Berkeley Engineers and Mentors

Sugar Rush

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Target Grades: Elementary/Middle
Semester: Fall 2019

Brief Overview

In this lesson, students will be learning all about nutrition and more specifically, carbohydrates. This lesson focuses on carbohydrate structure, digestion, nutritional facts, and dietary advice. Mentees will learn about the types of carbohydrates, carbohydrate digestion, calories, and the differences between sugar and artificial sweeteners. This lesson will be visual and demo based, so classroom control will be of utmost importance.

Dietary Warning :

This lesson contains several edible substances. Be sure to check if the students have any wheat, gluten, sugar, or Stevia allergies before hand before letting them participate in any activities. Additionally, be sure to check that none of the mentees have Type I Diabetes, as there is a significant amount of sugar used in Module 3 which could potentially pose a severe health risk.

Teaching Goals

- Types of Carbohydrates
    - **Simple Carbohydrates** - Simple sugars that can be broken down quickly (ex. glucose)
    - **Complex Carbohydrates** - Structured sugars that take time to be broken down (ex. starch)
- **Fiber** is an indigestible material that helps your body with the process of digestion
- **Saliva** contains chemicals and enzymes (**salivary amylase** [for advanced sites]) that help break down starches in your mouth
- **Blood Sugar** is the level of glucose found in your blood, which rises in response from eating food. It rises extremely quickly when eating simple carbs, as they break down quickly in comparison to complex carbs.
- **Artificial Sweeteners** are used as healthy alternatives to sugar. They are noticeably more potent than sugar and are usually zero calories.

- **Engineering Design Process** - The series of steps that engineers follow to come up with a solution to a problem. It involves a cycle of planning, testing, and adapting.

Careers and Applications

Nutrition is a huge part of our everyday life. Everyday, we make dietary choices that affect how our body functions, and it's important to understand the ramifications of how food is absorbed and affects the body. This lesson will help mentees understand the choices they make everyday, ranging from what vegetables to eat to what soda to drink.

Some career paths benefitting from nutritional knowledge are food scientists, personal trainers, and therapists. Many other fields also benefit from the general knowledge of carbohydrates, but this knowledge continues to be useful to individuals as a whole, no matter what career path they pursue.

Agenda

- Introduction (5 minutes)
- Module 1a : Iodine Test (5 min)
- Module 1b : Spit in a Cup (5-10 min)
- Module 2a : Breaking Bonds (10-15 min)
- Module 2b : Blood Rush (5-10 min)
- Module 3 : "Oh Yeah Stevia!" (10-15 min)

Introduction

Nutrition is an incredibly important field. By making better dietary choices, we can live healthier lifestyles with lower risk of disease. As a start, ask mentees about their last meal, and discuss what they think makes a healthy meal. Discuss a few potential sources of sugar, such as candy or fruit, a good point to transition into Module 1.

Module 1a : Iodine Test (5 minutes)

Introduction

In this module, mentees will be seeing how carbohydrates can be different in nutritional content. This is meant to be more of a demo visualizing the differences between the types of carbs and sugars, so don't worry about brushing past this fairly quickly.

Teaching Goals

- **Sugar** is a generic name for sweet tasting, soluble carbohydrates, usually made of one or two sugar molecules. Ex) Sucrose, or table sugar.
- **Starch** is a carbohydrate that's found in many foods, such as bread, rice, or corn. It's made of multiple glucose molecules chained together.
- **Fiber** is an indigestible material found in plant cells. This lets it go through the body and absorb water while also easing bowel movements.
    - Fiber is also a carbohydrate!

Background For Mentors
In this lesson, we'll be discussing the carbohydrate and the various types of carbohydrates. We will be focusing on primarily starch and sugar, but will cover fiber as well.

Sugar is a general term used to identify the class of carbohydrates that taste sweet. There are numerous types of sugars, some of the most common being lactose, glucose, fructose, and sucrose. Some examples of where these sugars can be found are milk for lactose, fruits such as oranges for fructose, and pineapples for sucrose. Glucose is the most common, and can be found in our blood stream, but is also created by plants through photosynthesis.

Starch is a polysaccharide that is formed from a chain of glucose molecules that are bonded together. There are different forms of starch, but the most common is the linear amylose form. It is typically used as energy storage in plants and can commonly be found in foods such as wheat and potatoes. When we eat starch, we also have to break it down into maltose/glucose before being able to digest it.

Fun Fact : Boba, also known as Tapioca Balls, are made of starch!

Figure 1 : Boba is a carb!

Dietary fiber is a type of carbohydrate. It's a plant based nutrient, also known as roughage or bulk, that cannot be completely broken down by your body. Generally, it acts as a sort of cleanser, absorbing water and easing bowel movements. Overall, It helps a lot with digestion, and is eventually excreted out.

Mentees may wonder why fruits are considered healthy despite containing mostly sugar. While fruits do contain a significant amount of sugar with fructose, they also contain a significant amount of water, fiber, and nutrients which causes it to not only provide valuable nutrition, but also digest slowly. This simultaneously makes it more filling, stopping consumers from eating too much while providing valuable nutrition.

There will be more information about sugar and starch in the next module.

Materials
- 1 Soda Cracker per mentee
- 1 Apple per site
- 1 pc. Broccoli per site
- Iodine (1 bottle)
- 2 Pipettes
- Paper Towels (2 sheets)

Procedure

1. Bring out the soda crackers, orange slices, and candy.
2. Ask students what they think each food has in them, based off what we just discussed. (The orange has mostly sugars beside the pulp, the crackers are mostly starch, and broccoli has a lot of fiber).
3. Put out a paper towel and lay the food on it. Drip a few drops of iodine on each food. The cracker should turn blue-black, while the other two should not.
4. Point out the blue-black color, and try to have the mentees identify what was different about the crackers compared to the other foods. (The crackers contain starch!)


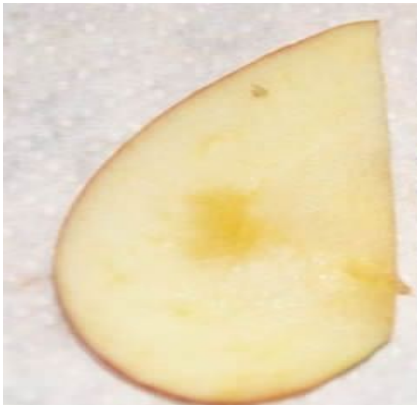

Figure 2 and 3: The cracker should turn blue-black, while the apple and broccoli should remain orange/brown in color

Module 1b : Spit in a Cup (10 minutes)

Introduction

Now that the students understand that there is a difference in the carbohydrates we eat, it's time to focus more on how these different sugars relate to what we eat. This module will focus on the difference between starch and simple sugars, as well as how they are digested within our bodies.

Teaching Goals

- **Saliva** contains chemicals and enzymes (salivary amylase) that help break down starches in your mouth
    - Linked chains of sugar molecules are broken down into their components. (**Starch** is broken down into **maltose**, a chain of two glucose molecules)
    - As a note, salivary amylase only accounts for 20% of this digestion. **Pancreatic Amylase,** along with other enzymes such as lactase does most of the heavy lifting in your small intestine.

Background For Mentors

This first phase of digestion is initiated through the smell, sight, thought, or taste of food. This in turn causes increased gastric secretions, which increases the amount of saliva generated, The salivary amylase in our mouths begins digesting the starches we eat by hydrolyzing them into

maltose. Maltose is then broken down into glucose with the help of maltase (an enzyme). Usually, only about 20% of carbohydrate digestion is done in the mouth, with the rest being done in the small intestine by pancreatic amylase.

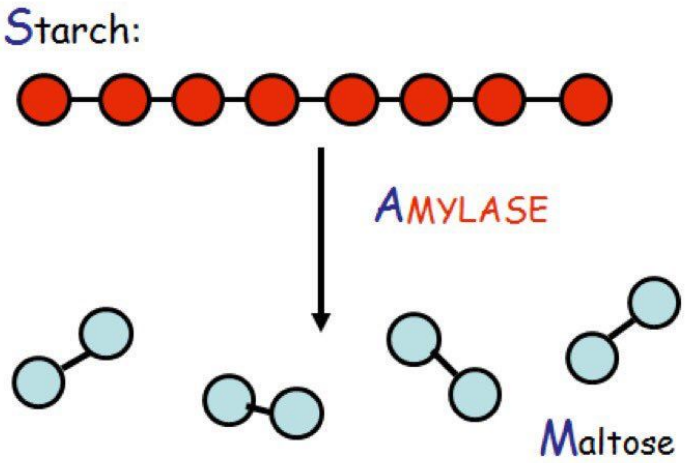

Figure 4 : The polysaccharide Starch is broken down into many different Maltose molecules with salivary amylase

The subtle sweet taste after chewing the crackers is caused by the breakdown of starch into maltose, and is why it takes about twenty seconds of chewing before really tasting the effects of the amylase. *We cannot taste the sweetness of starch despite it being a carbohydrate, as it is too big of a molecule to cause a response on the taste buds, so we begin tasting it as it is broken down into maltose.*

Materials

- 2 Unsalted Soda Crackers per mentee
- 1 Hershey Kiss per mentee
- 1 Ziploc Bag per mentee
- 1 Dixie Cup per mentee
- Iodine (1 bottle)
- Eyedropper (3-4 per site)
- 1 Gallon Jug Water per site
- 1 spoon per mentee

Procedure

1. While discussing the module, mentors can begin handing out the unsalted soda crackers and Hershey kisses. Have a mentor fill up a gallon jug of water for later use.
2. After chewing for some time, the crackers should begin to taste subtly sweet. This is due to the **starches** in the cracker breaking down into **maltose**, showing the effects of salivary amylase.
3. Have mentees raise their hands when they begin detecting a sweet taste. It's ok if some do not end up detecting it, as it is *very subtle* and varies from person to person due to

saliva generation.

4. After about a minute, have them stop chewing and discuss how the starch is breaking down into maltose in the mouth.
5. Have mentees then eat the kisses. They should instantly detect a sweet taste. This is since the candy is already in a form we can taste. (Sucrose)
6. The mentors should pass out the second set of crackers and Ziploc bags. Mentors should pour water into solo cups in order to keep the module running smoothly. Have each student put the cracker into bags and begin crushing them up until they become a powder.
7. Begin filling up the dixie cups to about ⅔ level and handing them out to each mentee.
8. Have each student pour out their cracker powder into their cups. Once ready, mentors can begin distributing the Iodine using the eyedroppers. The cups should turn purple/black to show that there is starch inside. Try to put about two to three drops in each cup.
9. Have the students swirl the mixture, and then spit into their cups. Have the mentees mix the spit in using the spoons. The purple/black color should gradually begin to fade away, as the starch gets broken down. If it does not fade away, have a mentor spit into the cup and mix it for the student.
10. Afterwards, the gallon of water should be refilled by another mentor for Module 3.

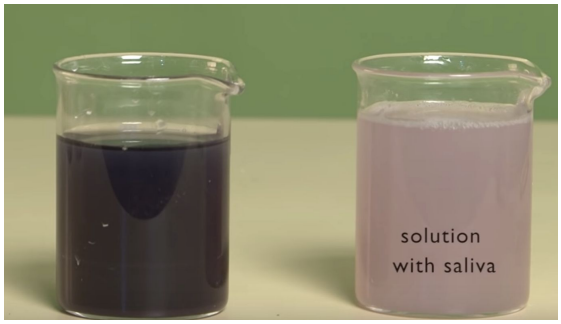

Figure 5: The solution on the left is the solution without saliva, while the one on the right shows how it should look after being broken down for some time

Additional Notes for Mentors

Please make sure the mentees do not try and consume the mixture after Iodine is added. If this module seems too difficult to do with your mentees, you can also perform this module as a demo with the mentors, or only have the mentors spit into the cups.

Module 2a : Breaking Bonds (10-15 minutes)

Introduction

This module is mainly focused around the differences between carbohydrate structure. This module will be hands on, with the mentees cutting and untying knotted strands of paracord to represent the differences in molecular structure and how it affects its function and structure.

Teaching Goals

- **Simple Carbohydrates** have basic structures, formed with one or two sugar molecules chained together.
    - They are also known as **monosaccharides** or **disaccharides**, depending on how many sugars are chained together.
- **Complex Carbohydrates** are made with sugar molecules that are strung into chains and complicated structures.
- **Starch** and **Glycogen** are complex carbohydrates, made from chains of glucose molecules. Glycogen is usually multibranched, but starch is commonly a single chain. This changes how they are digested!

Background For Mentors

Starch as stated before, is an extremely common and important polysaccharide in our diet as a huge source of our energy. It has two main structures, amylose, which is its straight chained structure, and amylopectin, which is its branched counterpart. We will mainly be talking about the amylose structure for the effect of this module.

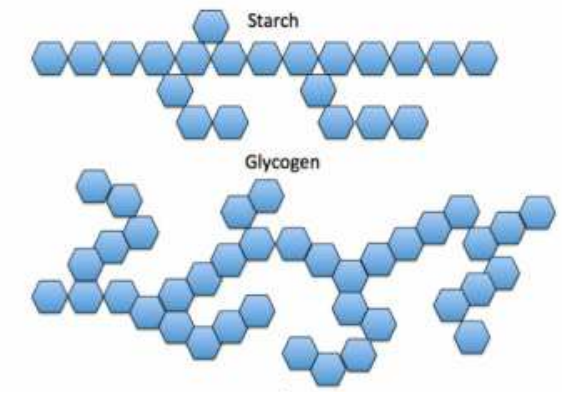

Figure 6: Starch has a noticeably more straight structure, while glycogen branches out significantly

Glycogen is used for energy storage in animals and is usually far more branched than starch. Due to this, more of it can be released at once for energy usage. More branches results in more ends, which consequently leads to faster release time for it. It's commonly stored in the liver as a stopgap measure to stop our blood sugar from running low.

Materials

- Paracord (2-3 ft per group, 1 length for Starch, 2 crossed for Glycogen)

Procedure

1. Separate the mentees into groups of 2 and 3-4 and give each group their respective paracord. Each 2 person group will either get a straight chain, representing **starch**, while each 3-4 person group will get crossed branches representing **glycogen**.
2. Start time for 3 minutes, and have each respective group attempt to untie the knots in the cords. Let them try to get as far as they can in untying and "releasing" the energy stored in the cords. Make sure to not let the mentees untie the central knot for the

glycogen.

3. When time runs out, compare the amount untied in the Glycogen strands vs the Starch strands. It should be noticeably more for the glycogen since there are multiple ends.
4. Once this is done, ask the students what the knots in the string represent from what we've learned. What would represent glucose? What would represent maltose? (Glucose would be a single knot, and maltose would be two knots chained together)

Figure 7: The paracord on top represents starch, and the one below represents glycogen

Module 2b : Blood Rush (5-10 minutes)

Introduction

The module focuses on the actual differences when absorbing different carbohydrates. Mentees will be learning how the body digests both simple and complex carbohydrates through a visual demo, and will be able to understand why complex carbohydrates are generally preferred.

Teaching Goals

- **Digestion** is the breakdown of food into smaller molecules before entering the bloodstream.
- **Blood sugar**, or glucose, is the body's main source of energy, and is the main sugar found in your blood. It rises as your body digests carbohydrates.
    - It spikes when eating simple carbohydrates, but rises more gradually when eating complex carbohydrates.
    - This is due to the time it takes for your body to break the food down!

Background For Mentors

Simple carbohydrates do not have to go through the process of being broken down, and can easily be digested and absorbed into the body. This results in a blood sugar spike soon after eating, which is harder for your body to manage. Because of the time it takes to break down a complex carbohydrate, your body absorbs it gradually as it is broken down and absorbed in the small intestine. This can be seen in the graph below.

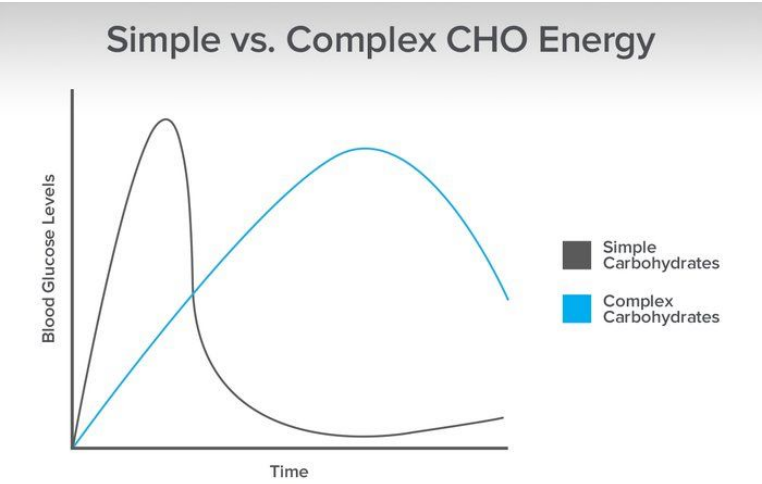

Figure 8: Simple carbohydrates cause a quick spike in blood sugar, while complex carbohydrates causes a more gradual shift

Due to how quickly simple carbohydrates are absorbed, it's easy to cause a large spike in blood pressure. In comparison, complex carbohydrates usually take more time to break down, and therefore are digested over a longer period of time, allowing us to avoid the complications caused by a large spike in blood sugar. This can lead to health problems such as Type II Diabetes, characterized by higher than normal blood pressure, and can lead to many other issues as well.

Materials

- 2 PET plastic cups per site
- ½ cup corn syrup per site
- 1 Spoon per site
- 1 Teaspoon Flour per site
- 1 Teaspoon Sugar per site
- 1 bottle of red food coloring per site

Procedure

1. Bring out the two PET plastic cups and fill each up halfway with corn syrup. Use a few drops of red food coloring to redden the mixtures, which will represent blood.
2. Explain that the sugar and flour represent the simple carbs and complex carbs discussed earlier, and then put a teaspoon of each into the respective cups.
3. Observe the cups. It will take a minute or two for there to be a visible difference.
4. The glass with the teaspoon of sugar should absorb noticeably faster than the other. This showcases how your body quickly absorbs simple sugars into your blood sugar, causing a spike.

Figure 9: After some time, the cup with the sugar should have sank noticeably compared to the flour

Module 3 : "Oh Yeah, Stevia!" (10-15 minutes)

Introduction

This module will focus on the difference between sugar and artificial sugar. The mentees then will get the chance to experiment and make their own kool-aid mixtures with both sugar and Stevia, an artificial sweetener.

Teaching Goals

- **Artificial Sweeteners** are sugar substitutes that can be used to reduce the amount of calories. They are noticeably more potent than regular sugar (250-300 times the sweetness of sugar for stevia!) and are usually zero calories.
    - They are made of chemical compounds that taste sweet, such as Stevia's steviol glycoside. They are generally safe to eat in small quantities.
    - They have several disadvantages, but many people use them successfully to diet.
- **Engineering Design Process** - The cycle of planning, testing, and adapting that scientists follow to solve a problem.

Background For Mentors

Artificial sweeteners are often used as replacements for regular table sugar, also known as sucrose. They are used often, especially in diet drinks and candy, and are usually many times sweeter than sucrose, while containing practically no calories. Artificial sweeteners can help those with diabetes due to their lack of carbohydrates, and can also aid in weight loss due to their lack of calories.

There are several different types of artificial sweeteners. Several other varieties include Aspartame (NutraSweet, Equal) and Sucralose (Splenda), etc,. Each have their own intricacies, one example being Aspartame's sweetness being less prominent in hot foods. Artificial Sweeteners are all synthetically derived in various ways. In this particular module, we will be using Stevia, the most popular organic artificial sweetener, made from the leaves of the plant

Figure 8 : Stevia rebaudiana

Stevia rebaudiana! The leaves of this plant contain the compounds steviol glycosides, which are what all the sweeteners marketed as “Stevia”, are created from.

While there has been controversy about artificial sweeteners, such as their potential links to cancer, they are generally recognized as safe by the FDA. Additionally, artificial sweeteners are typically packaged with unhealthy foods and can encourage addiction to these foods. Although there is no clear conclusion, there is also research that these chemicals can affect your metabolic rate as well.

Materials

- 4 Kool-aid mixture packets (2 per site)
- 1 Gallon jug per site
- 2 packets of Domino sugar per student
- 2 packets of Stevia per student
- 2 Dixie cups per student
- 1 Spoon per student
- Paper Towels

Procedure

1. During the discussion of the lesson, have one mentor begin mixing the gallon jug of water with two Kool-aid packets. Use the paper towel to funnel the kool-aid powder in.
2. Begin passing out the dixie cups, each filled up with the kool-aid mixture. Make sure that everyone gets a cup, as the gallon may need to be refilled for larger classes. One will be for sugar, and one will be for the artificial sweeteners. Give each student two packets of Stevia and two packets of sugar.
3. Have the students experiment with the taste, starting with the sugar packet. Try to make sure that they don’t just dump the whole packets in, and experiment with smaller quantities until they get to the taste they want.
4. Have the students drink some water once they’re done with the sugar packets so that they can accurately compare the taste between cups.
5. Now that they have gotten to the sweetness they like, try to have them replicate it with Stevia packets. Ask them some questions. How effective is Stevia as a sweetener? How much did they have to put in compared to the sugar?
6. At this point, mentors can either give refills and/or mix more Kool-aid, so that the students can experiment more with their drinks.

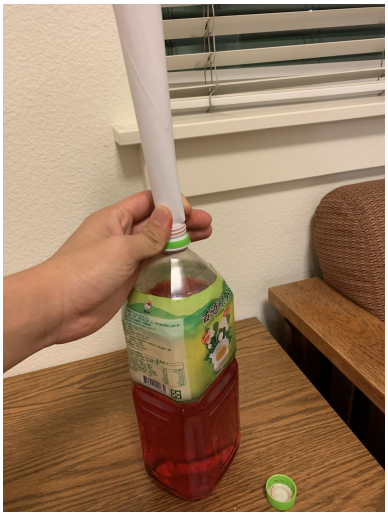

Figure 11: You can use paper to funnel the kool-aid powder!
Figure 12: Please don't let your mentees do this...

Conclusion

Conclude the lesson by asking mentees what they learned today, specifically about carbohydrates. Some good questions to ask could include: What are some examples of different types of carbohydrates, and where can you find them in your diet? What's the difference between simple and complex carbohydrates? How does this affect absorption? What is the difference between sugar and artificial sweetener?

Also use this time to wrap up a great semester at BEAM. Spend time with your mentees and ask them what their favorite lesson of the semester was. Did they learn anything new? Also, make sure to thank them for coming to BEAM each week and say goodbye!

Additional Notes for Mentor Development

Written by Summer Bui, Tiffany Tran, and Cammie Young

A lesson on FOOD? The kids will definitely be excited to participate, but what happens if they are too distracted by the food to listen to the lesson and do the modules? Mentors should attempt to keep the food hidden from the kids until each activity, but if the kids already see the materials, try to use **positive language** to draw attention away from the food. Review the first MD presentation on this topic found in the Files section of bCourses! If this strategy is ineffective, bring up the idea that only the good, obedient kids will be able to snack on the foods of the lesson! If they are being bad kids, then they might not be able to participate in the lesson.

For this lesson, we're talking about nutrition — more specifically carbohydrates! A great way for the kids to get involved and to participate in this lesson is to name some food items that are considered "carbohydrates." Have the kids think through the "definition" of what a carbohydrate is and have them **explore the numerous amounts of food items they've encountered in their own life** and share it out to the class. This will get them super excited and stoked to learn more about what we're going to be teaching throughout the lesson!

Additionally, in the beginning when asking about allergies and diabetes, be sure to be sensitive when asking the kids. Instead of asking if any kid is diabetic, try to ask if they have dietary restrictions involving sugar.

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Materials List

Material	Amount per Group	Approximate Cost	Link / Vendor
Soda Crackers	1-2 per mentee + 1 for Module 1a	2.74	Amazon
Apple	1 per site	1.50	Safeway / Trader Joe's Safeway
Iodine	1 bottle per site	11.99	PipingRock
Pipettes	2 per site		Bechtel Inventory
Paper Towels	2-3 sheets		Bechtel Inventory /

			Schools
PET Plastic Cups	2 per mentee + 2 for Module 2b		Bechtel Inventory
Corn Syrup	1 cup per site	7.99	Amazon
Spoons (400 cnt)		10.95	Amazon
Sugar (1 cup per site) (Instacart)		15.02	Safeway
Red Food Coloring	1 per site		Bechtel
Saccharine	1 packet per mentee, may be good to pack extra for more cups	10.99 (500 box)	Amazon
Water		Site	
Kool-aid Packets		7.42 (150 pc)	Amazon
Gallon Jugs	1 per site	26.00 (4 pc)	Amazon
Ziploc Bags	1 per mentee	13.90(125 pc)	Amazon
Paracord	About 20 ft per site	8:90 (100 ft)	Amazon