Lesson 2: What Is Chemistry?

Introduction

Version 0002

This document is Lesson 2 of the SEAChem2020 open source chemistry curriculum program for secular homeschoolers. This version was current as of 8 August 2017. To if there is a more current version of this document, visit www.SEAChem2020.org.

Table of Contents:

We welcome any help you are willing to provide in supporting this project. Even if you're not a chemist or a professional educator, you can help in the following ways:

- **Let us know about minor fixes**. If you find anything from a factual to a stylistic error, or even a typo, let us know by using this form.
- **Let us know if you find big problems**. Does something need rewriting? Let us know by contacting us using this form.
- **Give us your resources**. If you've done one of these lessons and have put something cool together, email us at misterguch@chemfiesta.com so we can include it!
- **Volunteer**. Do you want to edit this curriculum? Do you have things to add? Would you like to write some of these lessons? Let us know!
- **Publicity**. Tell your friends about these resources. When the community grows, the project keeps growing!

Thank you for using this resource, and please consider helping out!

Lesson 2: What Is Chemistry?

Parent Reference

Objective: To learn about chemistry and its subcategories.

This lesson contains the following:

- Text: What Is Chemistry?
- Lesson glossary
- Practice sheet
- Lab activity: Hard Choices
- Assessment
- References for further study

Additional resources needed: Internet-capable computer

How to use this material:

This lesson is set up to be used in the following way. During the course of this lesson, your child should:

- Read the material in the text.
- Rewrite the material in their own words. (Optional but recommended).
- Complete the practice sheet.
- Write their own practice sheet for the material, complete with answer key. (Optional but recommended).
- Complete the lab activity.
- Write their own lab activity for the material, complete with suggestions on how to best perform the lab. (Optional but recommended).
- Take the assessment to ensure they understand the material.
- Write their own assessment, along with solutions. (Optional but recommended).

These steps should be followed by a debrief, in which you and your child will discuss the lesson. Please send us your suggestions, as well as any materials your child writes (text, practice, lab, assessment) so that we may incorporate it into the curriculum.[1]

Practice Sheet:

This practice sheet is a mixture of the stuff universities expect and open-ended problems that challenge your child to think creatively (the good stuff). When your child is finished with the practice sheet, we recommend that they spend a few minutes writing their own practice sheet. Teaching is the best way to learn something, and by teaching others your child can help to teach him/herself. Please submit any practice sheets to SEAChem2020 at misterguch@chemfiesta.com.

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1 *Any submitted material added to the curriculum will be licensed under the same Creative Commons license as the rest of this material and will be free for others to use and adapt. Please make sure your name is included somewhere on the submitted resource(s) if you wish to receive credit for your work. All submitted resources may be edited for accuracy, formatting, and style.*

Lab:
The information about the lab is included in the lab document itself.

Assessment:
The assessment in this lesson, as in all of the lessons, is meant to not only indicate whether your child has learned the material, but to push them to think even further than they have before. After all, assessments should be part of the learning process, too. When your child is finished with the assessment, we recommend that they spend a few minutes writing their own assessment. Teaching is the best way to learn something, and by teaching others your child can help to teach him/herself. Please submit any assessments to SEAChem2020 at misterguch@chemfiesta.com.

Lesson 2: What Is Chemistry?

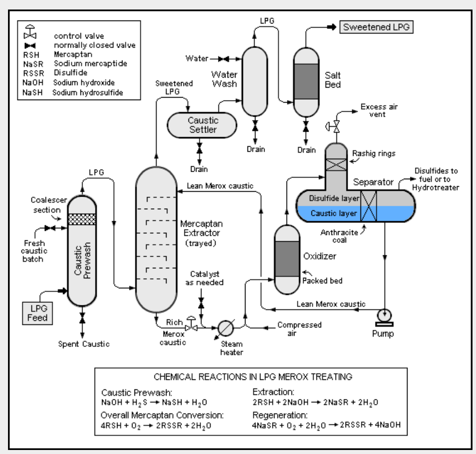
All scientists study the world using the same methods we talked about in lesson 1 and all are interested in learning more about how the world works. How, then, do the different fields of science differ from one another?

Traditionally, the sciences are categorized in the following way:

- **Physics** is the study of how matter and energy behave and how they interact with one another. Examples of physics include thermodynamics, quantum mechanics, and astronomy.
- **Chemistry** is the study of the composition of matter and the changes it undergoes when the atoms rearrange.
- **Biology** is the study of living things, including evolutionary biology, genetics, botany, and physiology.
- **Engineering** uses knowledge from other scientific disciplines for practical purposes. Engineering includes fields such as electrical engineering, civil engineering, chemical engineering, and mechanical engineering.

If engineering is just applied science, how does it differ from the sciences on which it's based?

The sciences discover what is possible and engineers make these things happen. For example, a chemist may invent a chemical compound that can cure diseases. Once this is done, it's up to a chemical engineer to determine ways in which this compound can be made efficiently in larger quantities. In order for somebody to be a good engineer, they must have a good grasp of the sciences.



A process flow diagram devised by a chemical engineer describing the Merox process for removing mercaptans from liquid petroleum gas.[2]

Though usually not described as a science in its own right, a good knowledge of mathematics is vital to scientists from all disciplines. **Mathematics** is often said to be the language of science, because scientific discoveries usually require analysis of quantitative data and because scientific principles are frequently described as mathematical statements.

2 *Image by Mbeychok [GFDL or CC-BY-SA-3.0], via Wikimedia Commons. The Merox process serves to remove sulfur from hydrocarbons, leading to lower sulfur fuels.*

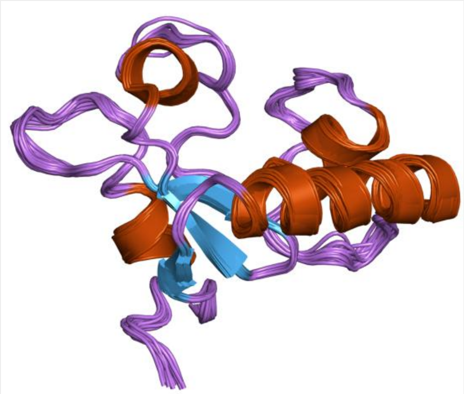
The Branches Of Chemistry

Just as science can be broken into smaller categories by subject matter, each of the sciences can be further subdivided depending on which aspect of that science they study. Chemistry is usually considered to have five subdisciplines:[3]

- **Organic chemistry** is the study of carbon-containing compounds. Categories within organic chemistry include pharmaceutical chemistry, petroleum chemistry, and polymer chemistry.
- **Inorganic chemistry** is the study of inorganic compounds (i.e. compounds that aren't based on carbon). Important areas within inorganic chemistry include electrochemistry, organometallic chemistry, and materials science.[4]
- **Physical chemistry** studies the relationship of energy with chemical reactions, as well as the fundamental processes underlying chemical phenomena. Physical chemists can be found working in the fields of thermodynamics, kinetics, and spectroscopy.
- **Analytical chemistry** analyses chemical samples for purity and to determine their structure. Analytical chemists are widely found working in quality control for industrial processes and in forensics.
- **Biochemistry** studies the chemistry of biological systems, and is very closely related to organic chemistry. Biochemists work in the area of genetics, medicine, and molecular biology.

Organic Chemistry vs. Biochemistry

Many of the chemical compounds found in biological systems (e.g. proteins, nucleic acids, etc.) are nothing more than very large organic molecules. As a result, biochemists typically use many of the same experimental methods as organic chemists. The main difference between the two fields, however, is that organic chemists usually deal with smaller compounds in isolation (e.g. new medications), while biochemists deal with larger compounds within more complex biological systems.



A steroid-binding protein that may be studied by biochemists.

3 *Some sources may break chemistry into more than five categories. For the sake of simplicity, we have broken it into the five traditional areas of chemistry as usually described in U.S. universities.*

4 *As the name suggests, organometallic chemistry involves compounds that contain both an organic group and a metal group. Though described here as inorganic chemistry, it's not at all uncommon for organic chemists to also be involved in working with these compounds.*

Mixing it up

Though we've treated each field as being distinct from the others, science really can't be broken down so easily. There's a great deal of overlap between each discipline because the world is rarely so simple that phenomena are limited to one specialty. Some examples:

- As the name suggests, physical chemistry studies physical phenomena from a chemist's viewpoint. Similarly, chemical physics studies chemical processes from a physicist's standpoint. Both fields overlap a great deal.
- Biophysics studies biological phenomena from a physicist's viewpoint. Such studies may include enzyme kinetics and quantum biology.
- Biochemistry is, as we mentioned before, an overlap of biology and chemistry.
- Fields such as materials science and geology include can simultaneously contain aspects of biology, chemistry, and physics.
- Physical organic chemistry is a field of chemistry in which physics and quantum mechanics are used to study the behavior of organic compounds.

The examples are countless, but the main point is clear: The labels we give to scientists are just that – convenient labels. What scientists actually do is usually a mixture of several disciplines.

Basic vs. Applied Research

In addition to the different fields of science, scientists also solve problems in different ways.

Basic research is research performed simply to advance human knowledge and may or may not have any particular goal. Organizations such as Bell Labs, the National Science Foundation, and the American Petroleum Institute fund a great deal of basic research.

Applied research is research that is performed with the goal of solving a particular problem. A great deal of applied research is performed by private companies and the military.

Mixing it up again

It's rare that any research is either entirely basic or applied in nature. Let's use, for example, the LANTIRN[5] navigation and targeting pod used on the F-15E and F-16 multirole fighter airplanes. While it may seem that LANTIRN would be an example of purely applied research, the designers had to develop new technologies to solve problems that came up in development. From this example (and many others), we can see that basic and applied research are both often required to complete a scientific project.

USAF F-15E equipped with LANTIRN pods (the rounded attachments in front of the wheels).[6]

The Main Ideas In This Lesson

- The traditional categories into which we break science include biology, chemistry, physics, and engineering.
- Chemistry is the study of the composition of matter and the changes it undergoes when the atoms rearrange.
- Chemistry is often broken into subcategories, including organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, and biochemistry.
- Basic research involves gaining knowledge for the sake of it, while applied research is performed to solve specific problems.
- The categories we mentioned in this lesson overlap a great deal, and are mainly defined for conveniences' sake.

5 *LANTIRN stands for Low Altitude Navigation and Targeting Infrared for Night. Introduced in 1987, LANTIRN has evolved into the Sniper Advanced Targeting Pod, which was deployed in 2005.*
6 *Image in the Public Domain, United States Air Force.*

Lesson 2: Glossary

analytical chemistry: The analysis of chemical samples' purity and structure.

applied research: Research performed with a specific goal in mind.

basic research: Research performed simply to advance human knowledge.

biochemistry: The study of the chemistry of biological systems.

biology: The study of living things.

chemistry: The study of the composition of matter and the changes it goes when the atoms rearrange.

engineering: The branch of science that uses knowledge from other scientific disciplines for practical purposes.

inorganic chemistry: The study of inorganic compounds (i.e. those that don't contain carbon).

mathematics: Mathematics can be thought of as the language of science, as the calculations and relationships it uses help us to describe how the world works.

organic chemistry: The study of carbon-containing compounds.

physical chemistry: The study of how chemical processes are affected by energy and of the fundamental processes underlying chemical phenomena.

physics: The study of how matter and energy behave, and how they interact with one another.

Lesson 2: Practice Sheet

1) Describe the difference between basic and applied research.

2) Give examples of basic and applied research that were not discussed in the text for Lesson 2. Explain how you came to this determination.

3) Explain how physics, chemistry, biology, and engineering differ from one another.

4) If I were to tell you that there was no real difference between the different sciences, would you agree or disagree with me? Explain your answer.

Lesson 2 Practice Sheet Answers

1) Describe the difference between basic and applied research.
Basic research is research which is performed for the sake of learning more about how the world works. Applied research is research that has the goal of solving a particular problem or completing a particular task. Applied research generally uses the discoveries from basic research in solving problems.

2) Give examples of basic and applied research that were not discussed in the text for Lesson 2. Explain how you came to this determination.
Examples of basic research:
- **What is dark matter?**
- **Research using supercolliders.**
- **What animals live on the floor of the ocean?**
- **Is there life on Europa?**

Examples of applied research:
- **Research into a malaria vaccine.**
- **Fuel cell research for powering automobiles.**
- **What effect does marijuana use have on human health?**
- **What technology will better allow military drones to fly for longer periods of time?**

3) Explain how physics, chemistry, biology, and engineering differ from one another.
- **Physics: The study of how matter and energy interact with one another.**
- **Chemistry: The study of the composition of matter and the changes it undergoes.**
- **Biology: The study of living things.**
- **Engineering: The use of science toward solving practical problems.**

4) If I were to tell you that there was no real difference between the different sciences, would you agree or disagree with me? Explain your answer.
The answer to this question will depend on on what you believe. However, there are two reasonable answers that can be given:
- **There is no difference between the sciences: The names given to each of the sciences may describe what these scientists generally study, but there's so much overlap between them that it's impossible to say where one ends and the next starts.**
- **There is a difference between the sciences: Though it's true that there's a great deal of overlap between the sciences, breaking them down into subject areas helps to limit the scope of each and allows scientists to focus on the fields they're best interested in.**

<u>Lesson 2 Activity: Hard Choices</u>

Goal: To teach your child that real-world science funding decisions are tougher than it may seem at first glance.

Home destruction factor/safety: N/A

Time: 1 hour.

Materials: Access to the Internet.

Overview:

In this activity, your child will take the role of an advisor who has to recommend to Congress what science projects should be funded in the next year. The overall science budget is $1.5 billion, and your child may fund as many projects as he/she would like within this spending cap. There are a total of 11 projects, with prices ranging from $4 million to $1.5 billion.

When your child has made his/her decision about what to fund, he/she will present his/her findings to you. It's your job to play "devil's advocate", challenging these decisions based on scientific, financial, or political reasons. Even if you believe that your child has chosen correctly, your child will get far more out of this activity if you challenge his/her thinking and question the validity of his/her thoughts. You may take this challenge as far as you believe is wise, considering your child's temperament.

So, what's the correct answer? There isn't one. It's not the answer that's important, but the reasoning they went through to get it. Part of being a science-literate person is spending time doing research and carefully thinking about what the right thing to do is. Hopefully, your child will spend the time needed to gain experience in being scientifically-literate!

Debrief:

When you've finished this exercise, please talk to your child about the following issues:

- Do you both agree on the best projects to fund? Why or why not?
- How much of a role did politics play in your decisions? If a project will be unlikely to be funded by Congress, does it still make sense to propose it to them?
- How much of a role did economic growth play in your decisions? Is it sometimes justifiable to choose a less deserving project if it will result in an increase in jobs?
- Are basic research projects better than applied research projects, or does it really depend on the project being discussed?

Note: The programs described in this activity are all completely made-up. The organizations named are sometimes based on actual organizations that are leaders in their fields, but are not, to our knowledge, engaged in any research mentioned here. A malaria vaccine with an effectiveness rate of 40% is currently being used; research on a more effective vaccine is currently being conducted.

Lesson 2 Activity: Hard Choices

It's not news to anybody that there's not enough money in the federal budget to go around. While there are countless problems that we would like to solve, there simply isn't enough cash to fund every research project. As a result, we as a society have to prioritize our spending, ensuring that we get the most "bang for our buck."

In this exercise, imagine that you are advising the U.S. Congress about how taxpayer money is spent on scientific research. You have a limited amount of money and you can only fund some of the projects that have been presented to you. Which will you choose to fund?

The following projects are presented for your consideration, along with "pro" and "con" viewpoints from supporters and detractors of each and the cost of funding it over the next year. Note: All projects are fictional.

The B-7 Mesofortress ($800 million): This is an Air Force program involved with the design and construction of a stealth bomber that flies at altitudes of approximately 75 km. The requested funding will be used to study the aerodynamics of airplanes flying at this altitude. The planned delivery date for the B-7 is 2035.

- **Pros**: The B-7 is estimated to generate 65,000 highly-skilled American jobs during peak production. The B-7 will be less expensive to fly and have a longer range than current aircraft. It is believed that U.S. allies will purchase the B-7, potentially adding over $500 billion to the economy. This aircraft will be more survivable for aircrew and precision targeting will ensure fewer civilian deaths than current designs. The aerodynamic research undertaken during this project may eventually be used in civilian aircraft, allowing two hour flights between London and Tokyo.
- **Cons**: Over the lifetime of this project, the B-7 will cost taxpayers an estimated $1.5 trillion. While this airplane is admittedly a huge upgrade from existing aircraft, it would cost only $300 billion to keep existing aircraft airworthy over the same time period. With fewer enemies to fight, it's not clear we need a high-performance bomber.

Mercury Observer space probe ($1.5 billion): Since 2015, NASA has not launched a mission to study the planet Mercury. However, in September 2017, the radio telescope at Arecibo Observatory in Puerto Rico found large and blocky features on Mercury, which some believe may be the ruins of an ancient alien city. The Mercury Observer is intended to orbit Mercury and collect data on these features.

- **Pros**: It may discover proof that we are not alone. It may lead to the collection of alien technology vastly superior to our own and give us information about how life evolved in other places. Some scientists believe that we may even be descended from the builders of these structures.
- **Cons**: It's not even clear that these are structures. People have imagined structures on other planets before only to find that they didn't actually exist. With so little information, how can we justify spending this kind of money?

Genetically-modified organism research ($80 million): This money will be spent on research that hopes to determine, once and for all, whether or not GMO foods pose any hazards to humans.

- **Pros**: With an answer to this question, we can finally move forward in either banning or supporting GMO technologies.
- **Cons**: There is already scientific consensus that GMOs are no more hazardous than non-modified foods. Spending money on this research will waste money confirming what we already know.

Dark Energy / Dark Matter Observatory (DEDMO) ($150 million): Planned for construction in the Atacama Desert in Chile, DEDMO will take extremely precise measurements to verify, once and for all, if dark matter or dark energy exist, and if they do, what form they take.

- **Pros**: With dark energy and dark matter accounting for roughly 95% of the universe, it's vital to our understanding of the universe to determine whether they truly exist.
- **Cons**: There have already been precise measurements that all but confirm the existence of dark matter and dark energy, making DEDMO a waste of money. Wouldn't this money be better spent by helping people here on earth?

Malaria vaccine ($75 million): Malaria is a tropical parasitic disease spread by mosquitoes that infects 300 million a year and kills 750,000. Because the current vaccine is only effective about 40% of the time, we could potentially save hundreds of thousands of lives and hundreds of millions of illnesses with a better vaccine.

- **Pros**: There is no better way to spend money than to ease human suffering. This is vital research that must be supported.
- **Cons**: The vaccine research being considered for funding has only a 50% chance of success, and may only confer 50% immunity to malaria. This means that even if this research results in a vaccine, the amount of suffering eliminated will be minimal. Additionally, why spend U.S. tax dollars to solve a problem that doesn't even occur in the U.S.?

Graphene body armor ($50 million): Right now, soldiers and police officers generally wear either heavy Kevlar jackets or jackets containing solid ceramic plates to protect them against bullets and shrapnel. However, the materials science division of Central Armor, Inc. claims to have developed graphene armor that weighs 1/3 as much and stops projectiles 80% better than existing body armor.

- **Pros**: First responders and soldiers deserve the best protection against gunshots and shrapnel. Additionally, this body armor will eventually be adapted to assist in crash-proofing automobiles, strengthening pressurized pipes and pressure vessels, and making clothing far more durable.
- **Cons**: Rather than spending money on new body armor, it's far more reasonable to stop sending combat troops abroad and to demilitarize our police. If the other potential uses are so great, then let's let private industry do the research rather than spending public money on it.

Next generation nuclear power plants ($850 million): Simons GmbH has recently developed a nuclear reactor small enough to power a city block and has requested grant money to build a larger version that can power a city. If all goes well, we could power the entire United States via nuclear power by the year 2040.

- **Pros**: With such a high benefit to the U.S., we definitely have to spend the money. Imagine how much our economy will grow with virtually unlimited power, and imagine how the environment will benefit if we stop our greenhouse emissions.
- **Cons**: Have we forgotten the Three Mile Island, Chernobyl, and Fukushima nuclear disasters? If we allow nuclear power to become more widely used, what's to keep our citizens from being irradiated?

Continuing funding for the Fielder Orbital Telescope ($120 million): The FOT requires additional funding to stay operational for the next fiscal year. As you know, FOT has, for the past 18 years, taken groundbreaking gamma ray pictures of astronomical phenomena and taught us a great deal about the universe.

- **Pros**: FOT has already resulted in countless discoveries and shown us about the universe. Who's to say what else we could learn by keeping it going?
- **Cons**: The Fielder Telescope is 25-year-old technology. Instead of spending money on an old telescope, why not spend this money to develop a next generation telescope. Or even better, let's save the money and analyze the data we already have!

Robotics technology ($210 million): The Dale-Melon University Robotics Labs has successfully developed humanoid robots. Though these robots can do little more than walk around, lift items, and solve simple problems, all agree that these labs are close to a breakthrough in robotics technology.

- **Pros**: Intelligent humanoid robots could one day do jobs too dangerous or too boring for humans. With these robots doing our dirty work, humans will have more time to enjoy life and relax.
- **Cons**: When is the last time that any high-tech project like this really worked out? And if it does, doesn't that just mean that the rich will get robots and the poor will still have to work the fast food counter? It sounds like the best-case scenario for this project is that all taxpayers pay for something that will only benefit the rich.

High-tech paper shredders ($4 million): Fellers Brands has developed new paper-shredding technology that will turn important documents into powder, ensuring that no data can be recovered from it. It only needs to be developed into a working product.

- **Pros**: It's cheap and will help document security.
- **Cons**: If it's so great, why does government need to pay for it? Since when did we get into the business of shredding paper, anyway?

Metallurgy research ($115 million): Scientists in several locations around the country are working on a new class of iron alloy that's inexpensive, incredibly strong, and lighter than existing materials.

- **Pros**: This class of alloy will change everything from manufacturing to construction to electronics. Though the research may be expensive, the low cost of the alloy itself and the many applications for which it is well-suited make it worthwhile.

- **Cons**: The Department of Defense is the organization pushing for this funding. Do you really think they're doing it so you can have a more durable dishwasher or a rustproof car? They're probably just going to use it to build new tanks.

Your problem? You have only $1.5 billion dollars to spend on science research. Will you spend it on a few large projects or will you spend it on many smaller projects? And what criteria will you use to decide which projects are best?

When deciding which products to select, ask yourself the following questions:

- Is this project going to produce something worthwhile, or is it unlikely to produce anything at all?
- Does this project cost too much?
- Is this project likely to benefit us in interesting and unexpected ways?
- Will Congress and the President support funding for this project?
- Will the general public support spending money on this project?
- How will it look when the media publicizes this project?
- Will this project create or cost American jobs?

Determine which of these projects you would fund with your limited store of money, and explain why using the criteria you feel are important.

Your last step in this activity will be to stand before a Congressional panel (i.e. mom, dad, etc.) to justify your conclusions. If you know that mom and dad may be more likely to support one idea than another, you might want to take that into consideration before presenting your findings. Just a suggestion!

Good luck!

Lesson 2: Assessment

1) Explain how chemistry and biology are different from one another.

2) Explain how chemistry and biology overlap with one another.

3) Based on what you've read, is mathematics a science? Why or why not?

4) Can somebody be a physical chemist and an analytical chemist at the same time? Why or why not?

5) Which sort of research is more useful, basic or applied research? Explain your answer.

Lesson 2: Assessment Answers

1) Explain how chemistry and biology are different from one another.
Biology studies living things, while chemistry studies the composition of matter and the changes it undergoes.

2) Explain how chemistry and biology overlap with one another.
Biological processes take place because of chemical reactions within living organisms. Additionally, many interesting and useful chemical compounds are created by organisms. It would not be unfair to say that, while we usually classify chemistry and biology as different sciences, both of them essentially use the same method to discuss different aspects of the world.

3) Based on what you've read, is mathematics a science? Why or why not?
It's usually not considered a science, but we usually refer to it as the language of science because mathematics is used to analyze experimental data and is also used to describe the fundamental laws of the universe.

4) Can somebody be a physical chemist and an analytical chemist at the same time? Why or why not?
Yes. Physical chemists study how energy is related to chemical processes and analytical chemists analyze chemical samples for purity and to determine their composition. Areas such as spectroscopy overlap both physical and analytical chemistry – physical chemistry is used to describe and develop new forms of spectroscopy, while analytical chemists use spectroscopy to identify chemical compounds.

5) Which sort of research is more useful, basic or applied research? Explain your answer.
It is really the reasoning you use here more than the actual answer that matters. If you believe that basic research is more important, it's probably because you believe that without new discoveries we won't have the necessary knowledge to apply to future problems. If you believe that applied research is more important, you probably take the view that science is more useful for what it can do for us, rather than as pure but impractical knowledge. In reality, pure and applied science are mixed up with one another, and it's nearly impossible to perform one without the other.

Lesson 2: References for further study

A much larger list of the branches of science:
http://www.onlinegkguide.com/list-of-different-branches-of-science-and-their-studies/ (Note: it lists “astrology” as a science because astrologers believe it is and not because it's actually a science).

The science that's rarely mentioned: Geology
https://en.wikipedia.org/wiki/Geology

What is engineering?
The definition of engineering in this lesson doesn't do a very good job of describing the different types of engineering and what engineers do. Learn more about engineering at http://whatisengineering.com/.

Mathematics and science:
Many people who are interested in the sciences turn away from it because they're afraid of mathematics. For a complete discussion of the relationship between math and science, have a look at https://blogs.scientificamerican.com/the-curious-wavefunction/do-you-need-to-know-math-for-doing-great-science/.

The branches of chemistry:
A more complete description of each of the branches and subbranches of chemistry: http://www.chemistry2011.org/branchesofchemistry.

The importance of basic research:
People frequently think of applied research as “useful research” and basic research as being esoteric and useless. This article explains why we should care about basic research: http://spectrum.mit.edu/spring-2014/the-brilliance-of-basic-research/.

DARPA:
The largest source of government spending on science research and development is the military. Find out how the Defense Advanced Research Projects Agency (DARPA) spends this money not just for military, but also for civilian uses: http://www.darpa.mil/.

Low Altitude Navigation and Targeting Infrared for Night (LANTIRN):
For everything you'd ever want to know about the LANTIRN project and how it works with the F-16 C/D Fighting Falcon aircraft, check out http://www.f-16.net/f-16_armament_article2.html.

Genetically-modified foods:
An article explaining how the anecdotal evidence against GMOs is unsubstantiated: https://www.forbes.com/sites/jonentine/2014/09/17/the-debate-about-gmo-safety-is-over-thanks-to-a-new-trillion-meal-study/#174514b38a63.