer.org/healthy-lifestyle/vitamin-d/damage*](http://www.skincancer.org/healthy-lifestyle/vitamin-d/damage)*)*
3. **“I drink lots of milk and get enough vitamin D from my diet, so I don’t need to expose myself to the sun.”** *It is difficult to get enough vitamin D from your diet alone unless you drink six glasses of milk and a couple of helpings of salmon every day. If you are going to rely on diet alone you may want to take cod liver oil or another vitamin D supplement to make sure you are getting enough vitamin D.*
4. **“Vitamin D is similar in function to all the other vitamins.”** *Vitamin D is different from all the other vitamins, both in structure and in function. Vitamin D is the only vitamin that can be synthesized by the body. All the others can only be acquired by diet. Many vitamins like the B vitamins are cofactors in enzymatic reactions while some like vitamins C and E act as antioxidants. Vitamin D is a unique vitamin in that it is really a prohormone. By itself it is inactive and requires the addition of two hydroxyl groups to become functional. The first hydroxyl group is added in the liver while the second hydroxyl group is added in the kidney. The active form of vitamin D is a steroid that functions in the endocrine system. Active vitamin D binds to a carrier protein, where it is transported throughout the body. It is responsible for absorption of calcium and phosphate ions in the intestines as well as the retention of calcium by the kidneys. It functions intracellularly in the transcription of DNA to activate or suppress many genes. We are just beginning to understand the multiple functions of this prohormone.*

# Anticipating Student Questions

1. **“Does vitamin D2 behave the same way as vitamin D3 in the body?”** *Vitamin D2 affects the same mechanisms for calcium and phosphate retention as vitamin D3 so, in this respect, they behave functionally the same. Vitamin D3 is made by the body when the skin is exposed to UVB radiation, and the body is tailored for this form. The plant-produced vitamin D2 does not bind as well to the receptors in human tissues compared to D3, due to a slight difference in molecular structure. Also, D2 has a shorter half-life in the body because D2 is deactivated and rendered irretrievable sooner than D3. Overall, D3 is 300% more effective than D2.*
2. **“If I can’t be outside between 10 am and 3 pm, can I get enough sunlight during the other hours of the day to produce sufficient vitamin D?”** *During the recommended hours, the percentage of radiation that is attributed to UVB is 5%. Times outside this window have only 1% UVB radiation. UVA makes up the balance of the UV radiation to which you are exposed. It would take much longer to produce the same amount of vitamin D3 that can be produced in 15–20 minutes during these peak hours of maximum sunlight. The average person produces 10,000 IU of vitamin D3 in 15–20 minutes during these times.*

“*Regarding the amount of vitamin D production in human skin, it depends on several variables including environmental factors such as geographic* latitude*,* season*, time* of day*,* weather conditions *(cloudiness), amount of* air pollution *and* surface reflection *which can all interfere with the amount of UVB radiation reaching the skin.*” *(*[*http://www.sciencedirect.com/science/article/pii/S209012321400023X*](http://www.sciencedirect.com/science/article/pii/S209012321400023X)*)*

1. **“Do vitamin D levels vary according to climate and geographical location?”** *Vitamin D levels will vary as a function of climate and/or geographical location. Latitudes near the equator receive more sunshine, and populations in those areas generally have higher levels of vitamin D. Northern latitudes receive less sunshine, so populations there have lower vitamin D levels. Altitude also affects the amount of UVB that reaches the earth’s surface. In mountainous regions of high altitude, the atmosphere is thinner and more UVB gets to the earth’s surface. Mountainous populations thus often have higher vitamin D levels. Increased cloud cover or pollution that screens out some of the UVB can be responsible for decreasing vitamin D production in affected populations. However, not all people who live in sunny locations have high vitamin D levels. In Saudi Arabia, which is one of the sunniest spots in the world, 90% of the population is vitamin D deficient. Dress and lifestyle may also play a part here, as Saudi Arabians expose little skin to the sun and spend a good amount of time indoors out of the heat.*
2. **“Do people have seasonal variation in vitamin D levels?”** *People who live in the northern hemisphere and spend a considerable amount of time indoors during the winter months of the year can show a seasonal variation in their vitamin D level if they are not taking vitamin D supplements. The further you get from the equator, the more pronounced the seasonal variation in vitamin D levels becomes. In those areas, vitamin D levels decline during the winter months.*
3. **“Can you get vitamin D toxicity by spending too much time outdoors?”** *Vitamin D toxicity would be difficult to acquire by spending too much time outdoors. Besides vitamin D3, other compounds are also formed. These substances are part of a feedback loop that shuts down the production of vitamin D3 after maximal levels are reached. Vitamin D toxicity is usually obtained after several months of high doses of vitamin D supplements. (*<http://www.sciencedirect.com/science/article/pii/S209012321400023X>*)*
4. **“I have bowed legs, does that mean I had rickets?”** *All bowed legs are not necessarily caused by the vitamin D and calcium deficiency seen in rickets. Due to their position in the uterus, most babies are born with bowed legs. The legs usually straighten with time. Breastfed babies whose mother’s milk does not contain enough vitamin D or calcium are most at risk for developing varying degrees of rickets. However, there are other conditions that cause bowing of the legs. Blount’s disease causes the tibia to grow in a way that causes the legs to bow. Leg braces are usually used to treat this disorder. Sometimes bowed legs can be acquired due to the way the legs are used over time, such as in the bowed legs of many horse jockeys.*
5. **“If I have applied sunscreen, will my skin still be able to make vitamin D?”** *Your skin will still be able to make some vitamin D after sunscreen is applied, but not as well as it does without sunscreen, and adequate levels of vitamin D may not be produced, unless you are spending a lot of time outdoors. Sunscreen creates a barrier between the skin and the UV radiation from the sun. This protects the skin, but it prevents the reaction that produces vitamin D; however, the way that most people use sunscreen—too lightly applied and not often enough—not all UVB radiation will be blocked by wearing sunscreen. Well applied sunscreen typically blocks between 93–98% UVB. Some resources recommend getting 15–30 minutes of sun without sunscreen twice a week, but then protecting your skin with sunscreen afterward. The position of the American Academy of Dermatology is that “there is no scientifically validated, safe threshold level of UV exposure from the sun that allows for maximal vitamin D synthesis without increasing skin cancer risk.” They recommend getting vitamin D through diet and supplements.*
6. **“How much skin needs to be exposed for adequate vitamin D production to take place?”** *How much skin needs to be exposed depends on the UV index, which is dependent on the time of day and the season. Also, vitamin D production varies in different skin types. People with very fair skin need less exposure than do people with darker skin. The different times for sun exposure for each skin type are given in the table below. The recommendations in the chart assume exposure to this amount of sunlight three times per week while wearing a T-shirt and shorts, without applying sunscreen. The UV index is highest between 10 am and 4 pm during the summer months. (*[*https://www.gbhealthwatch.com/Did-you-know-Get-VitD-Sun-Exposure.php*](https://www.gbhealthwatch.com/Did-you-know-Get-VitD-Sun-Exposure.php)*)*



1. **“Does my skin make vitamin D when it is exposed to the UV lights of a tanning bed?”** *If the tanning bed emits some UVB, then your skin will produce vitamin D. Tanning beds primarily use UVA but some UVB is usually present in most beds. Combination tanning beds (those with bulbs that emit both UVA and UVB rays) emit between 93–99% UVA and 1–7% UVB. It has been found that people who regularly use tanning beds that emit UVB radiation have higher vitamin D concentrations, but they also have higher incidences of skin cancer.*

# Activities

**Labs and demos**

**Experiments with UV-sensitive beads:** Demonstrate the effectiveness of a variety of sunscreens with different SPF ratings using plastic bags filled with UV-sensitive beads. One procedure for doing this as a teacher demonstration can be found here: <https://www.stevespanglerscience.com/lab/experiments/uv-reactive-beads/>.

Or, instructions for setting it up as an inquiry style lesson that encourages students to design their own procedures to test variables such as sunscreen, eyeglasses, sunglasses, clothing, and water can be found here: <http://solar-center.stanford.edu/activities/UVBeads/UV-Bead-Instructions.pdf>.

“**The Photochemical Redox Reactions of Thionin”:** Light from an overhead projector (or light box?) initiates the reaction that changes a colorless thionin solution to blue. This reaction, the procedure for which can be found in an online book of chemical demonstrations, can be used as a teacher demonstration simulating how the reaction of 7-dehydrocholesterol to vitamin D3 is initiated by UVB light. (<http://www.cee.org/tep-lab-bench/pdf/Demo.Manual.CPS.pdf>; note this source includes many other demonstrations that may be useful to you.)

**Media**

**“Understanding Vitamin D” video (6:18):** An advanced presentation about the metabolism of vitamin D in the body and its multiple functions, the video contains animated diagrams that show the intracellular reactions of vitamin D. The explanations are thorough, yet not too complex. <https://www.youtube.com/watch?v=onSPZ0aBUKM>

**“D News” video (4:15):** This fast-paced video could be used as a fun infomercial to recap much of what is written in the Warmflash vitamin D article. In the course of the segment, it emphasizes that many foods are fortified with vitamin D2, rather than vitamin D3. Students could fact check this claim by reading food labels. (<https://www.youtube.com/watch?v=4VlXGA1FnSk>)

**“Hydrogen and Chlorine Reaction” video (2:56):** This explosive chemical reaction demonstrates the power and speed of a photochemical reaction. Molecular hydrogen and chlorine are placed in a stoppered test tube and exposed to red, yellow, green, blue, and ultraviolet light to show the wavelength specificity of the reaction; typically, only the UV light has sufficient energy to initiate the reaction. (<https://www.youtube.com/watch?v=NN82GoBG98s>)

**Lessons and lesson plans**

**“Teen Years: A Once in a Lifetime Chance to Build Bone”:** This set of learning activities includes a PowerPoint presentation with accompanying presentation notes, lesson plan, and resources to present lessons around building bone in the teen years. The roles of calcium and vitamin D are a significant portion of the lesson. (<https://bcdairy.ca/nutritioneducation/lesson-plans#secondary>) Additional resources referred to in these lessons: <https://bcdairy.ca/nutritioneducation/calciumcalculator/> and <http://www.eatracker.ca/food_search.aspx>.

**A TED-Ed lesson on how vitamins work:** A short video (4:43) titled “Vitamins” is accompanied by three written segments “Think”, “Digging Deeper”, and “Discuss”, which contain questions for students to answer, links for students to search for more information, and a final topic to discuss. (<https://ed.ted.com/lessons/what-s-the-value-of-vitamins-ginnie-trinh-nguyen#watch>)

**Projects and extension activities**

**“When Something’s Missing: Exploring Vitamin Deficiencies”:** Students research various vitamin deficiencies using links to several *New York Times* articles. Suggestions for class activities include having students keep a food diary and analyze it using some tools provided. (<https://learning.blogs.nytimes.com/2012/03/14/when-somethings-missing-diagnosing-vitamin-deficiencies/>)

**Make UV sensitive blueprint paper:** Students experiment with the photochemical reaction present in making blueprints in this lab, analogous to the photo-initiated reaction of sunlight helping the body produce vitamin D. The instructions to this lab are thorough and include alternate formulas for the sensitizer solution to accommodate different stockroom supplies. (<http://www.sserc.org.uk/chemistry-resources/1347-chemistry-workshops/3797-cyanotypes>)

**“Basic Vitamins: Water-Soluble and Fat-Soluble”:** This plan from Utah Education Network concerns the functions and sources of vitamins and their roles regarding maintenance of optimum health. The lesson plan lists eight optional activities and provides written materials that accompany them. (<http://www.uen.org/Lessonplan/preview.cgi?LPid=1261>)

# References

**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”*.**

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 In the “Open for Discussion” segment of this issue, the authors discuss UV radiation as it relates to students tanning themselves in preparation for the prom. There is a good chart of the percentage of UV-A and UV-B present in sunlight at various times of day. The interaction between UV-B and the skin to produce vitamin D3 is mentioned. (Sitzman, B.; Goode, R. A Tan—Quick, Easy, and Safe? *ChemMatters,* 2012, *30* (1), p 5)

 The difference in vitamin D levels in African-Americans compared to Caucasians is discussed in a sidebar of this article about the chemistry of skin color. African-Americans have lower vitamin D levels, yet denser and stronger bones. The difference in levels of a vitamin D carrier protein may help explain this phenomenon. (Harper, K. Skin Color: A Question of Chemistry. *ChemMatters*, 2014, *32* (2), pp 12–14).

# Web Sites for Additional Information

**Vitamin D**

 **“**Vitamin D and the Skin: Focus on a Complex Relationship” presents extensive information about vitamin D, with a special look at its immune function. The article contains an extensive list of skin disorders that may be linked to low levels of vitamin D. (<http://www.sciencedirect.com/science/article/pii/S209012321400023X>)

This publication from the National Institute of Health, “Dietary Reference Intakes for Calcium and Vitamin D”, contains extensive information about vitamin D. It addresses all aspects of vitamin D, from metabolism, to function, to variations in production among races, and it includes some diagrams of the chemical pathways involved in vitamin D synthesis and metabolism that might be useful when explaining these to students. (<https://www.ncbi.nlm.nih.gov/books/NBK56061/>)

**Vitamin D—actually, a hormone, NOT a vitamin**

Vitamin D is actually a hormone rather than a vitamin. The Society of Endocrinology provides information about how vitamin D functions as a hormone in the body at this site: <http://www.yourhormones.info/hormones/vitamin-d/>.

“From Vitamin D to Hormone D: Fundamentals of the Vitamin D Endocrine System Essential for Good Health” reveals that vitamin D initiates the physiologic response of more than 36 cell types that contain the vitamin D receptor protein. Vitamin D has an extensive role in the health of many systems within our bodies. (<http://ajcn.nutrition.org/content/88/2/491S.long>)

**Vitamin D variations in different skin colors**

The article “Skin Color Adaptation” attributes variations in vitamin D levels in different races to the evolutionary differences in the amount of melanin in the skin. The article includes a map of the world showing the geographic distribution of skin color across the globe. (<https://www2.palomar.edu/anthro/adapt/adapt_4.htm>)

 The article “Vitamin D Photosynthesis and Skin Pigmentation” cites several research studies that refute the claim that difference in skin pigmentation evolved due to the need for vitamin D. One study found the amount of cholesterol in the skin was more closely correlated to skin vitamin D levels than pigmentation. (<https://www.chronicillnessrecovery.org/index.php?option=com_content&view=article&id=297%3Avitamin-d-photosynthesis-and-skin-pigmentation&catid=1%3Ageneral&Itemid=5>)

**Vitamin D2 vs vitamin D3**

Several scientific studies show that vitamin D3 is more effective than vitamin D2 as a supplement to increase serum vitamin D levels. This research paper is a meta-analysis of these studies. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3349454/>)

“Vitamin D3 vs. Vitamin D2—What’s the Difference?”compares of the efficacy of vitamin D3 vs vitamin D2 showing that vitamin D3 supplements are better at raising the vitamin D levels in humans. The site also contains re is a list of 11 references from well-known refereed journals at the end of the article to support the conclusion.

(<https://www.globalhealingcenter.com/natural-health/vitamin-d3-vs-vitamin-d2/>)

**Vitamin D toxicity**

Vitamin D toxicity does not come from overexposure to the sun but from over-supplementing with vitamin D. In the report “Vitamin D: A Rapid Review”, one segment is devoted to discussing vitamin D toxicity. ([http:www.medscape.com/viewarticle/589256\_10](http://www.medscape.com/viewarticle/589256_10))

**Rickets**

 The link between vitamin D and rickets has been known since the early 1900s. The vitamin D council presents thorough information on rickets: diagnosis, prevention, treatment, and research results. (<https://www.vitamindcouncil.org/health-conditions/rickets/>)

The rickets Wikipedia Web page contains extensive information that includes historical anecdotes, as well as a discussion on the evolutionary hypotheses surrounding vitamin D deficiencies and skin pigmentation. (<https://en.wikipedia.org/wiki/Rickets>)

**Sunlight requirements for vitamin D synthesis**

“The Required Vitamin D per Day” appears in the San Francisco journal *SFGATE*.

Besides information on vitamin D requirements, there are over 15 links to other articles concerning vitamin D. (<http://healthyeating.sfgate.com/required-vitamin-d-per-day-4314.html>)

This site contains an excellent table on the amount of sun exposure required for sufficient vitamin D synthesis, based on skin type and UV index. It explains the UV index and includes a link to a Web site that will help you find the UV index for your location at any given time and date. (<https://www.gbhealthwatch.com/Did-you-know-Get-VitD-Sun-Exposure.php>)

**Interactive nutrition calculators**

The “Calcium Calculator” is an interactive tool that students can use to calculate the calcium in their diets to see if they are getting enough. Students can draft and print plans of changes to make in their diets. (<https://bcdairy.ca/nutritioneducation/calciumcalculator/>)

The “Eat Tracker” is an interactive tool students can use to look up the nutritional information of various foods, calculate BMI, and learn the number of calories expended by different activities. It is also possible to enter recipes and get their food value analyzed. (<http://www.eatracker.ca/food_search.aspx>)

**Vitamin D research**

This site has a tab, labeled “Research”, which contains a plethora of information describing what is known about supplementation with vitamin D. A table of contents at the beginning of the section makes looking for specific information quick and easy. (<https://examine.com/supplements/vitamin-d/>)

 An infographic titled “Snake Oil Supplements: Scientific Evidence for Popular Health Supplements” consists of various dietary supplements or foods in interactive dots that, when clicked upon, reveal a recent study about that constituent. The supplements are arranged by level of supporting evidence for the claim. (<http://www.informationisbeautiful.net/visualizations/snake-oil-scientific-evidence-for-nutritional-supplements-vizsweet/>)

# 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>.