

GSK Science in the Summer™



do more
feel better
live longer

Science of Sports

Educator Guide



GSK Science in the Summer™

Science of Sports

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The Franklin Institute in Philadelphia, Pennsylvania is proud to support the implementation of the national GSK Science in the Summer™ program.

*Questions about the Science of Sports content or about the program?
Contact: NationalSIS@fi.edu*



GSK Science in the Summer™

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Note to Educators

The curriculum for this topic is divided into four parts with discussions and hands-on activities. Each day's content builds on the previous day. You can differentiate the activities to meet the readiness and capabilities of the age levels within your class where needed. You can extend an activity if there is interest from the students and skip other activities if you run out of time. The goal of the program is to engage student interest and provide an enriching experience. If students want to continue with a particular activity, by all means let them, even if it means another activity is missed.

An estimated time to complete each activity has been provided. Level one students tend to need more time to complete the activities than the level two students. Please alter these times as needed for your group of students. These times are to assist you with planning the day's activities and allow for time management.

We encourage you to ask the students open-ended questions and guide conversations so the students are interacting instead of being passive listeners. If the students have an interest in a particular subject that relates to the overall topic, feel free to extend the activity and discussion if you feel comfortable with the information. If you are not knowledgeable about a particular subject in which the students are interested, please ask the children's librarian to find a book about it for the students to learn more or visit a reputable website for additional information that you can share with the students.

Important Safety Notice

GSK has adopted a set of safety standards, one of which deals with the requirement that eye protection be worn in all laboratories. The GSK Science in the Summer™ program aligns with these standards and strives to instill an appropriate awareness of the importance of safety by providing program participants with safety glasses. A goggle icon will be next to the activities that require the use of safety glasses. Please enforce student use of safety glasses when noted in this guide.

At the end of part four, students should be encouraged to create their own thank you note to express what they enjoyed about the program. This is intended not just as a way to express gratitude to GSK, but also to provide the program administrators with information about which activities were more memorable for the students.

Your feedback is also welcomed, of course. Please contact the program administrator at NationalSIS@fi.edu with comments and suggestions.

Thank you for all your hard work to make the GSK Science in the Summer™ program a success.

MASTER SUPPLY LIST

- Safety poster
- Poster paper & markers for teacher use
- Safety goggles & labels
- Student bags & pencils
- “What is a Scientist?” book by Barbara Lehn
- Masking tape for taped Y pattern (20 feet)
- Masking tape for Starting line (20 feet)
- Masking tape for Finish line (20 feet)
- Blocks (16)
- Timers (8)
- Tape measures (8)
- Yard sticks (8)
- Data sheets
- Profile Cards 1, 2, 3, 4, 5, 6, 7, & 8
- Small beverage cups – 4 oz. (16)
- Pitchers of drinking water
- Bucket for dumping unwanted liquid (if sink is not available)
- Fruit juice
- Honey
- Sea salt
- Liquid measuring cups marked FOOD ONLY (8)
- Measuring spoons marked FOOD ONLY (8)
- Measuring spoons (8)
- Stir sticks (16)
- Aluminum foil sheets
- Colored paper clips (240)
- Yarn or string (16 pieces, each 8-10 inches long)
- Pony Beads or beads big enough to go on yarn (240)
- Construction paper strips (64)
- Tape (4 rolls)
- Baseball bat cards (8)
- Bean bags – 6 per pair of students – 2 of each color/style (48)
- Bean bag holders (8)
- Decks of Profile Cards (8)
- Paper/wax cups – 8 oz. (16)
- Plastic bowls (16)
- Popsicle sticks (16)
- Warm water – 8 cups
- Borax – 16 tablespoons
- Corn starch – 16 tablespoons
- White glue – 32 tablespoons
- Food coloring – variety of colors
- Paper towels
- Baseballs (8)
- Tennis balls (8)
- Ping-pong balls (8)

Note: Supplies for the optional activities are NOT included on this list or in the kit. Refer to each optional activity for its required supplies.

GSK Science in the Summer™

Science of Sports

Introduction

The Science of Sports content is intended to be presented in four, one-hour blocks. Each session is designed to serve a group of sixteen children at the same level—either level one or level two. Level one children are entering grades two or three. Level two children are entering grades four, five, or six.

The content invites children to explore this big idea:

How does science help athletes perform in their sports?

While exploring this idea, children will learn that:

- **Science is a tool** that can be used to better understand and advance performance in sports.
- Athletes need to be **physically fit, mentally fit, and be properly equipped** in order to excel in their sports.
- Athletes are supported by a large **network of people with a range of expertise in science, technology, engineering, and math**. These include biologists, chemists, engineers, psychologists, neuroscientists, physicians, material scientists, technologists, mathematicians, nutritionists, trainers, and physical therapists, among others.
- Athletes are a **diverse group of individuals** with respect to gender, race, ethnicity, body shape, age, and people with disabilities.

The Science of Sports content is designed with this presentation plan in mind.

Science of Sports Session – Level 1 or 2 – 16 children

Part 1 – 60 minutes	Part 2 – 60 minutes	Part 3 – 60 minutes	Part 4 – 60 minutes
Physically Fit Balance & Stability	Physically Fit Nutrition	Mentally Fit	Equipped to be Fit

STEM Showcase – Featured Roles for STEM Professionals

GSK Science in the Summer™

Science of Sports

Part 1 – Physically Fit – Balance & Stability

OVERVIEW

Part one begins with an introduction to the concept of being scientific, thinking like a scientist, and doing so safely. Next, students will apply scientific strategies to an exploration of physical fitness with a focus on balance and stability. Finally, students will consider some of the scientific professionals involved in physical fitness as it relates to sports.

TIME MANAGEMENT

Introduction & Safety Guidelines = 10 minutes

What is a Scientist? = 10 minutes

What is Physical Fitness? = 5 minutes

Physical Challenges = 25 minutes

Balance Challenge #1

Balance Challenge #2

Balance Challenge #3

Standing Long Jump Challenge

Block Run Challenge

STEM Showcase = 10 minutes

MATERIALS & SUPPLIES

- Safety poster
- Safety goggles & labels
- Student bags
- “What is a Scientist?” book by Barbara Lehn
- Poster paper & marker for teacher use
- Taped Y pattern
- Starting line (tape on floor)
- Finish line (tape on floor)
- Blocks (2)
- Timers (8)
- Tape measures (8)
- Data sheets
- Pencils
- Profile Cards 1 & 2

PREPARATION & SET-UP

Arrange the classroom so that there is an area for students to sit and listen as well as open space for the physical activities.

In the open space, use the masking tape to create two lines on the floor. If possible, the lines should be 20' long and 10' apart. If there is extra space, make the lines farther apart. If there is less space, shorten the length before moving them closer together.

In the open space, use the masking tape to create the uppercase Y pattern for balance challenge #2. For level one students, the open ends of the Y should be about 2 feet apart. For level two students, 3 feet apart. Taper the two arms of the Y to a point and extend the trunk proportionally.

During the run challenge, students will run along a line's 20' length from end to end. During the jump challenge, students will jump away from a line, out to the side.

Gather the other materials—the poster, the book, the profile cards, poster paper & marker—near where you will be instructing. You will distribute the goggles to the students during the safety overview. You will distribute the data sheets and pencils during the physical challenges.

At the end of the day, the masking tape lines and pattern can be removed from the floor and discarded. Used data sheets can also be discarded. If it is not possible to keep the safety and scientific behaviors posters in place for tomorrow, carefully remove it and save it for replacement tomorrow. All other supplies should be returned to the kit for later use.

Introduction & Safety Guidelines = 10 minutes

Begin by introducing yourself to the students and share with them why you enjoy science. Orient them to their surroundings. Establish appropriate rules. These will vary according to the space.

Give students a general overview of the four-part program. By the end, we hope that the students will find science interesting and will consider science as a possible career. Also, we hope to encourage students to visit your museum to learn more about science or visit their local library to take out books about science and attend future programming.

Safety First

- Safety Poster
 - Safety Goggles
 - Labels
1. Talk to the students about the importance of following laboratory safety rules and directions. Discuss, without frightening them, the dangers of working with certain materials such as borax.
 2. Distribute safety goggles to the students and show them how to vent them. Show the students how to adjust the straps to fit their face comfortably. Attach a label to each pair of goggles and write the student's name/initials as a way to identify them.
 3. Remind the students that during some of the activities, the safety goggles will need to be over their eyes for protection. Tell them that you will instruct them when goggles need to be worn. Throughout this guide, note the times when goggles are required to be worn.
 4. Tell students that scientists never put their noses into cups to smell. Instead, they use an action called "wafting," which is moving the air over the beaker towards their noses, to detect odors. Have the students practice this motion. On days two and four, students may be tempted to smell the contents of their cups. Be sure to remind them about wafting.
 5. Scientists do not taste substances even when they may look like food because the substances could be harmful or even poisonous.
 6. Discuss the need for closed-toed shoes and remind them not to wear sandals or flip flops during the program.

What is a Scientist? = 10 minutes

- “What is a Scientist?” book by Barbara Lehn
- Poster paper & marker for teacher use

Engage students in a conversation about being a scientist.

1. Read the book to the students.
2. When finished, ask students to name some of the behaviors mentioned in the book. These should be emphasized:

Asks questions	Measures	Observes
Learns from senses	Counts	Records
Draws	Sorts	Keeps trying
Writes	Experiments	Makes & tests predictions
Notices details	Thinks logically	Has fun

3. Explain that this week, we will practice these behaviors as we work like scientists.
4. Ask students what they think a scientist is and does. Hold a brief discussion, eliciting students’ preconceptions about science. Have students share why they like or don’t like science or how this program can help improve their opinion of science. Explain to students that they will use these behaviors as they learn about the science of sports.
5. Write the above behaviors on poster paper and display during all the classes to remind students and refer to them. Help students continue to identify scientific behaviors throughout the week as the class works on different activities.

What is Physical Fitness? = 5 minutes

Prepare students for the challenges to come by explaining that exercising helps people become physically fit. In particular, exercising their bodies helps them have better balance and stability. To prevent injuries, athletes start slowly and allow time to stretch their muscles before beginning to play. Let's start stretching our muscles.

1. Ask students to stand with their feet flat on the floor.
2. Lead them in simple stretching movements for just two or three minutes.
3. Have them bend over to touch their toes and hold position.
4. Extend your arms at shoulder height. Touch left knee with right hand. Touch right knee with left hand. Touch left foot with right hand. Touch right foot with left hand. Continue repetitions.
5. Extend arms above your head. Alternate clasping elbow of one arm with opposite hand.

Physical Challenges = 25 minutes

Balance Challenge #1

Students will test their balance and stability. Now that blood is flowing to our muscles because we stretched, let's work on our balance.

1. Have the students stand with both feet together and look forward with arms at their side. Hold this position for the count of 10.
2. Have the students lift one foot off the floor keeping their hands at their side and hold that position for the count of 10.
3. Have the students repeat the above, but close their eyes for a count of 10.
4. Ask the students to discuss what happened each time.
5. Ask the students which stance allowed them to stay balanced. Why do they think that stance was the best? What factors are needed to have balance?

Balance Challenge #2

- Taped uppercase Y pattern
1. Invite the students to the area where the taped Y has been placed on the floor.
 2. Invite one student to start at the wide end of the Y with one foot on each end.
 3. Have the student walk slowly from the open end of the Y towards the stem with his/her arms at the side of the body.
 4. Challenge the same student to walk down the Y again with his/her their arms in a different position such as straight out at shoulder height.
 5. Have all students take turns walking down the Y both ways.
 6. Ask the students to reflect:
 - a. What happens as you get closer to the bottom of the Y?
 - b. What happened when you walked with your arms in different positions?
 - c. Why does using your arms make balancing easier?
 - d. Which sports require athletes to have good balance?
 - e. How can we improve our balance?

Balance Challenge #3

Demonstrate a few easy yoga positions that require balance and don't require a yoga mat. If time allows, students can repeat the poses each day to see if their balance improves by the end of the session.

Did you know that many football players do yoga and take ballet lessons to improve their balance and flexibility? These abilities come in handy while running on the field avoiding the other team.



Standing Long Jump Challenge

- Starting line (tape on floor)
 - Yard sticks (8)
 - Measuring tapes (8)
 - Data sheets
 - Pencils
1. Now that we've worked on our balance and stability, let's add movement. Invite students to work with a partner to measure each other's long jumps past the starting line. Demonstrate for the students how to use the measuring tape or the yard sticks, whichever you choose.
 2. One partner will start as the Jumper and the other will be the Measurer and then switch.
 3. Demonstrate the activity for students: the Jumper stands on the starting line with feet shoulder width apart, rocking their feet and swinging their arms to build energy. Then when ready, jump with both feet at once. They must land on both feet and not take any steps, or the jump won't count. They need to "stick the landing" like in gymnastics. Use your balance skills to help you stand still.
 4. The Jumper stays still while the Measurer measures.
 5. The Measurer measures the distance from the starting line to the partner's heels with yard stick or measuring tape and records the distance on the data sheet.
 6. Repeat three times and record all the distances.
 7. Switch roles to let the other partner jump.

Level 2 students could also find the average, mode, and median of the distances for each student and across the group.

8. Discuss as a whole group:
 - a. Was there anything we did to help our jump?
 - b. What do you think would help us get better at this?
 - c. What sports need this skill?
9. Reflect on activities: Why are balance and jumping helpful skills in sports?

Block Run Challenge

- Starting line (tape on floor)
 - Finish line (tape on floor)
 - Blocks (16)
 - Timers (8)
 - Data sheets
 - Pencils
1. Continuing to work with a partner, each student will take a turn as the Runner and as the Data Recorder. Demonstrate how to use the timer and explain the activity:
 - a. The Runner runs from the one end of the line to the other end to collect two blocks—one at a time—from the opposite end and return each of them to the starting line. Blocks must be placed down on the starting line and cannot be thrown or tossed.
 - b. The Data Collector will record the time it takes to complete the task on the data sheet. The Runner should return the blocks back to the finish line before starting the next trial.
 2. Repeat three times and then switch roles.

Level 2 students could also find the average, mode, and median of the times for each student and across the group.

3. Discuss as a whole group:
 - a. How did our first times compare to our second and third? Why do you think it changed?
 - b. Are there any things that could change to make you faster?
 - c. What do you think would help us get better at this?

STEM Professionals = 10 minutes

- Profile Cards 1 & 2

Throughout the week, students will learn about STEM professionals involved in sports.

1. Explain to students that many different kinds of people work in sports, not just athletes and coaches. Many people help make sure that the players and teams can succeed. Today, we will look at two of the jobs that people do behind the scenes in sports.
2. Display and read aloud profile cards 1 and 2. Ask students to think about why that job is important. Ask students if they know anyone with those jobs.

Wrap-Up

1. Ask the students to recall the activities from today involving safety and other topics.
2. Discuss what it means to be a good scientist and how the students were like scientists today. Refer back to the list of scientific behaviors.
3. If the program is happening at a library, show the students the books the children's librarian has collected for them.
4. Distribute the student bags. Tell them that they will carry their goggles and pencils in it. Remind them that they need to bring their bag with them tomorrow.

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Part 2 – Physically Fit – Nutrition

OVERVIEW

Part two continues to focus on why athletes need physical fitness. Students will explore how the food they eat contributes to their fitness and ability to perform physical activities. Roles for STEM professionals will be highlighted.

TIME MANAGEMENT

Introduction & Review = 5 minutes

Nutrition Activities = 45 minutes

Food Breakdown

Hydration

STEM Showcase = 10 minutes

MATERIALS & SUPPLIES

- Safety poster
- Small beverage cups – 4 oz. (16)
- Pitcher of drinking water
- Bucket for disposing of unwanted liquid if a sink is not available
- Fruit juice
- Honey
- Sea salt
- Poster paper & marker for teacher
- Measuring cups (8)
- Measuring spoons (8)
- Stir sticks (16)
- Aluminum foil sheets
- Data sheets
- Pencils
- Colored paper clips (240)
- Yarn or string (16 pieces, each 8-10 inches long)
- Pony Beads or beads big enough to go on yarn (240)
- Construction paper strips (64)
- Tape (4 rolls)
- Profile cards 3 & 4

PREPARATION & SET-UP

Today the students will be working at tables. Prepare the chart with the recipe for the hydration activity in advance. If you removed the safety and scientific behaviors posters yesterday, return them to view for your discussion.

Prepare the materials for the Food Breakdown activity. Cut the construction paper along the long side so that each strip is about 11 inches long. Make sure to cut enough pieces so that each student can have 4 pieces. Cut yarn/string into 8-10 inch segments that are able to hold 15 beads. Pre-tie one end of the string if you don't want to have students tie their own.

Prepare the materials for the hydration activity. Each student will need a cup.

At the end of the session, if the safety and scientific behaviors posters cannot be left in place for tomorrow's session, remove them carefully for storage overnight. The plastic cups and plastic spoons should be discarded. Opened containers of fruit juice should be refrigerated for safety.

Introduction & Review = 5 minutes

Welcome students back and explain that they are going to learn a little bit about nutrition today. They are going to investigate healthy food and beverages. Athletes need to pay attention to what they eat and drink to make sure they are staying physically fit in order to perform at their best.

Ask students if they have ever heard of protein, fats, and carbohydrates? What kind of foods have protein? What about fats? What about carbs? Athletes eat all of these kinds of foods because our bodies break them down to provide energy. We're going to learn today about how our body breaks food down into its parts.

Ask students if they like to drink sports drinks like Gatorade. Why do they drink it? Why do athletes drink it? Besides hydrating your body with water, it also has salt and sugar in it to help nourish you.

Remind students about scientific behaviors. Today students are going to experiment with model foods and make a sports drink.

Nutrition Activities = 45 minutes

Food Breakdown = 20 minutes



- Colored paper clips (240 total – 15 per student)
 - Yarn or string (16 pieces, each 8-10 inches long)
 - Pony Beads or beads big enough to go on yarn (240 total – 15 per student)
 - Construction paper strips (64 pieces total – 4 per student)
 - Tape (4 rolls – 1 roll shared per 4 students)
1. Make a chain of the colored paper clips by hooking them together. Each paper clip represents a sugar and the whole chain is called a **carbohydrate**.
 2. Next grab your yarn and beads to make a different chain. Tie a knot at one end of a piece of yarn so that a bead will stay on. Now string beads onto the piece of yarn. Do not tie the other end! This chain is like a **protein** and each bead represents an amino acid.
 3. The strips of construction paper represent **fats**.
 4. Now for the breakdowns:
 - a. For the **carbohydrate**, unhook paper clips. How can you do this? At what places can you break the chain? Can you put pieces back together?

Explain to the students that carbohydrates are long chains of sugars that can be easily broken down at any point in the chain and can also be reassembled by the body. This process of breaking down and reassembling these chains releases energy that the body uses to function. The chain of paperclips represents this as they can easily be hooked and unhooked at any point in their chain.

- b. For **protein**, take off individual beads. Can you do this from different places? Can you add pieces back on?

Explain to the students that proteins are long chains of amino acids and act as the body's "building blocks" with a variety of uses such as building or repairing muscles. Unlike carbs and fats they cannot be broken down at any point in the chain, the beads on the string are a great example of this since the beads can only be removed at one end.

- c. For **fats**, rip pieces off of the strip. At what places can you rip the strips? Do this for 2 of the fat strips, tearing to make halves of different lengths. Can you put the ripped pieces back together? Use a small piece of tape to make a new fat strip. Use half of one strip and half of another.

Explain to students that fats are long chains of fatty acids. Like the construction paper they can be broken down anywhere but cannot be easily put back together. The body must first modify the fatty acids before they can be broken down and used as energy. Our tape is helping us "modify" the paper pieces to put them back together. Breaking down fatty acids takes much longer to break down than carbohydrates but releases more energy.

Hydration = 20 minutes



Students will learn about hydration by making their own sports drink.

NOTE: BE ALERT FOR POSSIBLE FOOD ALLERGIES

- Small beverage cups – 4 oz. (16)
- Pitcher of drinking water
- Bucket for disposing of unwanted liquid if a sink is unavailable
- Fruit juice
- Honey
- Sea salt
- Poster paper & marker for teacher
- Measuring cups (8)
- Measuring spoons (8)
- Stir sticks (16)
- Aluminum foil sheets
- Data sheets
- Pencils

1. Introduce the activity by asking students about their experience with sports drinks: How many of you have ever had a sports drink like Gatorade or Powerade? Why do athletes drink these kinds of drinks instead of water?
2. Explain to the students what electrolytes are and why they are important.
3. Invite students to make their own sports drink by combining key ingredients: water, fruit juice, honey, and sea salt.
4. Show the standard recipe on poster paper.

INGREDIENT	AMOUNT
Fruit juice/Water	½ cup
Honey	½ teaspoon
Sea salt	½ pinch

5. Remind students about wafting! While these ingredients are unlikely to cause problems, good scientific practice requires that students not smell the contents of their cups directly.
6. Hand out the ingredients, cups, measuring cups, stir sticks, and measuring spoons.
7. Show the students which measuring devices to use and how to measure accurately.
8. Allow students to sample their drink (beware of allergies), and discuss:
 - a. What do you taste? Is it too sweet, too salty?
 - b. How would we change it to taste different?

9. If desired, students can start again and create a new recipe with different ratios, taste, and modify. Students should use the recipe data sheet to keep track of the different ingredients and measurements they tried.
10. Encourage students to share their *recipes* with one another—but NOT their cups!
11. If time permits, tell the story of Gatorade which is included in the background information section of this guide.

STEM Professionals = 10 minutes

- Profile Cards 3 & 4

Throughout the week, students will learn about STEM professionals involved in sports.

1. Explain to students that many different kinds of people work in sports, not just athletes and coaches. Many people help make sure that the players and teams can succeed. Today, we will look at two of the jobs that people do behind the scenes in sports.
2. Display and read aloud profile cards 3 and 4. Ask students to think about why that job is important. Ask students if they know anyone with those jobs.

Wrap-Up

5. Ask the students to recall the activities from today involving protein, fats, carbohydrates, and hydration. Suggest that they read the labels on food and sports drinks to see these ingredients.
6. Recall what it means to be a good scientist and how the students were like scientists today. Refer back to the list of scientific behaviors.
7. If the program is happening at a library, remind the students that books are available to learn more.
8. Remind the students to put their things in their bags before they go.

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Part 3 – Mentally Fit

OVERVIEW

Part three turns attention to mental fitness as students explore aspects of physical activity that are controlled by the brain. Reaction time and hand-eye coordination are the two main concepts for this hour. Students will also continue to encounter roles for STEM professionals in sports.

TIME MANAGEMENT

Introduction & Review = 5 minutes

Reaction Time Challenge = 15 minutes

Hand-Eye Coordination Challenge = 20 minutes

Memory Game = 10 minutes

STEM Showcase = 10 minutes

MATERIALS & SUPPLIES

- Safety Poster
- Baseball bat cards (8)
- Data sheets
- Pencils
- Bean bags – 6 per pair of students – 2 of each color/style (48)
- Decks of Profile Cards (8)
- Profile Cards 5 & 6

PREPARATION & SET-UP

Today's activities require students to move around. Make sure that there is open space available for them. If you removed the safety and scientific behaviors posters yesterday, return them to view for your discussion.

At the end of the session, if the safety and scientific behaviors posters cannot be left in place for tomorrow's session, remove them carefully for storage overnight. The data sheets can be discarded. All other supplies should be returned to the kit.

Introduction & Review = 5 minutes

Welcome students back and explain that they are going to learn about mental fitness today. They are going to test reaction time, hand-eye coordination, and memory. Athletes need to stay mentally sharp in order to perform at their best level in their chosen sports.

Explain to students that our brains determine our reaction time, our coordination, and our ability to remember things. The more we use our brains, the better we get. At first, we may struggle with the challenges today and that's okay. If we keep trying, we'll see that our brains learn and adapt very quickly so that we get better almost right away.

Remind students about scientific behaviors. Today's activities will particularly challenge them to keep trying. Persistence is an important part of being scientific.

Reaction Time Challenge = 15 minutes

- Baseball bat cards (8)
- Data sheets
- Pencils

This challenge will test reaction time and show how practicing something over and over again can help improve skills needed including those needed in sports.

1. Students will work in pairs, taking turns between being the dropper and the catcher.
2. The dropper holds the paper strip overhead, counts down from three, and releases the card on one.
3. The catcher stops the card's fall by grabbing it between their thumb and pointer finger as soon as they can after it's dropped. The catcher holds still until the dropper can record the measurement on the data sheet.
4. Repeat the drop 5 times, recording each result.
5. Then, the dropper and catcher switch roles and repeat.

Level 2 students could also find the average, mode, and median of the distances for each student and across the group.

6. Discuss as whole group:
 - a. How did your times compare on the first and last tries? Why do you think it changed?
 - b. What do you think would help us get better at this?
7. Ask the students which sports need the players to have a fast reaction time.

Hand-Eye Coordination Challenges = 20 minutes

► **GOGGLES ON** ◀



- Paper
- Pencils
- Bean bags – 6 per pair of students – 2 of each color/style (48)

Drawing

1. Give each student a piece of paper and a pencil. Tell them to draw a star on the page. Then, tell them to turn the paper over. Now, with their eyes closed, draw a star again.
2. Ask them if it was hard to draw with their eyes closed. Explain that with practice, they could get better.

Level two students could also be challenged to draw the star with their “opposite” hand. While hard at first, with practice the task does become easier as the brain adapts.

Tossing & Catching

1. Next, have students work with a partner. Pick any one of their six bean bags. (Style doesn't matter for this activity.)
2. Level 1 students should stand about 4' apart. Level 2 students should stand about 6' apart.
3. Tell the students that they are going to have an easy catch, tossing the bag back and forth. However, they can only use one hand.
4. First, put your left hand behind your back. One partner tosses the bag (with right hand) and opposite partner catches it with right hand. As soon as you toss the bag, switch hands and put your right hand behind your back. In this way, students are alternating the tossing/catching hand back and forth.
5. Keep going until you can catch at least two bags in a row. If time allows, have students challenge themselves to get three or more in a row.

Deciding to Catch

1. For this activity, one student will toss all six bean bags to the other before they switch roles. Emphasize that they should be easy, underhand tosses. The receiver should be able to catch the bags easily. Everyone can use both hands for this activity.
2. The student throwing the bean bags decides the order of the colors/styles to throw so that the receiver doesn't know what to expect.
3. You should announce one color/style that will be the “no catch” color. So, the student receiving the throws should NOT catch those two bean bags. After all six bags have been thrown, the players switch roles.

4. When you notice that all of the students have had at least one turn as the catcher, stop play and reset. This time announce a different color/style as the “no catch” color/style.
5. This activity challenges the brain to process information very quickly to make a decision about whether or not to move your hands into position to catch the bag. Hand eye coordination is an important skill in many sports, like tennis. When the ball is near the line, the player needs to make a split second decision about whether or not to hit it or let it go out of bounds.

Memory Game = 10 minutes

- Decks of small Profile Cards (8)
1. Explain that playing games that test your memory can help you improve your mental fitness.
 2. Students should work with a partner. Have students spread the cards face-down in a four by four grid.
 3. Students take turns turning over one card and then a second. If the cards match, they are removed from the grid. If not, they are turned back over and left in place. The player who makes more matches “wins” the game. If time allows, have students shuffle the cards, reset the grid, and play again.
 4. Explain to students that many athletes need good memories. In football, players need to memorize formations and plays. In baseball, players memorize coaching signals that change frequently.

STEM Professionals = 10 minutes

- Profile Cards 5 & 6

Throughout the week, students will learn about STEM professionals involved in sports.

1. Explain to students that many different kinds of people work in sports, not just athletes and coaches. Many people help make sure that the players and teams can succeed. Today, we will look at two of the jobs that people do behind the scenes in sports.
2. Display and read aloud profile cards 5 and 6. Ask students to think about why that job is important. Ask students if they know anyone with those jobs.

Wrap-Up

1. Ask the students to recall the activities from today involving mental fitness. Ask about reaction time, hand-eye coordination, and memory.
2. Recall what it means to be a good scientist and how the students were like scientists today. Refer back to the list of scientific behaviors.
3. If the program is happening at a library, remind the students that books are available to learn more.
4. Remind students to take their bags.

GSK Science in the Summer™

Science of Sports

Part 4 – Equipped to be Fit

OVERVIEW

Part four focuses on the science behind sports equipment. Students make their own bouncy balls. The Bounce Challenge requires students to apply concepts from earlier parts—they'll need balance and stability as well as good hand-eye coordination as they bounce the balls they made from scratch. Finally, the end of session activities bring their week of science exploration to a close.

TIME MANAGEMENT

Introduction & Review = 5 minutes

Bouncy Balls = 20 minutes

Bounce Challenge = 15 minutes

STEM Showcase = 10 minutes

Conclusion = 10 minutes

MATERIALS & SUPPLIES

- Safety Poster
- Plastic cups – 8 oz. (16)
- Plastic bowls (16)
- Plastic spoons (16)
- Pitcher of warm water – 64 tablespoons
- Borax – 8 teaspoons
- Corn starch – 48 tablespoons
- White glue – 16 tablespoons
- Food coloring – variety of colors
- Aluminum foil sheets
- Paper towels
- Measuring spoons
- Markers
- Baseballs (8)
- Tennis balls (8)
- Ping-pong balls (8)

- Yard sticks
- Data sheets
- Pencils
- Profile cards 7 & 8

PREPARATION & SET-UP

Today's activities may be messy. Be sure to have paper towels handy in case of spills. If you removed the safety and scientific behaviors posters yesterday, return them to view for your discussion.

At the end of the session, the scientific behaviors poster can be discarded as your next group of students should make their own. The safety poster should be returned to the kit with all other supplies. The used cups, bowls, and spoons should be discarded.

Introduction & Review = 5 minutes

Welcome students back and explain that they are going to learn about sports equipment today. They are going to make bouncy balls and learn about materials. Different materials have different properties that determine whether they bounce a lot, a little, or not at all. In many cases, sports are designed around a ball's (or other equipment's) properties.

Remind students about scientific behaviors. Today's activities will particularly challenge them to be precise. Measuring the ingredients to make their polymer balls requires just the right amount—too much or too little of an ingredient changes the formula and the ball might not bounce. Scientists have to be very precise with their measurements to make sure their experiments succeed.

Bouncy Balls = 20 minutes

► **GOGGLES ON** ◀



- Paper/wax cups – 8 oz. (16)
 - Plastic bowls (16)
 - Popsicle sticks (16)
 - Warm water – 8 cups
 - Borax – 16 tablespoons
 - Corn starch – 16 tablespoons
 - White glue – 32 tablespoons
 - Food coloring – variety of colors
 - Paper towels
 - Measuring spoons
 - Markers
1. Remind students about wafting! They may be tempted to smell the contents of their cups and bowls.
 2. In the cup, combine $\frac{1}{2}$ cup of warm water, 1 tablespoon of borax, and 1 tablespoon of cornstarch. Use the popsicle stick to mix well. Have paper towels handy in case of spills.
 3. In the bowl, combine 2 tablespoons of white glue with a few drops of food coloring. One drop will result in a pale shade, three drops a darker shade, etc. Use the popsicle stick to mix well. (Use your discretion as to whether or not your students should be allowed to mix colors. Limiting to the primary colors ensures pleasant outcomes. Mixing colors risks unappealing colors at the end, although mixing, if managed carefully, can result in fun colors.)
 4. Slowly pour the warm water mixture from the cup into the glue mixture in the bowl. Mix well with the stick. The mixture will begin to clump. Keep mixing until all clumps make one big ball.
 5. Use bare hands to take the big ball out of any residual liquid in the bowl and roll the ball between your palms. It will be sticky at first and a little messy. Keep rolling until it is no longer sticky. It should become smooth and dry.
 6. Bounce the ball!
 7. If desired, use a marker to write each student's name on the balls to avoid confusion as similar balls are bouncing.

Bounce Challenge = 10 minutes

► **GOGGLES ON** ◀



- Bouncy balls (16)
 - Baseballs (8)
 - Tennis balls (8)
 - Ping-pong balls (8)
 - Yard sticks
 - Data sheets
 - Pencils
1. Invite students to compare the “bounciness” of their new balls with one another and with standard baseballs, tennis balls, and ping-pong balls. Invite hypotheses about which balls will be bounciest.
 2. This activity works best on a hard surface, so move to a hard floor if possible. If not, have the students use the tabletops as their floor.
 3. Working with a partner, take turns collecting data about each ball’s bounce. One student will be dropper while the other is the measurer. After collecting data on all four balls, the students should rotate and repeat.
 4. The measurer should hold the yard stick vertically (with the lowest number at the bottom) by placing one end flat on the floor/tabletop. Instruct the measurers to keep their eyes focused on the floor/tabletop as the bounce will be fast.
 5. The dropper selects one of the four balls (the testing order doesn’t matter) and holds it level at the top of the stick, counts down to the release, and then simply releases the ball. (The dropper should not be adding force to the drop.) The measurer watches the ball hit the floor/tabletop and then notes how high it bounces. If the measurer “misses” the bounce, the dropper should repeat the drop.
 6. If time remains, encourage the students to keep repeating as scientists always try to collect more data before they draw conclusions.
 7. Once all students have had at least one chance to be both dropper and measurer, invite the students to share their data.
 8. Which ball bounced highest? Lowest? What are the characteristics of the balls that bounced higher/lower? What result surprised you? Why are these balls good for the sports that use them?

STEM Professionals = 10 minutes

- Profile Cards 7 & 8

Throughout the week, students have been learning about STEM professionals involved in sports.

3. Explain to students that many different kinds of people work in sports, not just athletes and coaches. Many people help make sure that the players and teams can succeed. Today, we will look at two of the jobs that people do behind the scenes in sports.
4. Display and read aloud profile cards 7 and 8. Ask students to think about why that job is important. Ask students if they know anyone with those jobs.

Wrap-Up

9. Ask the students to recall the activities from today involving bounce.
10. Recall what it means to be a good scientist and how the students were like scientists today. Refer back to the list of scientific behaviors. Go through the list and ask students to volunteer examples of each behavior that they used throughout the sessions.
11. If the program is happening at a library, remind the students that books are available to learn more.

Conclusion = 10 minutes

- Paper
- Pencils
- Crayons

Invite level one students to draw a picture of their favorite part of the week.

Invite level two students to write a thank-you note to GSK about their favorite part of the week.

Collect the pictures/notes at the end of the session for return to The Franklin Institute.

Distribute certificates, take-home activity books, and Family Day flyers. Encourage the students to show the flyers to their parents so that they can come to the event. Remind the students to take their goggles, pencils, and bags with them.

Thank the students and anyone else who is present for participating in the GSK Science in the Summer™ program. See you next year!

GSK Science in the Summer™

Science of Sports

Optional Activities

See the Beat = 10 minutes

Balancing Act = 15 minutes

Balloon Launch = 10 minutes

Multitasking = 20 minutes

See the Beat = 10 minutes

Note that this activity may be too difficult for level one students. You can use it as a demonstration for them instead.

- Toothpick (16)
 - Mini-marshmallow (16)
1. First, show students how to find the pulse point. Hold two fingers (not your thumb) to the inside of your wrist until you feel your pulsing blood.
 2. Put the marshmallow on the spot where you feel your pulse is the strongest, and gently push the toothpick partially into it. What happens? Now take off the marshmallow and toothpick and do 25 jumping jacks or run in place for a minute. What happens when you put the marshmallow and toothpick back on your pulse point?
 3. Your heart is a muscle that sends blood rushing through your body when it beats. The surge of blood at each beat is called your pulse. You can feel it in your wrist, neck, and ankles. Your pulse makes the stick move every time your heart beats. When you exercise, your heart beats faster.

Balancing Act = 15 minutes

Gravity seems to pull an object downward from just one point, its center of gravity. In order for a gymnast to balance on a beam or a surfer to ride a wave, they must understand their own center of gravity. Let's find the center of gravity of an uneven object!

- Large piece of cardboard
- Modeling clay (or other weight)
- String
- Scissors
- Paper clip
- Tape
- Ruler
- Pencil

1. On the cardboard, draw and cut out an uneven shape. Be creative.
2. With the tip of the pencil, punch two small holes on opposite edges of the shape.
3. Take the piece of string, and on one end, make a loop and wrap a lump of clay around the other end. This is known as a plumb line.
4. Unbend the paperclip, make a hook, and tape it onto the edge of a table.
5. Hang the shape and then the plumb line on the hook.
6. Wait until the string stops swaying and mark an "X" where the string is resting against the lower edge of the cardboard.
7. Take the plumb line and cardboard off the hook and draw a line with the ruler from the hole to the "X."
8. Hang the shape from the other hole and repeat steps 5 to 7.
9. Place the shape on your finger at the point where the two lines cross.
10. Does your shape balance where the two lines cross? If yes, was the center of gravity for the shape where you thought it would be? If no, why do you think it doesn't balance at that point? What could you do to find the true center of gravity?

Balloon Launch = 10 minutes

This activity can be completed in 10 minutes or it can be extended with multiple balloon releases to last much longer.

- String
 - Tape
 - Balloon (oblong balloons work better than circular ones)
 - Paper clamp
 - Three paper clips
1. Run string across the room. Pull taut and attach securely to opposite walls.
 2. Inflate the balloon. Instead of tying a knot, secure the open end of the balloon with the paper clamp. Sometimes it helps to fold the end once or twice before clamping it.
 3. Bend the paper clips into “L” shapes and tape them in a straight line on top of the balloon. Use these clips as hooks to hang the balloon on the string.
 4. Have a countdown and then release the clamp from the balloon.
 5. The escaping air pushing against the inside of the balloon provides propulsion. As the air escapes in one direction, the balloon is pushed in the opposite direction. This is an example of Newton’s Third Law of Motion, which states that “For every action, there is an equal and opposite reaction.” For an extra challenge, try building a model rocket!

Multitasking = 15 minutes

- Masking tape
- Calculators (8)

1. Use the masking tape to make 8 straight lines on the floor, each about 12 feet long.
2. Students take turns being the walker and the watcher. The walker begins by walking along the taped line. The challenge is to make it to the end without stepping off the tape. The watcher looks for any steps off the line. It should be fairly easy to stay on the line.
3. When the walker makes it to the end, the watcher hands the walker a calculator. Now, the walker's challenge is to walk to the end while calculating the numbers that the watcher calls out. Post this for the watchers to read to their partners:

For level one students: $4 + 6 + 2 + 9 + 10 + 3 + 15 + 7 = ?$ [56]

For level two students: $18 + 6 - 4 + 22 + 8 - 25 \div 5 \times 7 = ?$ [35]

4. While the watcher is calling out the numbers, (s)he is also looking for any steps off the line. When the walker steps off the line, (s)he returns to the beginning and clears the calculator to reset. It will be very difficult at first to stay on the line while calculating. With repeated attempts it should get easier.
5. Multitasking is a myth. The brain is not capable of focusing on two things at once. When we attempt to do two things at the same time, the brain switches between the tasks. As a result, controlling balance on the line competes with thinking about the buttons on the calculator and causes you to do neither perfectly.

Note: If your classroom is small, you may not be able to have eight watchers calling out the numbers at the same time. If your room is small, you may want to reduce the number of lines so that students can be far enough apart so as to concentrate on hearing their own numbers. For example, you might have four students taking turns on four lines or else eight students taking turns on two lines.

Science of Sports

Background Information

The following information is provided to help you prepare to teach the Science of Sports content and to help you respond to student questions.

Athletes & STEM Professionals

A variety of STEM professionals and athletes are featured on the profile cards that you will use with the students. They represent the diversity of ethnicity, gender, age, body shape, and people with disabilities. Examples include **Simone Biles** who is a 4'8" Olympic gymnast who has won the most world gymnastics medals in US history (14), and the most world gold medals (10) of any female gymnast ever. **Michael Phelps** is a 6'4" Olympic swimmer who has competed in five Olympics and has won 28 Olympic medals, making him the most decorated Olympian of all time. **Danica Patrick** is a 5'2" female NASCAR driver, and is the only woman who has led in both the Daytona 500 and Indianapolis 500 races. **Misty Copeland** is a 5'2" ballet dancer, and is the first African American woman to ever become the Principal Dancer in the American Ballet Theater. **Serena Williams** is a 5'9" tennis champion, who has won 23 Grand Slam titles, the second most of all time. **Lionel Messi** is a 5'6" soccer player from Argentina who has become one of the greatest soccer players in the world. **Sidney Crosby** is a 5'11" ice hockey player, who is the youngest captain in NHL history. **Stephen "Steph" Curry** is a 6'3" professional basketball player in the NBA, with a record of making 90% of his free throw attempts and 44% of his 3-point attempts. **J.J. Watt** is a 6'5" football player who plays defensive end in the NFL. **Tatyana McFadden** is a 5'3" Paralympic champion wheelchair racer and Nordic skier, who has won 16 medals and placed first in numerous marathon races across the world. **Richard Browne** is a 6'2" Paralympic track & field sprinter and high jumper who lost his right leg below the knee, and has broken numerous world records for various races in disability athletics. **Ibtihaj Muhammad** is a 5'7" fencer, who was the first American woman to wear a hijab during an Olympic competition in which she won a bronze medal in 2016.

There are many people involved in sports, besides athletes, who use science to contribute to and enhance sports. **Coaches and trainers** use knowledge of how the body works, health, and practice to keep athletes strong and effective. **Nutritionists** help athletes understand how a healthy diet with proper nutrients can maximize their body's effectiveness in their sport. **Sports medicine doctors, team doctors, and physical therapists** help athletes recover from injuries in ways that protect their bodies and maximize performance. **Psychologists and neuroscientists** study and treat the impact of sports on athletes' brains, often helping them to develop healthy mindsets for competition. **Designers, engineers, material scientists, and chemists** design and create the equipment, gear, and tools used by athletes and coaches in playing sports. **Technologists and computer scientists** develop proper technology needed to track and show data during sporting events. **Mathematicians and statisticians** record and analyze data that takes place across sporting events that help interpret

performance of individual athletes and teams. All of these STEM professionals play important roles in making sports what they are today.

Physical Fitness

Balance and stability are important skills for most sports. Our bodies balance by evenly distributing weight around a center of gravity, which is usually slightly above one's waist depending on each person's height and weight. A lower center of gravity maximizes balance and stability. This is why being short is an advantage in sports like gymnastics. Race cars are also designed low to the ground, to minimize risk of turning over while going at high speeds. A wider stance and bent knees, like that used by a surfer, also improve stability and mobility by widening one's base of support.

Speed, agility, and reaction time all involve the ability to move quickly and easily while maintaining control of one's body. These skills require changes in one's center of gravity while experiencing quick and coordinated muscle movements. Though agility and speed seem to come naturally to some, these are skills that develop through numerous repetitions and practice. Practice allows muscles get stronger and the brain's neural pathways involved in these skills to get faster, allowing the body to more easily perform with little thought needed. Improvement in speed and agility take a long time to build and maintain through ongoing practice and conditioning.

Energy is key for successful performance in sports. When athletes exert themselves physically, they expend a great amount of energy (and sweat) and need to replenish what is lost in order to continue playing and recover afterwards. Electrolytes are minerals that are necessary for specific functions in the body which are lost through sweating, including calcium, sodium, potassium, magnesium, phosphate, and chloride. These electrolytes help to regulate nerve and muscle function, hydration, the pH of blood, rebuilding damaged tissue, and determining blood pressure, and are important to replenish after they are lost when playing sports. Athletes often drink sports drinks with high concentrations of electrolytes like Gatorade or PowerAde to replenish the body's concentration of important nutrients and water.

History of Gatorade

www.gatorade.com/company/heritage

In early summer of 1965, a University of Florida assistant coach sat down with a team of university physicians and asked them to determine why so many of his players were being affected by heat and heat-related illnesses.

The researchers—Dr. Robert Cade, Dr. Dana Shires, Dr. H. James Free and Dr. Alejandro de Quesada—soon discovered two key factors that were causing the Gator players to “wilt:” the fluids and electrolytes the players lost through sweat were not being replaced, and the large amounts of carbohydrates the players' bodies used for energy were not being replenished.

The researchers then took their findings into the lab, and scientifically formulated a new, precisely balanced carbohydrate-electrolyte beverage that would adequately replace the key components lost by Gator players through sweating and exercise. They called their concoction “Gatorade.”

In the summer of 1969, Coach Ray Graves of the Florida Gators suggested to the Kansas City Chiefs that they use Gatorade to combat the staggering effects of a blistering Missouri sun during training camp. The Chiefs were so impressed with the “Gator coach's aid” that they kept it on their sidelines

throughout the entire season...which concluded with a stunning victory over the heavily favored Minnesota Vikings in Super Bowl IV.

In the years that followed, more and more NFL teams began placing Gatorade on the sidelines of their games and practices, and in 1983, Gatorade became the official sports drink of the NFL—a title it holds to this day.

Two decades after Dr. Cade and his team worked diligently to develop the optimum hydration formula that would become Gatorade, the Gatorade Sports Science Institute was founded in Barrington, Illinois, to conduct scientific research in the areas of exercise science, hydration, and sport nutrition. Three years later, the lab would be expanded to provide advanced testing for athletes and new Gatorade products and flavors and develop education materials for sports health professionals around the world. Gatorade is now also the official sports drink of the NBA, AVP, and PGA, Major League Baseball, Major League Soccer, and numerous other elite and professional organizations and teams.

Mental Fitness

Competitive sports require significant mental focus and resilience in order to perform well. Disappointments and losses are inevitable, so finding a way to cope with and bounce back from loss is essential. Injuries and time away from one's sport are also common, especially with the intensive training that athletes experience. Coaches, trainers, and psychologists help athletes remember to have fun and not let the stress of winning hinder the ability to enjoy and play the sport to their best ability. Like building physical skills through practice, mental skills require practice as well. It can be hard to bounce back from loss, but through repeated practice in a positive and proactive mindset, these skills and approaches become easier to embrace.

Sports Equipment

Sporting equipment and gear are purposefully engineered to keep athletes safe, comfortable, and able to move quickly and easily. Examples of sporting equipment include balls, sticks, nets, surfaces, racquets, etc. Examples of sporting gear include clothing, pads, shoes, helmets, gloves, mouth guards, etc. Scientists and engineers carefully design, test, and revise these items to maximize performance as well as safety.

A **polymer** is a substance made up of several similar molecules that form a long chain. Some polymers are rubbery in texture and bounce, such as the one students create in the Bouncy Balls activity. This bounciness is a result of the long chain of molecules staying together even when thrown with force.

Sports balls are engineered differently depending on their function in a particular sport. For example, a football has a prolate spheroid shape which makes it easy to carry and throw. A tennis ball has a fuzzy surface, which allows for controlled bounce so that it doesn't move too high or too fast to stay within the space of a tennis court. A golf ball has dimples on it, which allow the ball to glide farther through the air. The stitches on a baseball allow pitchers to put spin on the ball, and the height of the stitches impact how it flies through the air. Softballs are bigger (but not softer) than baseballs, since a softball field is smaller and the ball doesn't need to travel as far. A basketball has dimples like a golf ball which helps with grip, and a soccer ball's black and white pattern helps athletes see it easily from far away.

The inside of sports balls is also engineered to support necessary functions in each sport. Some balls are filled with air and have more flexibility (football, basketball, soccer ball), while others have a cork center that is covered with rubber and yarn (baseball, softball). Footballs, basketballs, and soccer balls are all manipulated by athlete's bodies, and need to be thrown, caught, and kicked. Softness upon catching or hitting one's body is important to maximize safety. For baseball and softball, bats are used to hit the balls a far distance. Those balls need to be much harder in their center in order for it to withstand the great force from the swing of a bat, to reverse the direction and speed of a ball moving as fast as 100+ miles per hour.

For the bounce challenge, it is important to use a hard floor. Different sports are played on different surfaces, including grass, artificial grass/turf, hard courts covered with acrylic, wood, ice, concrete, asphalt, clay, sand, and more. Each of these materials provide different advantages, and require different levels of maintenance. Grass and turf both offer a surface with natural resistance so players don't slip easily as they are running to catch or kick balls. Turf offers advantages like being long-lasting and not needing time to regrow like grass. Polished wood surfaces like basketball courts allow for smooth surfaces on which to bounce balls and make quick pivoting movements. Tennis takes place on a variety of surfaces, each highlighted in different Grand Slam tournaments: Wimbledon is on a grass court, the US Open and Australian Open are on hard courts covered with acrylic, and the French Open takes place on red clay, which is made from crushed brick or stone. A clay surface provides unique challenges for a tennis player. The unstable surface makes it easier to slide and lose one's balance, and the added friction between the clay and the tennis ball requires different amounts of force and spin to achieve typical results. Hard courts allow players to grip the surface better with their shoes, and balls move faster.