

GRADE 7 PHYSICAL EDUCATION & HEALTH

First edition

5 units

10 lessons • one quarter

A video for every lesson

FIRST EDITION

COURSE GUIDE

This short course follows five strands of health and fitness through one quarter of the school year: keeping active, water, food, strength and the heart and lungs. In seventh grade the questions get sharper. Why does training make you stronger only if you rest? How much does a little lost water slow you down? What did the race to the South Pole teach about food and fuel? Why are some muscles built for speed and others for endurance? Each lesson is built around a real person, study or moment: Cheri Mah's sleep study with the Stanford basketball team, Gabe Mirkin's RICE rule and how doctors have refined it, Edward Adolph's desert water studies, the new "Added Sugars" line on the Nutrition Facts label, Amundsen and Scott in Antarctica, the USDA food guides from 1916 to MyPlate, Louis Ranvier's red and white muscles, the research that showed supervised strength training is safe for young people, A. V. Hill's oxygen experiments and Emil Zátopek's interval training.

Every lesson follows the same path. First comes **the story**. Then **how they figured it out**: the question, what was tried, what was measured. Then **how your body works**, explained with real vocabulary and a little arithmetic: beats per minute, ounces of fluid, grams on a label, sets and reps in a training table. Last, **try it**: the student does a real workout, test or kitchen task, records it in a fitness journal, and tries to improve on the second try.

God made the body good, and He gave it to us to care for. This course is about stewardship, strength, joy in movement and good habits. It is never about size or looks: students are measured only against their own effort and improvement. The old Latin saying *Fabricando fit faber*, "by making, one becomes a maker," fits training well: strength and endurance are built by practice, a little more each week, with rest in between. The quarter ends with a family fitness day, when the student plans and leads the whole household in moving, playing and eating together.

Most videos come from trusted health and teaching channels: children's hospitals (Johns Hopkins All Children's, CHOC, Nemours, Texas Children's and Nationwide Children's), the U.S. Food and Drug Administration, the USDA, TED-Ed, the Olympics' official channel, and British school-revision channels such as Cognito and Teach PE. Every video was previewed for accuracy and for modest dress. A few are made for adults or for slightly older students; the lesson notes say so. Some channels end with an invitation to subscribe; you can stop the video when the teaching ends. Watch together, and do the warm-up drills along with any video that shows them.

Start with Lesson 1.1 →

WHO IT IS FOR

Written for students in grade 7 (about ages 12–13) who read independently, work with decimals, percents and simple formulas, and can make tables and graphs. A parent or teacher reads along, supervises every activity and helps in the kitchen. Nothing needs to be bought: every activity uses household things such as a towel, a sturdy chair, a step, a wall, a backpack with books, water jugs, measuring cups and a timer. A light resistance band is optional in Unit 4.

HOW TO USE THIS COURSE

- 1. The weekly rhythm.** The quarter has 10 lessons, one a week, each with three sessions of 40–45 minutes. Session 1 is the warm-up, the video, the teaching and the picture study, with a little movement. Session 2 is the activity (the workout, the test or the kitchen task) and the fitness journal. Session 3 repeats the activity and tries to improve on it. In the second week of each unit, use part of Session 3 for the unit review and the unit challenge. On the other days, aim for at least 60 minutes of moderate to vigorous activity in play, chores, sport and walking, with muscle- and bone-strengthening activity on at least 3 days a week.
- 2. Check with your doctor first.** A parent should know about and supervise every activity. If your child has asthma, a heart condition, diabetes, a recent injury or any other health concern, check with your doctor before starting, and follow the doctor's advice about what to change.
- 3. Story, then science, then doing.** The core ideas can be read by the student alone, but they are better read and discussed together. The paragraphs marked *The story*

and *How they figured it out* tell what happened and how people learned it; *How your body works* explains the science; *Try it* explains the activity. Ask the student to explain each paragraph back in his or her own words, and to point out what was measured.

4. **Picture study.** Each lesson has one public-domain painting, print or historic photograph chosen for what it shows about work, rest, food, water or movement. Look at it quietly for two minutes, put it away and tell everything you remember, then bring it back and work through the “look for” items and questions.
5. **The fitness journal.** Use any notebook for the whole quarter. Every activity is done, recorded and done again: reps, seconds, minutes, ounces, grams, beats per minute, hours of sleep. Date every page. Write how it felt (an effort rating from 1 to 10 is used throughout) and what you will try next time. Honest records matter more than big numbers.
6. **Health, not looks.** In this course we talk about what bodies can do and how to care for them, never about size or shape. We do not count or restrict calories or call foods bad. Calories appear only as a unit of food energy, the way miles measure distance. Foods are “nutrient-dense” foods and “treat” foods, and feasts and treats are good gifts in their place. In Lesson 2.1 a student may, with a parent, read a scale before and after exercise to measure the fluid lost in sweat; that number is recorded only as fluid lost, never as body weight, and the scale step may be skipped. Grades come from effort, consistency and personal improvement, never from comparing one student with another.
7. **Optional books and gear.** Some units list a free government or children’s-hospital web page, a book, or simple gear such as a light resistance band, a jump rope or a water bottle with ounce marks. They are never required.
8. **Unit review and unit challenge.** Each unit ends with a review (50 points, with one or two calculations and a short written answer) and a unit challenge: a recovery-week log, a game-day hydration plan, a planned and cooked day of meals, a four-week strength plan with a retest, or an interval plan and the family fitness day. Keep the challenge pages in a folder.
9. **Safety.** Read the safety note before each activity. Warm up first and cool down after. Clear a space with a flat, non-slip floor and wear good shoes. Stop and tell an adult right away at chest pain, dizziness, fainting, trouble breathing or sharp pain; tired muscles are normal, but joint pain is not. Strength work in this course

uses body weight, a backpack with books, water jugs and an optional light resistance band, always with good form; there is no maximum-lift testing. A parent supervises knives and the stove, and checks for food allergies before any tasting. Exercise and food are never used as a reward or a punishment.

10. **The family fitness day.** In the last week, plan and lead a family fitness day: a warm-up you lead, stations from every unit, a water table, a meal or snack you help cook, and a family interval relay. Everyone moves at his or her own pace.

SCOPE AND SEQUENCE

UNIT 1 • WEEKS 1–2

Keeping Active

Why rest is part of training, through the Stanford sleep study, the Sabbath and Jesus’ call to “rest a while,” with a recovery-week log; and preventing injuries with a good warm-up, good shoes, the “too much, too soon” rule, balance training and first aid for minor sprains.

- 1.1 Rest Is Part of Training
- 1.2 Preventing Injuries: Too Much, Too Soon

UNIT 3 • WEEKS 5–6

Nutrition

Amundsen and Scott’s race to the South Pole in 1911–12 and what it teaches about food as fuel and careful planning; and the USDA food guides from 1916 to MyPlate, with a balanced day of meals the student plans and helps cook.

- 3.1 Amundsen and Scott: Food for the South Pole
- 3.2 Planning a Balanced Day of Meals

UNIT 2 • WEEKS 3–4

Hydration

How even a small loss of body water slows you down, from Edward Adolph’s desert studies to a sweat check done with a parent; and sports drinks, water and the Nutrition Facts label, with a label lab and a drink plan.

- 2.1 Water and Performance
- 2.2 Sports Drinks, Water and Labels

UNIT 4 • WEEKS 7–8

Strength

Louis Ranvier’s red and white muscles and the fast and slow fibers in your own legs, with speed and endurance tests; and progressive overload, with a four-week strength plan using body weight, a backpack and an optional band.

- 4.1 Fast and Slow Muscle Fibers
- 4.2 Progressive Overload: A Four-Week Plan

UNIT 5 • WEEKS 9–10

Aerobic Training

A. V. Hill's oxygen experiments, aerobic and anaerobic energy and the talk test; and Emil Zátopek's interval training and three gold medals at Helsinki in 1952, with an interval session, a retest and the family fitness day.

5.1 A. V. Hill and Oxygen

5.2 Emil Zátopek and Interval Training

WEEKLY PACING CALENDAR

WEEK	PLAN
1	• Session 1: Lesson 1.1 Rest Is Part of Training: warm-up, video, teaching and picture study • Session 2: Lesson 1.1 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it <i>Three short sessions a week is the usual rhythm: one to learn, two to move. Keep moving every day, even on days with no lesson.</i>
2	• Session 1: Lesson 1.2 Preventing Injuries: Too Much, Too Soon: warm-up, video, teaching and picture study • Session 2: Lesson 1.2 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it • Session 3 (end of unit): Unit 1 review and unit challenge
3	• Session 1: Lesson 2.1 Water and Performance: warm-up, video, teaching and picture study • Session 2: Lesson 2.1 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it
4	• Session 1: Lesson 2.2 Sports Drinks, Water and Labels: warm-up, video, teaching and picture study • Session 2: Lesson 2.2 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it • Session 3 (end of unit): Unit 2 review and unit challenge

WEEK	PLAN
5	• Session 1: Lesson 3.1 Amundsen and Scott: Food for the South Pole: warm-up, video, teaching and picture study • Session 2: Lesson 3.1 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it
6	• Session 1: Lesson 3.2 Planning a Balanced Day of Meals: warm-up, video, teaching and picture study • Session 2: Lesson 3.2 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it • Session 3 (end of unit): Unit 3 review and unit challenge
7	• Session 1: Lesson 4.1 Fast and Slow Muscle Fibers: warm-up, video, teaching and picture study • Session 2: Lesson 4.1 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it
8	• Session 1: Lesson 4.2 Progressive Overload: A Four-Week Plan: warm-up, video, teaching and picture study • Session 2: Lesson 4.2 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it • Session 3 (end of unit): Unit 4 review and unit challenge
9	• Session 1: Lesson 5.1 A. V. Hill and Oxygen: warm-up, video, teaching and picture study • Session 2: Lesson 5.1 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it
10	• Session 1: Lesson 5.2 Emil Zátopek and Interval Training: warm-up, video, teaching and picture study • Session 2: Lesson 5.2 activity and fitness journal • Session 3: Repeat the activity, try to improve, and log it • Session 3 (end of unit): Unit 5 review and unit challenge <i>Last week. Hold a family fitness day: the student leads the family through a warm-up, a favorite activity from each unit and a cool-down, serves a healthy snack and water, and shows the fitness journal.</i>

MATERIALS

Fitness journal (any notebook)

One for the quarter: logs, tallies, heart-rate tables, sleep and water charts, meal plans, training tables, how it felt and what to try next time.

A timer or stopwatch (a phone timer with a lap button works)

For timed holds, work-and-rest intervals, pulse counts and timed runs.

Good athletic shoes and comfortable, modest clothes for exercise

Every activity lesson. Lesson 1.2 includes a shoe check.

A towel or mat, a sturdy chair that will not slide, a wall and a bottom stair or sturdy step

For push-ups, planks, step-ups, wall sits and stretches.

A backpack and books, and two gallon or half-gallon water jugs

Light household loads for the strength plan in Unit 4 and the sledge haul in Lesson 3.1.

A reusable water bottle and a measuring cup

For the drinking logs in Unit 2. A bottle with ounce marks is handy but not needed.

Drink and food labels, measuring spoons and a calculator

For the label lab in Lesson 2.2 and the meal plan in Lesson 3.2.

Ordinary groceries for one day of meals

Lesson 3.2: the student plans and helps cook a balanced day. Use what the family normally buys.

Sidewalk chalk or a few cones (cups or shoes work), and a tape measure

To mark a running loop, a shuttle course, jump distances and interval lines.

Colored pencils and graph paper

For bar and line graphs of sleep, heart rate, fluid, reps and lap times.

GRADING

Grades come mostly from the activities and the fitness journal, because fitness is learned by doing, recording and doing again. A student who works hard, records honestly and improves on his or her own numbers earns full credit, whatever those numbers are.

PART	%
Activities (effort, participation and good form)	40

PART	%
Fitness journal (dated logs, tables, graphs and reflections)	25
Unit reviews	15
Unit challenges	20

Scale: A 90–100, B 80–89, C 70–79, D 60–69. Below 60: repeat the activity or review with help.

- Fitness marks reward effort, consistency and improvement against the student’s own earlier numbers. They never depend on body size, body measurements or comparison with other students.
- A journal page earns full marks when it has a date, the numbers with units (reps, seconds, ounces, grams, beats per minute, hours), an effort rating, a sentence about how it felt and a sentence about what to try next time.
- In the unit reviews, calculations earn partial credit for correct steps even if the final number is off.
- A student who finds sport hard, or who has a health condition that limits some activities, is graded on faithful effort within what the doctor allows. Every body can grow stronger; the goal is faithfulness, not being the best.

A NOTE TO PARENTS

You do not need to be a coach to teach this course. Read the story together, watch the video, and then be the timer, the spotter for good form and the encourager. Do the workouts alongside your child when you can. A seventh grader is ready to take more charge of his or her own training, so let the student plan the sessions and keep the records, and check the plan together before each unit’s activity.

These years bring fast growth and, for many children, new self-consciousness about their bodies. Keep the talk on what bodies can do and how to care for them, never on size or shape. Praise effort, good form, honest records and wise rest. If a sibling or friend is faster or stronger, steer back to the journal: “Did you beat your own number from last month?” Exercise is good for the body, and Scripture says plainly that

godliness is better still (1 Timothy 4:8). We move, eat, drink and rest to the glory of God.

Lesson 3.1 tells the story of the race to the South Pole. As history requires, it says plainly that Captain Scott and the four men who reached the Pole with him died on the return journey in 1912. It is told briefly and without detail, with the focus on planning, food and fuel. Lesson 2.1 includes an optional sweat check in which the student reads a bathroom scale before and after exercise with a parent; the number is recorded only as fluid lost, and families may skip the scale and use the thirst and urine-color checks instead.

UNIT 1

KEEPING ACTIVE

You already know that God made your body to move and that young people need at least 60 minutes of activity a day. This year you will learn the other half of training: rest. Muscles do not grow stronger during a workout; they grow stronger while you recover from it, and most of that repair happens while you sleep. You will hear how a sleep researcher at Stanford asked a basketball team to sleep more and then measured their sprints and their shooting, read what Scripture says about the Sabbath and about Jesus calling His tired disciples to “rest a while,” and keep a week-long sleep and recovery log with a test and a retest.

Then you will learn how athletes keep from getting hurt: a real warm-up, good shoes, balance training and the “too much, too soon” rule. You will meet Dr. Gabe Mirkin, who gave the world the RICE rule for sprains in 1978, and see how doctors have refined it since. You will build your own dynamic warm-up, run a balance-training program like the one that cut ankle sprains among high-school athletes, and practice first aid for a minor sprain.

PREREQUISITES

- Knows that children and teens need at least 60 minutes of activity a day
- Can take a pulse at the wrist for 15 seconds and multiply by 4
- Can work with averages, percents and simple tables

MASTERY CHECKLIST

- ☐ I can explain why muscles grow stronger during rest and sleep, not during the workout itself.
- ☐ I can say how much sleep people my age need and keep an honest sleep and recovery log.
- ☐ I can tell the story of the Stanford sleep study and say what was measured.
- ☐ I can lead a 10-minute dynamic warm-up and explain why it comes before hard exercise.
- ☐ I can explain the “too much, too soon” rule, check my shoes, and give first aid for a minor sprain and know when to see a doctor.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“How Much Sleep Do I Need?” (Centers for Disease Control and Prevention):** Free. The CDC’s table of recommended sleep by age, with tips for better sleep. For Lesson 1.1.
- **“Sports Safety” (Nemours KidsHealth for Teens):** Free. A clear article for teens on gear, warm-ups and avoiding overuse injuries. For Lesson 1.2.
- **A reusable cold pack and an elastic bandage:** Optional, for a home first-aid kit. A bag of frozen peas wrapped in a light towel works as a cold pack.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1 Rest Is Part of Training

3 sessions of 40–45 minutes

1.2 Preventing Injuries: Too Much, Too Soon

3 sessions of 40–45 minutes

UNIT 1 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Explain why a muscle grows stronger during recovery and not during the workout itself. Name two things the body does during recovery.

2. **5 pts**

How many hours of sleep do children ages 6–12 need each night? Teens ages 13–18?

3. **5 pts**

Describe the Stanford sleep study of 2011: who took part, what they changed, and two things that improved.

4. (5 pts)

A player's sprint time dropped from 16.2 seconds to 15.5 seconds. By how many seconds did it drop, and by about what percent?

5. (5 pts)

Plan a sensible training week for a student who has soccer practice on Monday and Thursday and a game on Saturday. Mark each day hard, easy or rest.

6. (5 pts)

What is the difference between a dynamic warm-up and a static stretch? When should each be done?

7. (5 pts)

A runner ran 60 minutes total last week. Using the 10 percent rule of thumb, about how many minutes should she plan this week? Why does the rule exist?

8. (5 pts)

What does RICE stand for? What did Dr. Mirkin later add to his advice, and why?

9. (5 pts)

Name four signs that an injury needs a doctor and not just first aid at home.

10. (5 pts)

In two or three sentences, explain how balance training can prevent ankle sprains, and describe the 2006 study that tested it.

ANSWER KEY

1. The workout places a load on the muscle, uses up stored fuel and causes tiny damage to the fibers. During recovery the body repairs the fibers a little stronger, refills its fuel stores, and builds the nerve pathways for skills. Much of this happens in deep sleep, when growth hormone is released.
2. Ages 6–12: 9 to 12 hours. Ages 13–18: 8 to 10 hours (CDC and American Academy of Sleep Medicine).
3. Eleven Stanford men's basketball players kept normal sleep for 2–4 weeks, then aimed for at least 10 hours in bed each night for 5–7 weeks. Their 282-foot sprint time dropped from 16.2 to 15.5 seconds, and free-throw and three-point shooting improved by about 9 percent. Reaction time, sleepiness and mood also improved.
4. $16.2 - 15.5 = 0.7$ seconds. $0.7 \div 16.2 \approx 0.043$, or about 4.3 percent faster (about 4–5 percent).
5. Sample: Monday hard (practice), Tuesday easy (walk, stretching, light play), Wednesday hard (strength or run, different muscles if possible) or easy, Thursday hard (practice), Friday easy, Saturday hard (game), Sunday rest. Full credit for no more than 3–4 hard days, no back-to-back hard days for the same muscles, and one rest day.
6. A dynamic warm-up uses movements through a full range of motion (leg swings, lunges, skips) to raise heart rate and muscle temperature; it comes before exercise. A static stretch is held still for 20–30 seconds; it fits best in the cool-down.
7. $60 \times 0.10 = 6$, so about 66 minutes. Muscles adapt faster than bones, tendons and growth plates; gradual increases give the slower tissues time to adapt and help prevent overuse injuries.
8. Rest, Ice, Compression, Elevation. Around 2014 he wrote that long icing and complete rest may slow healing, because swelling is the first step of repair; doctors now advise brief icing for pain (10–20 minutes, wrapped) and gentle movement as pain allows after a day or two.
9. Any four: severe pain; fast or large swelling; the joint looks out of shape; numbness or tingling; cannot walk four steps or bear weight; pain that does not improve after a few days; a pop with immediate swelling.
10. Balance training sharpens proprioception, the sensors and quick muscle reactions that keep the ankle from rolling on an uneven landing. McGuine and

Keene had 765 high-school soccer and basketball players either do a balance program or train as usual; the balance group had significantly fewer ankle sprains, especially players with past sprains.

UNIT CHALLENGE: MY RECOVERY AND INJURY-PREVENTION PLAN

Put together a two-week record and a plan you can keep using. Include your seven-night sleep log with its graph, your training week marked hard, easy and rest, your balance-test results and a log of at least eight balance-training sessions over two weeks. Then write a one-page plan for your next sport season or training block: your bedtime goal, your weekly pattern of hard, easy and rest days, your dynamic warm-up, your balance routine, how you will increase training gradually, and your first-aid card.

LOOK FOR	WHAT IT MEANS
Complete records	Seven nights of sleep and two weeks of balance training logged honestly with dates and numbers.
Wise weekly plan	Hard, easy and rest days balanced sensibly, with no back-to-back hard days for the same muscles and one day of rest.
Injury prevention	A complete dynamic warm-up, a balance routine with levels, and a gradual plan for increasing training.
First aid	A correct first-aid card for minor sprains, with the signs that mean a doctor is needed.
Reflection and improvement	A paragraph comparing before and after numbers and naming one habit that will continue. Effort and honest records count, not the size of the numbers.

1.1 REST IS PART OF TRAINING

OBJECTIVES

- Explain how muscles, bones and the nervous system repair and grow stronger during rest and sleep.
- Tell the story of Cheri Mah’s 2011 sleep study with the Stanford basketball team and what it measured.
- State how much sleep people ages 12–13 need and plan a week of training with hard days, easy days and a day of rest.
- Keep a seven-night sleep and recovery log with a test and a retest.

Warm-up. March in place for 1 minute, then 10 arm circles each way, 10 slow squats, 10 jumping jacks and 30 seconds of easy jogging in place. Sit down and take your pulse for 15 seconds. Think about it: how many hours did you sleep last night, and how do you feel today compared with a day after a short night?

WATCH

Why Sleep is Important for Teens?

Johns Hopkins All Children's Hospital • 4:10

<https://www.youtube.com/watch?v=7mTQbtZnN68>

WHEN TO WATCH

After the “How your body works” paragraph. Listen for how many hours teens need and why screens make it harder to fall asleep.

Note: A sleep doctor at Johns Hopkins All Children’s Hospital answers a teenager’s questions about sleep, delayed sleep timing and screens.

BACKUP VIDEO

The benefits of a good night's sleep - Shai Marcu

TED-Ed • 5:45

<https://www.youtube.com/watch?v=gedoSfZvBgE>

For a deeper look at how sleep helps the brain store what you practiced.

KEY TERMS

recovery

The time after exercise when the body repairs muscle, refills its energy stores and adapts so it can do more next time.

adaptation

The way the body changes to meet a demand placed on it again and again, such as muscles growing stronger or the heart pumping more blood with each beat.

growth hormone

A hormone that helps the body grow and repair tissue. Much of it is released during deep sleep.

Sabbath

The day of rest God set apart, following His own rest on the seventh day of creation (Genesis 2:2-3).

overtraining

Training hard too often without enough rest, so that performance falls, sleep suffers and injuries become more likely.

CORE IDEAS

The story. Cheri Mah was a sleep researcher at Stanford University in California. While working on other sleep studies, she noticed that some student athletes who slept more than usual for a study were setting personal records. So she designed a study to test it. In 2011 she and her colleagues, including the sleep pioneer Dr. William Dement, published the results: eleven players from the Stanford men's basketball team had spent several weeks trying to spend at least ten hours in bed every night.

How they figured it out. First the players kept their normal sleep habits for two to four weeks, and the researchers measured them after practice: a timed sprint of 282 feet (down the court, back, and down again), ten free throws and fifteen three-point shots. Then, for five to seven weeks, the players aimed for ten hours in bed each night. On average they slept almost two hours more. At the end, their average sprint time had dropped from 16.2 to 15.5 seconds, and both their free-throw and three-point shooting had improved by about 9 percent. They also had faster reaction times and said they felt less sleepy and in a better mood. The study was small and had no

separate comparison group, so the scientists called for more research, but it fit what many other studies had already found about sleep and the body.

How your body works. A hard workout does not make you stronger by itself. It places a load on your muscles, uses up their stored fuel and even causes tiny bits of damage in the muscle fibers. During recovery, your body repairs those fibers a little stronger than before, refills the fuel stores and builds the nerve pathways that make a skill smooth. Much of this work happens in deep sleep, when your body releases growth hormone. Your brain also uses sleep to lock in what you practiced. That is why a skill often feels easier the day after you practice it. The CDC and the American Academy of Sleep Medicine say children ages 6–12 need 9 to 12 hours of sleep a night and teens ages 13–18 need 8 to 10. Without enough sleep, reaction time slows, mood sinks, and injuries become more common.

Think it through. God Himself rested on the seventh day (Genesis 2:2-3) and gave His people a weekly Sabbath. When the apostles came back tired from their work, Jesus told them to come apart and “rest a while” (Mark 6:31). Rest is not laziness; it is part of the design. A wise training week follows the same pattern: hard days, easy days and at least one day of real rest each week.

Try it. This week you will measure your reaction time, your speed and your accuracy, keep a seven-night sleep log, plan a week with hard, easy and rest days, and then test yourself again.

PICTURE STUDY



Noon – Rest from Work (after Millet), Vincent van Gogh, 1889–1890 · Oil on canvas · Musée d’Orsay, Paris

Image: [Wikimedia Commons](#), public domain

Vincent van Gogh admired the French painter Jean-François Millet, who painted country people at work. While he was in the hospital at Saint-Rémy in France, van Gogh painted his own versions of Millet’s drawings in his own bright colors. This one shows two harvesters who have stopped at noon, the hottest part of the day, to sleep in the shade before going back to work.

Look closely

- Find the sickles lying on the ground. What hard work were these two doing all morning?
- Look at the man. How has he made himself comfortable to sleep? Why might the two of them have taken off their shoes?
- Find the shade. What is making it, and how is it different from the field behind?
- Find the cart and the oxen. Are they working or resting too?
- Look at the colors. How does van Gogh make the field look hot and the shade look cool?

Talk about it

1. These harvesters rest in the middle of a long, hard day so they can finish it. How is that like a rest day in the middle of a training week?

2. What would happen to a harvester, or an athlete, who never rested?
3. Where in your own week is your “noonday rest”?

Safety first. A parent should know about and supervise all activity. If you have asthma, a heart condition, diabetes, a recent injury or any health concern, check with your doctor before starting this course. Warm up first and cool down after; stop and tell an adult right away if you feel chest pain, dizziness, faintness, trouble breathing or sharp pain (tired muscles are normal, but joint pain is not).

ACTIVITY

The Recovery Week

Can a week of good sleep and wise rest make you quicker and more accurate? You will run a small study on yourself, like the Stanford players: test, sleep well and train wisely for a week, and test again under the same conditions.

You will need

- A 12-inch (30 cm) ruler
- Five or six pairs of rolled-up socks and a laundry basket or box
- Chalk, tape or two shoes to mark a 5-yard (about 4.5 m) shuttle course on grass or a safe floor
- A timer with a stopwatch, a helper and your fitness journal

Steps

1. **Set up your journal.** Make a sleep log for seven nights with columns for Date, Lights out, Wake-up time, Hours slept, How rested I feel (1–5) and Training that day (hard, easy or rest). Below it, make a test table with three tests and two columns: “Day 1” and “Retest.”
2. **Warm up (5 minutes).** March for 1 minute, 10 arm circles each way, 10 squats, 10 walking lunges, 10 high knees and 20 seconds of easy jogging.
3. **Test 1: Reaction time (ruler drop).** Sit with your forearm on a table and your hand just past the edge. Your helper holds the ruler at the 12-inch end so the zero mark is between your open thumb and finger. Without warning, the helper lets go; you catch it as fast as you can. Record the inches (or centimeters) at the top of your thumb. Do 5 catches and record the average. A smaller number means a faster reaction.
4. **Test 2: Accuracy (sock shots).** Stand 10 feet (about 3 m) from the basket and take 15 underhand shots with the sock balls, collecting them after every 5 or 6. Record how many go in, like the players’ free throws.
5. **Test 3: Speed (5-10-5 shuttle).** Mark three lines 5 yards apart. Start at the middle line in a ready stance, then sprint 5 yards to the right line and touch it, sprint 10 yards to the far line and touch it, and sprint 5 yards back through

the middle. Bend your knees and stay low at each turn. Rest 2 minutes, do it again, and record your better time.

6. **Plan your week.** Write a seven-day plan with 2 or 3 hard days (a run, a sport practice, a strength workout), 3 easy days (walking, biking, light play, stretching) and 1 full day of rest from training, such as the Lord's Day. Never put two hard days for the same muscles back to back.
7. **Sleep well for seven nights.** Choose a lights-out time that gives you at least 9 hours before you must get up, and keep it every night, weekends too. Put screens away 30 minutes before bed and keep your room dark and cool. Log each night honestly, even the nights you miss your goal.
8. **Session 3: Retest.** At the same time of day as Day 1, after the same warm-up, repeat all three tests in the same order, with the same helper and the same rests. Record the results and circle every number that improved.
9. **Cool down and reflect.** Walk slowly for 2 minutes and stretch your calves, thighs and shoulders for 20 seconds each. Find your average hours of sleep for the week and compare it with the recommended range.

Tips

- A study with one person cannot prove that sleep made the difference, because you also practiced the tests once. Scientists call this a practice effect. Still, honest numbers will teach you a lot about how you feel and perform.
- If you play a sport, plan your hard days around your practices and games, not on top of them.
- A short nap can help after a short night, but steady bedtimes help more.

Check your work

- ☐ I kept an honest seven-night sleep log and found my average hours.
- ☐ I tested and retested reaction time, accuracy and speed the same way both times.
- ☐ I can explain why rest days and sleep are part of training.

FITNESS JOURNAL

1. Draw a bar graph of your hours of sleep for each of the seven nights, with a band shaded across from 9 to 12 hours (or 8 to 10 if you are 13).
2. Copy your test table and write the change for each test. Which one changed most?

3. Write your training week as a table with each day marked hard, easy or rest, and one sentence about how your body felt on the day after a hard day.
4. Write three changes to your evening that help you fall asleep on time.

From history. William Dement, one of the authors of the Stanford study, helped found the science of sleep medicine. In the 1950s, as a medical student in Chicago, he worked in the laboratory where scientists first described REM (rapid eye movement) sleep, and in 1970 he started one of the first sleep clinics, at Stanford.

COMMON MISTAKES

- Thinking that more training is always better. Without rest, performance gets worse, not better.
- Staying up late on weekends and “catching up” in the morning. A steady bedtime is better for the body clock.
- Using a phone or tablet in bed. The light and the stimulation keep you awake longer.
- Doing a hard workout for the same muscles two days in a row.

Make it a game • Recovery Week Report. Teach your parent how sleep and rest repair muscles, bones and nerves, using the words adaptation and overtraining. She asks three questions about Cheri Mah's Stanford study; you answer from memory. She slips in one false fact; catch it. Then plan a week with two hard days, one easy and one real rest day.

Scripture. “And he said unto them, Come ye yourselves apart into a desert place, and rest a while: for there were many coming and going, and they had no leisure so much as to eat.” (Mark 6:31, KJV)

Jesus saw that His disciples were worn out and had not even had time to eat, and He called them to rest. Rest is part of how God made us to work well.

1.2 PREVENTING INJURIES: TOO MUCH, TOO SOON

OBJECTIVES

- Lead a 10-minute dynamic warm-up and explain why it comes before hard exercise.
- Explain the “too much, too soon” rule and how overuse injuries happen.
- Tell how Dr. Gabe Mirkin’s RICE rule (1978) became famous and how doctors have refined it, and give first aid for a minor sprain.
- Run a balance-training program and measure improvement in a one-leg balance test.

Warm-up. Stand on one foot for 30 seconds, then the other. Now try it with your eyes closed. Then do 1 minute of easy jogging in place, 10 leg swings forward and back on each leg (hold a wall), and 10 arm circles each way. Think about it: why is balancing so much harder with your eyes closed, and what might that have to do with twisted ankles?

WATCH

Preventing Sports Injuries: Dr. John Schlechter and Mollee Smith, CHOC Children's

Rady Children's Health - Orange County • 3:35

<https://www.youtube.com/watch?v=Hd59fS1NA4Q>

WHEN TO WATCH

After the “How your body works” paragraph. Watch for the warning signs of overuse and what the doctor and therapist say about rest and warm-ups.

Note: A short health-news segment from CHOC Children’s hospital with an orthopedic surgeon and a physical therapist. It includes brief clips of youth soccer, basketball and judo.

BACKUP VIDEO

Dynamic Warm-Ups for Youth Athletes | Nemours Children’s Health

Nemours • 2:42

<https://www.youtube.com/watch?v=KkcmTCvNC4c>

In Session 2, before you write your own warm-up. Try each drill along with the video.

KEY TERMS

dynamic warm-up

A warm-up of movements done through a full range of motion, such as leg swings, lunges and skips, that raises your heart rate and body temperature before exercise.

strain

An injury to a muscle or tendon, often called a pulled muscle.

proprioception

Your body's sense of where its parts are and how they are moving, from tiny sensors in your muscles, tendons and joints. Balance training sharpens it.

sprain

An injury to a ligament, the tough band that holds bones together at a joint. Ankle sprains are the most common.

overuse injury

An injury caused by repeating the same motion too often without enough rest, such as shin splints or a sore heel or knee.

RICE

Rest, Ice, Compression, Elevation: first aid for a minor sprain or strain in the first day or two.

CORE IDEAS

The story. In 1978 Dr. Gabe Mirkin, an American physician and marathon runner, published *The Sportsmedicine Book*, written with Marshall Hoffman. In it he gave a simple rule for a fresh sprain or strain: **RICE**, for rest, ice, compression and elevation. The rule was easy to remember, and for decades coaches, trainers and parents everywhere used it. Then Dr. Mirkin did something good scientists do: he looked at newer research and changed his mind about part of it. Around 2014 he wrote that long periods of icing and complete rest may slow healing, because the swelling and redness after an injury are the first step of the body's own repair.

How they figured it out. Doctors still agree on much of RICE: protect the injury, rest it at first, use a cold pack wrapped in a cloth for 10 to 20 minutes at a time to ease pain, use a snug (not tight) wrap and raise it to limit swelling. But they now add that after a day or two, gentle movement as pain allows helps an injury heal better than keeping it still for a long time. Researchers have also studied how to keep sprains from happening at all. In 2006 Timothy McGuine and James Keene tested a balance

program with 765 high-school soccer and basketball players in Wisconsin. Half the teams did ten-minute balance exercises a few times a week; the other teams trained as usual. Over the season, the players on the balance teams had significantly fewer ankle sprains, especially those who had sprained an ankle before.

How your body works. Your muscles, tendons and ligaments contain tiny sensors that tell your brain where each joint is. When you land on an uneven spot, those sensors and the muscles around your ankle react in a fraction of a second to keep it from rolling. Balance training sharpens this reaction. A **dynamic warm-up** raises your heart rate and the temperature of your muscles so they stretch and contract more easily, and it rehearses the movements of your sport. Long, still stretches are better saved for the cool-down. Many injuries in young athletes are **overuse injuries**: bones, tendons and growth plates (the growing areas near the ends of your bones) need time to adapt to new work. Muscles adapt faster than bones and tendons, so a sudden jump in training can leave the slower tissues behind. That is the “too much, too soon” rule. Many coaches suggest increasing your weekly running or training time by only about 10 percent a week; it is a rule of thumb, not a law, but it keeps changes gradual.

Good form. Good shoes matter too. Shoes should fit with a thumb’s width of space in front of your longest toe, bend at the ball of the foot, and support your heel. Look at the soles: when the tread is worn smooth or the cushioning is crushed, it is time for new shoes. Wear the right shoes for the sport, and protective gear where the sport calls for it.

Try it. This week you will check your shoes, build and lead your own dynamic warm-up, test your balance, train it for a week, practice first aid for a sprain, and retest.

PICTURE STUDY



The Skating Minister, Attributed to Henry Raeburn, c. 1795 · Oil on canvas · Scottish National Gallery, Edinburgh

Image: [Wikimedia Commons](#), public domain

This small painting shows the Reverend Robert Walker, a minister of the Church of Scotland, skating on Duddingston Loch near Edinburgh. He was a member of the Edinburgh Skating Society, one of the first skating clubs in the world. For two centuries the painting was thought to be by Henry Raeburn; some experts now think it may be by a French painter, Henri-Pierre Danloux. Either way, it has become one of the most loved pictures in Scotland.

Look closely

- Look at his supporting leg. Is it bent or straight? How does that help him balance?
- Find his arms. Why might he fold them instead of waving them?
- Look at where his head and body are over the skate. What would happen if he leaned too far forward or back?
- Look at the ice. Is it smooth or scratched? What do the faint lines tell you about other skaters?

Talk about it

1. Skating on one foot takes years of practice. How is that like the balance training in this lesson?

2. What injuries could a skater get from a fall, and what would help prevent them?
3. What does the minister's calm face tell you about how practice changes a hard skill?

Safety first. Do the balance exercises beside a wall or sturdy counter you can touch if you wobble, on a clear, flat floor, and try the eyes-closed and pillow versions only after the easier ones feel steady. In the first-aid practice, never put ice directly on the skin; wrap the cold pack in a light towel and use it for no more than 20 minutes. A real injury that is very painful, swells quickly, looks out of shape, goes numb, or that you cannot walk on for four steps needs a doctor.

ACTIVITY

Warm-Up Leader and the Balance Challenge

Athletes who stay healthy prepare well. You will check your shoes, design a warm-up and lead your family through it, test your balance, train it like the Wisconsin players, and practice first aid so you know what to do if someone does get hurt.

You will need

- Your athletic shoes
- A clear, flat space beside a wall or counter
- A firm pillow or a folded bath towel, and a soft ball or rolled socks
- A cold pack or a bag of frozen peas, a light towel, an elastic bandage (optional) and two pillows
- A timer, a helper and your fitness journal

Steps

1. **Shoe check.** Look at the soles of your athletic shoes. Is the tread worn smooth anywhere? Press the cushioning: is it flat or cracked? Stand up and check for a thumb's width of space in front of your longest toe. Write what you find and whether your shoes need replacing.
2. **Build your dynamic warm-up (10 minutes).** Write a warm-up with these parts and lead it: 2 minutes of easy jogging or brisk marching; 10 walking lunges with a reach overhead; 10 leg swings forward and back and 10 side to side on each leg (hold a wall); 20 high knees and 20 butt kicks; 10 arm circles each way; 2 lengths of skipping and 2 lengths of side shuffles; 3 easy build-up runs of about 20 yards, getting a little faster each time.
3. **Balance test (before).** Stand on your right foot, hands on hips, other foot lifted beside your ankle. Close your eyes. Your helper times until you open your eyes, your hands leave your hips, or your lifted foot touches down (stop at 30 seconds). Do 3 tries on each foot and record the best time for each.
4. **Balance training, level 1.** Stand on one foot with your eyes open for 30 seconds, 3 times on each foot. Then do 10 slow one-leg mini squats on each

foot, bending the knee only a little and keeping it over your toes. Rest 30 seconds between sets.

5. **Level 2.** When level 1 feels steady, do the same on a folded towel or firm pillow, then try 30 seconds on each foot with eyes closed (touch the wall if you wobble).
6. **Level 3.** Stand on one foot and play catch with a helper using a soft ball, 20 catches on each foot. Then hop gently forward onto one foot and hold the landing for 3 seconds, 5 times on each foot, landing softly with a bent knee.
7. Do the warm-up and 10 minutes of balance training on at least 4 days this week, moving up a level when the last one feels easy. Log each day.
8. **First-aid practice.** Your helper pretends to have rolled an ankle. Help him or her sit down and stop playing (rest). Wrap a cold pack in a light towel and hold it on the ankle for 2 minutes (in a real injury, 10–20 minutes). Practice a snug figure-eight wrap with the bandage if you have one, then prop the foot on two pillows above the level of the heart. Say aloud the signs that mean “see a doctor.”
9. **Session 3: Retest.** After your warm-up, repeat the eyes-closed balance test exactly as before: 3 tries on each foot, best time recorded. Compare.

Tips

- Look at one spot on the wall while you balance with eyes open; it helps your brain steady your body.
- Wobbling is part of training. Your ankle muscles are learning.
- If you have had an ankle sprain before, this kind of training is especially worth keeping up all season.

Check your work

- ☐ I can lead a 10-minute dynamic warm-up and explain each part.
- ☐ I tested, trained and retested my balance and recorded the results.
- ☐ I can give first aid for a minor sprain and name the signs that mean a doctor should see it.

FITNESS JOURNAL

1. Copy your warm-up as a numbered list a younger sibling could follow, with times or reps for each part.

2. Record your balance test before and after for each foot, and work out the percent change: $(\text{after} - \text{before}) \div \text{before} \times 100$.
3. Draw the sole of your shoe and shade where it is most worn. What does the wear pattern tell you?
4. Write a short first-aid card: what RICE stands for, how long to use a cold pack, and four signs that mean “see a doctor.”

From history. Duddingston Loch, where the Reverend Robert Walker skated, lies below Arthur’s Seat in Edinburgh. The Edinburgh Skating Society, founded in the 1700s, is often called the oldest skating club in the world; members had to pass a test, which included skating a full circle on each foot, before they could join.

COMMON MISTAKES

- Skipping the warm-up, or doing only long, still stretches before hard exercise.
- Doubling your running or training all at once because you feel good. Bones and tendons need weeks to catch up.
- Putting ice straight on the skin or leaving it on too long.
- Playing through sharp pain or a limp. Pain that changes how you move is a signal to stop.

Make it a game • Too Much Too Soon. Lead your parent through a ten-minute dynamic warm-up from memory, naming each move. Then she reads injury stories and you decide whether sprain, strain or overuse, and give the first aid. Balance on one leg with eyes closed and time yourself. Beat your record on each leg. Explain the too-much-too-soon rule.

UNIT 1

KEEPING ACTIVE

You already know that God made your body to move and that young people need at least 60 minutes of activity a day. This year you will learn the other half of training: rest. Muscles do not grow stronger during a workout; they grow stronger while you recover from it, and most of that repair happens while you sleep. You will hear how a sleep researcher at Stanford asked a basketball team to sleep more and then measured their sprints and their shooting, read what Scripture says about the Sabbath and about Jesus calling His tired disciples to “rest a while,” and keep a week-long sleep and recovery log with a test and a retest.

Then you will learn how athletes keep from getting hurt: a real warm-up, good shoes, balance training and the “too much, too soon” rule. You will meet Dr. Gabe Mirkin, who gave the world the RICE rule for sprains in 1978, and see how doctors have refined it since. You will build your own dynamic warm-up, run a balance-training program like the one that cut ankle sprains among high-school athletes, and practice first aid for a minor sprain.

PREREQUISITES

- Knows that children and teens need at least 60 minutes of activity a day
- Can take a pulse at the wrist for 15 seconds and multiply by 4
- Can work with averages, percents and simple tables

MASTERY CHECKLIST

- ☐ I can explain why muscles grow stronger during rest and sleep, not during the workout itself.
- ☐ I can say how much sleep people my age need and keep an honest sleep and recovery log.
- ☐ I can tell the story of the Stanford sleep study and say what was measured.
- ☐ I can lead a 10-minute dynamic warm-up and explain why it comes before hard exercise.
- ☐ I can explain the “too much, too soon” rule, check my shoes, and give first aid for a minor sprain and know when to see a doctor.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“How Much Sleep Do I Need?” (Centers for Disease Control and Prevention):** Free. The CDC’s table of recommended sleep by age, with tips for better sleep. For Lesson 1.1.
- **“Sports Safety” (Nemours KidsHealth for Teens):** Free. A clear article for teens on gear, warm-ups and avoiding overuse injuries. For Lesson 1.2.
- **A reusable cold pack and an elastic bandage:** Optional, for a home first-aid kit. A bag of frozen peas wrapped in a light towel works as a cold pack.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1 Rest Is Part of Training

3 sessions of 40–45 minutes

1.2 Preventing Injuries: Too Much, Too Soon

3 sessions of 40–45 minutes

UNIT 1 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Explain why a muscle grows stronger during recovery and not during the workout itself. Name two things the body does during recovery.

2. **5 pts**

How many hours of sleep do children ages 6–12 need each night? Teens ages 13–18?

3. **5 pts**

Describe the Stanford sleep study of 2011: who took part, what they changed, and two things that improved.

4. (5 pts)

A player's sprint time dropped from 16.2 seconds to 15.5 seconds. By how many seconds did it drop, and by about what percent?

5. (5 pts)

Plan a sensible training week for a student who has soccer practice on Monday and Thursday and a game on Saturday. Mark each day hard, easy or rest.

6. (5 pts)

What is the difference between a dynamic warm-up and a static stretch? When should each be done?

7. (5 pts)

A runner ran 60 minutes total last week. Using the 10 percent rule of thumb, about how many minutes should she plan this week? Why does the rule exist?

8. (5 pts)

What does RICE stand for? What did Dr. Mirkin later add to his advice, and why?

9. (5 pts)

Name four signs that an injury needs a doctor and not just first aid at home.

10. (5 pts)

In two or three sentences, explain how balance training can prevent ankle sprains, and describe the 2006 study that tested it.

ANSWER KEY

1. The workout places a load on the muscle, uses up stored fuel and causes tiny damage to the fibers. During recovery the body repairs the fibers a little stronger, refills its fuel stores, and builds the nerve pathways for skills. Much of this happens in deep sleep, when growth hormone is released.
2. Ages 6–12: 9 to 12 hours. Ages 13–18: 8 to 10 hours (CDC and American Academy of Sleep Medicine).
3. Eleven Stanford men's basketball players kept normal sleep for 2–4 weeks, then aimed for at least 10 hours in bed each night for 5–7 weeks. Their 282-foot sprint time dropped from 16.2 to 15.5 seconds, and free-throw and three-point shooting improved by about 9 percent. Reaction time, sleepiness and mood also improved.
4. $16.2 - 15.5 = 0.7$ seconds. $0.7 \div 16.2 \approx 0.043$, or about 4.3 percent faster (about 4–5 percent).
5. Sample: Monday hard (practice), Tuesday easy (walk, stretching, light play), Wednesday hard (strength or run, different muscles if possible) or easy, Thursday hard (practice), Friday easy, Saturday hard (game), Sunday rest. Full credit for no more than 3–4 hard days, no back-to-back hard days for the same muscles, and one rest day.
6. A dynamic warm-up uses movements through a full range of motion (leg swings, lunges, skips) to raise heart rate and muscle temperature; it comes before exercise. A static stretch is held still for 20–30 seconds; it fits best in the cool-down.
7. $60 \times 0.10 = 6$, so about 66 minutes. Muscles adapt faster than bones, tendons and growth plates; gradual increases give the slower tissues time to adapt and help prevent overuse injuries.
8. Rest, Ice, Compression, Elevation. Around 2014 he wrote that long icing and complete rest may slow healing, because swelling is the first step of repair; doctors now advise brief icing for pain (10–20 minutes, wrapped) and gentle movement as pain allows after a day or two.
9. Any four: severe pain; fast or large swelling; the joint looks out of shape; numbness or tingling; cannot walk four steps or bear weight; pain that does not improve after a few days; a pop with immediate swelling.
10. Balance training sharpens proprioception, the sensors and quick muscle reactions that keep the ankle from rolling on an uneven landing. McGuine and

Keene had 765 high-school soccer and basketball players either do a balance program or train as usual; the balance group had significantly fewer ankle sprains, especially players with past sprains.

UNIT CHALLENGE: MY RECOVERY AND INJURY-PREVENTION PLAN

Put together a two-week record and a plan you can keep using. Include your seven-night sleep log with its graph, your training week marked hard, easy and rest, your balance-test results and a log of at least eight balance-training sessions over two weeks. Then write a one-page plan for your next sport season or training block: your bedtime goal, your weekly pattern of hard, easy and rest days, your dynamic warm-up, your balance routine, how you will increase training gradually, and your first-aid card.

LOOK FOR	WHAT IT MEANS
Complete records	Seven nights of sleep and two weeks of balance training logged honestly with dates and numbers.
Wise weekly plan	Hard, easy and rest days balanced sensibly, with no back-to-back hard days for the same muscles and one day of rest.
Injury prevention	A complete dynamic warm-up, a balance routine with levels, and a gradual plan for increasing training.
First aid	A correct first-aid card for minor sprains, with the signs that mean a doctor is needed.
Reflection and improvement	A paragraph comparing before and after numbers and naming one habit that will continue. Effort and honest records count, not the size of the numbers.

UNIT 2

HYDRATION

About 60 percent of your body is water, and every hard workout sends some of it out through your skin as sweat. In this unit you will learn how much that matters: losing even a small share of your body's water makes your heart work harder, raises your body temperature and slows you down. You will hear how a team of scientists led by Edward Adolph studied men walking and working in the deserts of southern California in the 1940s and learned that people cannot be trained to do without water. Then, with a parent, you will measure how much fluid you lose in a workout and make a drinking plan to match it.

Next you will look hard at the drinks on store shelves. Sports drinks were made for long, hard exercise in the heat, but many young people drink them every day. You will learn how the Nutrition Facts label changed in 2016 to show added sugars, measure the sugar and sodium in common drinks, and decide when water is the right choice (almost always) and when a sports drink makes sense.

PREREQUISITES

- Knows the four jobs of water in the body and the signs of dehydration (earlier grades)
- Can convert cups and ounces (1 cup = 8 fluid ounces $\approx$ 240 mL)
- Can work with percents and divide decimals

MASTERY CHECKLIST

- ☐ I can explain how losing body water affects the heart, body temperature and performance.
- ☐ I can tell how Edward Adolph's desert studies showed that people need water and cannot train themselves to need less.
- ☐ I can measure my fluid loss in a workout with a parent and make a drinking plan to match it.
- ☐ I can read a Nutrition Facts label for a drink, find added sugars and sodium, and turn grams of sugar into teaspoons and a percent of the Daily Value.
- ☐ I can explain when water is the best drink and when a sports drink makes sense.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“How to Understand and Use the Nutrition Facts Label” (U.S. Food and Drug Administration)**: Free. The FDA’s own guide to every line of the label, including added sugars and percent Daily Value. For Lesson 2.2.
- **A reusable water bottle with ounce or milliliter marks**: Optional, but it makes the drinking plans in this unit easy. Any cup and a measuring cup work just as well.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1 Water and Performance

3 sessions of 40–45 minutes

2.2 Sports Drinks, Water and Labels

3 sessions of 40–45 minutes

UNIT 2 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Explain step by step how losing water in sweat makes your heart beat faster during exercise.

2. **5 pts**

Why does body temperature rise when you are low on water?

3. **5 pts**

What did Edward Adolph’s team study in the 1940s, and name two things they learned.

4. **5 pts**

In a sweat check, a student’s fluid lost was 1.5 pounds, and he drank 8 ounces during the 45-minute workout. How many ounces of fluid did he lose in total? What was his sweat rate in ounces per hour?

5. (5 pts)

Give a sensible drinking plan for before, during and after a 1-hour soccer practice on a warm day.

6. (5 pts)

A 20-ounce sports drink has 2.5 servings, each with 13 g of added sugar. How many grams of added sugar are in the bottle? How many teaspoons? What percent of the 50 g Daily Value?

7. (5 pts)

What changed on the Nutrition Facts label in 2016, and why does it help shoppers?

8. (5 pts)

When does a sports drink make sense, and when is water the better choice?

9. (5 pts)

Plain milk lists 12 g of total sugars and 0 g of added sugars. Explain how that can be.

10. (5 pts)

In three or four sentences, explain to a teammate why you bring water to practice instead of a soda or sports drink, using at least two facts from this unit.

ANSWER KEY

1. Sweat comes from blood plasma, so blood volume drops. With less blood returning to the heart, each beat pumps less (lower stroke volume), so the heart must beat faster to deliver the same blood and oxygen.
2. With less blood volume, less blood can be sent to the skin to release heat, and you may sweat less, so heat builds up inside the body.
3. How men lived and worked in desert heat near Indio, California (and in a hot room in Rochester). They learned: men could sweat about a quart an hour or more; without enough water their heart rate and temperature rose and they tired or collapsed; thirst alone often did not make them drink enough; people cannot be trained to do without water.
4. $1.5 \times 16 = 24$ ounces from the scale difference, + 8 ounces drunk = 32 ounces lost. Sweat rate = $32 \div 45 \times 60 \approx 42.7$ ounces per hour (about 43 oz/hour).
5. About 1–2 cups of water in the 1–2 hours before; about 4–8 ounces (a few big gulps) every 15–20 minutes during; enough afterward to bring urine back to pale. Water is the drink; no forcing huge amounts.
6. $13 \times 2.5 = 32.5$ g. $32.5 \div 4 \approx 8.1$ teaspoons. $32.5 \div 50 \times 100 = 65\%$ of the Daily Value.
7. The FDA added a line for Added Sugars with a % Daily Value (and made serving size and calories easier to read). It lets shoppers tell sugar added at the factory apart from natural sugar in milk and fruit.
8. A sports drink can make sense in long, hard exercise in the heat (usually more than about an hour) or several games in a day, to replace sodium and supply sugar for fuel. For everyday life, ordinary play and practices of an hour or less, water is better.
9. The sugar in plain milk is lactose, which is naturally present in milk. None was added during processing, so added sugars are 0 g.
10. Answers vary. Full credit for clear reasoning using facts such as: water hydrates as well as sports drinks for practices under an hour; a 20-oz sports drink has about 30–36 g of sugar and a 12-oz soda about 39 g; the AHA recommends under 25 g added sugar a day for young people; the AAP says water is the right drink for most young athletes; sugary drinks feed cavity-causing bacteria.

UNIT CHALLENGE: MY GAME-DAY HYDRATION PLAN

Create a complete hydration plan for a real or imagined game day or long hot day of work or play. Include your sweat-check results (or your no-scale observations) with your sweat rate, a timeline from waking up to bedtime showing every drink with amounts in ounces, shade and rest breaks, the warning signs of dehydration and heat illness and what to do, and a short label comparison of three drinks you might be offered. Then follow your plan on an active day, log it, and write what worked and what you would change.

LOOK FOR	WHAT IT MEANS
Measured basis	The plan uses your own sweat-check numbers or observations, with the calculation shown.
Complete timeline	Drinks before, during and after activity with amounts and times, water as the main drink, and rest and shade breaks.
Label smarts	Three drinks compared correctly by serving size, added sugars (grams, teaspoons and % DV) and sodium.
Safety	At least five warning signs of dehydration or heat illness and the right response, including telling an adult.
Test and reflection	The plan was followed on a real day, logged honestly, and improved with at least one specific change.

2.1 WATER AND PERFORMANCE

OBJECTIVES

- Explain how losing body water affects blood volume, heart rate, body temperature and performance.
- Tell how Edward Adolph's team studied people in the desert in the 1940s and what they learned.
- Measure fluid lost in a workout with a parent, convert it to ounces, and make a drinking plan to replace it.
- Use thirst, urine color and effort ratings to judge hydration.

Warm-up. Do 1 minute of jumping jacks, 1 minute of high knees and 1 minute of slow, deep squats. Take your pulse for 15 seconds and multiply by 4. Then lick the back of your hand and blow on it. Think about it: your body cools itself with water. What happens to an engine, or an athlete, whose cooling system runs low?

WATCH

What would happen if you didn't drink water? - Mia Nacamulli

TED-Ed · 4:52

<https://www.youtube.com/watch?v=9iMGFqMmUFs>

WHEN TO WATCH

After the “How your body works” paragraph. Listen for what happens to the body and brain when you lose even a little water.

Note: A TED-Ed cartoon. It also mentions that drinking far too much water can be dangerous, and includes one quick cartoon joke of a witch's hat in a puddle (from a well-known story). Its suggested daily amounts are for adults.

BACKUP VIDEO

Johns Hopkins All Children's Sports Medicine - Hydration

Johns Hopkins All Children's Hospital · 1:40

https://www.youtube.com/watch?v=ZcAXt0iNV_I

After the sweat check, to compare your drinking plan with a sports dietitian's advice.

KEY TERMS

blood volume

The total amount of blood in your body. Its liquid part, plasma, is mostly water, so losing water lowers blood volume.

sweat rate

How much fluid your body loses in sweat in a set time, such as ounces per hour.

heat exhaustion

An illness from working hard in the heat without enough rest and fluid. Signs include heavy sweating, dizziness, headache, nausea, cramps and weakness.

stroke volume

The amount of blood your heart pumps with each beat. When blood volume falls, stroke volume falls and the heart must beat faster.

thermoregulation

The way your body keeps its temperature steady, mainly by sweating and by sending more blood to the skin.

CORE IDEAS

The story. In 1942, the U.S. Army needed to know how soldiers could live and work in the hot deserts where they were about to fight. It turned to Edward Adolph, a physiologist at the University of Rochester in New York, and his team. They set up camp in the desert near Indio, California, where summer afternoons are often well over 100 °F, and studied men walking, marching and resting in the heat, some with plenty of water and some with little. They also tested men in a heated laboratory room in Rochester. One of their questions was whether men could be trained to need less water.

How they figured it out. Adolph's team measured almost everything: how much each man drank, how much he sweated, his body temperature, his heart rate and how far he could walk. They found that a man walking in the desert sun could sweat about a quart (about a liter) an hour or more. When the men did not drink enough to replace it, their heart rates and temperatures climbed, they tired quickly, and some collapsed. They also found that thirst alone often did not make the men drink as

much as they had lost. And the answer to their question was plain: people cannot be trained to do without water. The only way to save water is to avoid wasting it, rest in the shade and avoid needless work in the heat. Adolph published the results in 1947 in a book called *Physiology of Man in the Desert*.

How your body works. When you sweat, the water comes from your blood plasma. As you lose water, your **blood volume** drops, so your heart pumps less blood with each beat (its **stroke volume**) and must beat faster to keep up. Less blood can reach your skin to release heat, so your body temperature rises. Exercise feels harder at the same speed, and skill and concentration slip. Sports scientists, including the American College of Sports Medicine, report that losing water equal to about 2 percent of your body mass is enough to lower endurance performance, and a bigger loss raises the risk of heat illness. On a hot day an active young person can sweat a pound or more of water in an hour, and one pound of sweat is about 16 ounces (2 cups) of fluid.

Try it. This week you will do a sweat check with a parent: a 30-to-45-minute workout with your drinking measured, so you can find out how much fluid you lose. Your parent reads the scale and writes down only the difference; the number we care about is fluid lost, not body weight. If your family prefers, you can skip the scale and use thirst, urine color and effort ratings instead. Then you will make a drinking plan and test it.

PICTURE STUDY



Harvester Drinking from a Flask (The Thirst), Léon-Augustin Lhermitte, 1905 · Oil on canvas · Dahesh Museum of Art, New York

Image: [Wikimedia Commons](#), public domain

Léon-Augustin Lhermitte was a French painter who spent his life painting the farm families of his home region at work. He painted harvesters again and again: cutting wheat, binding sheaves, eating at noon and being paid at the end of the day. Here a harvester stops in the middle of the hot field to drink, while the work goes on around him.

Look closely

- Look at how the harvester tips back his head and the jug. Does he look a little thirsty or very thirsty?
- Find the girl and her small pail. What job might she have in the field?
- Find clues about the weather: the light, the clouds, the color of the field.
- Look at the woman binding the sheaf. What hard work is the family doing together?

Talk about it

1. Adolph found that thirst often comes too late to keep up with sweat. How could this harvester plan his drinking better?
2. What would happen to his work in the afternoon if he had no water?

3. How is a long day of harvest like a long practice or tournament?

Safety first. Drink steadily, but never force down a large amount at once or hold drinking contests; drinking far more than you sweat can also be dangerous. Do the sweat check only with a parent, on a mild day or indoors, not in the hottest part of the day. If you feel dizzy, sick to your stomach, very tired, confused, or get a bad headache or cramps, stop, move to the shade, sip water, cool off with wet cloths and tell an adult right away.

ACTIVITY

The Sweat Check

How much fluid do you lose in a workout? Like Adolph's team, you will measure what goes in and what comes out, and then use the numbers to plan your drinking.

You will need

- A bathroom scale (read by a parent) or the no-scale method below
- A water bottle and a measuring cup
- A towel, a timer and a safe space for a 30–45 minute workout
- Your fitness journal and an 8-square urine color chart (1 = very pale, 8 = dark amber)

Steps

1. **Set up.** Make a table: Date, Temperature outside (or room), Workout and minutes, Fluid drunk (oz), Fluid lost (oz, from your parent), Urine color before and after, Thirst (1–5), Effort (1–10).
2. **Before.** Use the bathroom, then put on your workout clothes. Your parent reads the scale privately and writes the number on a slip of paper you do not need to see. Check and record your urine color. Fill your bottle with a measured amount of water.
3. **The workout (30–45 minutes).** Warm up for 5 minutes. Then do rounds of: 3 minutes of jogging or brisk walking (outside loop or in place), 1 minute of step-ups on the bottom stair (hold the rail), 15 squats and 10 push-ups at your level. Rest 1 minute after each round. Keep going for 30 to 40 minutes. Cool down by walking for 3 minutes.
4. **Drink as you normally would** during the workout, and measure how much you drank by refilling the bottle to the starting line with a measuring cup. Rate your thirst and effort after every second round.
5. **After.** Towel off the sweat, change into the same kind of dry clothes, and have your parent read the scale again. Your parent works out the difference and tells you only that number. Convert it: each pound = about 16 ounces of fluid. Add the ounces you drank. That total is the fluid you lost in sweat and breath.

6. **Your sweat rate.** Divide your fluid lost by the minutes of exercise, then multiply by 60 to find ounces per hour. Example: 20 ounces lost in 40 minutes → $20 \div 40 \times 60 = 30$ ounces per hour.
7. **No-scale method.** If you skip the scale, record urine color before and 1 hour after, thirst ratings and effort ratings, and note how much you drank. Darker urine and higher thirst mean you drank less than you lost.
8. **Make a drinking plan.** Plan to drink about 1 to 2 cups of water in the 1 to 2 hours before exercise, a few big gulps (about 4–8 ounces) every 15–20 minutes during it, and enough afterward to bring your urine back to pale. Use your sweat rate to decide how much is enough for an hour, without forcing more than you lost.
9. **Session 3: test your plan.** Repeat the same workout at the same time of day and follow your plan. Record thirst, effort and urine color again (and fluid lost, if you used the scale). Compare: did the plan keep your fluid loss smaller and your effort ratings lower?

Tips

- Weather matters. A sweat rate measured on a cool day will be lower than on a hot one, so add a note about the temperature.
- Cool water is easier to drink during exercise than warm water.
- If you play a sport, take your plan to practice: a full bottle with marks for each 15 minutes is a good reminder.

Check your work

- ☐ I can explain how losing water makes my heart beat faster and my body temperature rise.
- ☐ I measured my fluid loss (or used the no-scale method) and found my sweat rate.
- ☐ I made a drinking plan and tested it on a second day.

FITNESS JOURNAL

1. Copy your sweat-check table for both days and write your sweat rate in ounces per hour.
2. Draw a bar graph of your effort ratings round by round on both days.

3. Draw a flow chart: sweat → less plasma → lower blood volume → smaller stroke volume → faster heart rate → less blood to the skin → higher body temperature.
4. Write your drinking plan on a card you could tape to your water bottle.

From history. Edward F. Adolph (1895–1986) spent most of his career at the University of Rochester studying how the body handles water. His team’s desert book is still cited by scientists who study heat and hydration today, more than seventy-five years later.

COMMON MISTAKES

- Waiting until you feel very thirsty. Adolph found that thirst often lags behind what you have lost.
- Thinking a cool or rainy day means no sweat loss. You still sweat and breathe out water.
- Trying to drink a huge amount before a game “to be safe.” Drink steadily instead.
- Treating the scale number as body weight. In this activity it only measures fluid lost.

Make it a game • Sweat Check Duel. Do a fixed three-minute workout and write how thirsty, warm and tired you feel. Then explain how fluid loss changes blood volume, heart rate and performance. Tell Edward Adolph's desert story. Your parent grades each explanation out of three and trades roles.

2.2 SPORTS DRINKS, WATER AND LABELS

OBJECTIVES

- Read a drink's Nutrition Facts label: serving size, servings per container, total and added sugars, sodium and percent Daily Value.
- Explain why the FDA added an “Added Sugars” line to the label in 2016 and what the Daily Value of 50 grams means.
- Convert grams of sugar into teaspoons and into a percent of the Daily Value.
- Explain when water is the best drink and when a sports drink makes sense.

Warm-up. Do 10 jumping jacks, 10 squats, 10 push-ups at your level and 30 seconds of high knees, twice through. Then pick up a drink bottle from your kitchen and, before you read anything, guess how many teaspoons of sugar it holds. Write your guess. Think about it: how would you find out for sure?

WATCH

The New Nutrition Facts Label: Q&A With FDA's Susan Mayne

U.S. Food and Drug Administration • 6:30

<https://www.youtube.com/watch?v=DTI3yOtctw4>

WHEN TO WATCH

After the story paragraph. Listen for why the FDA changed the label and what “added sugars” means.

Note: An official FDA interview with Dr. Susan Mayne, then head of the FDA's food-safety and nutrition center, made for adults. The label is shown on screen throughout.

BACKUP VIDEO

Hydration: Sports Drinks vs Water - Texas Children's Sports Medicine

Texas Children's • 1:32

<https://www.youtube.com/watch?v=nMzXIJu7MTQ>

After the “How your body works” paragraph. Listen for when water is enough and when a sports drink makes sense.

KEY TERMS

added sugars

Sugars and syrups put into foods and drinks when they are made, not the sugars found naturally in fruit or milk. About 4 grams equals 1 teaspoon.

serving size

The amount of a food or drink that the label's numbers describe. A bottle may hold more than one serving.

% Daily Value

How much one serving gives of a nutrient compared with the amount for a whole day, based on a standard 2,000-calorie day. 5% or less is low; 20% or more is high.

sodium

The mineral in table salt and the main electrolyte lost in sweat. Measured on labels in milligrams (mg).

sports drink

A drink with water, sugar and electrolytes, made to replace fluid, salt and fuel during long, hard exercise.

CORE IDEAS

The story. The Nutrition Facts label you see on every package began with a law passed by Congress in 1990, and it first appeared on foods in 1994. For more than twenty years it listed “Sugars” as one number, which mixed the natural sugar in milk and fruit with sugar and syrup added at the factory. Shoppers could not tell the difference. In May 2016, after years of studying the science, the U.S. Food and Drug Administration announced a redesigned label. It made the serving size and calories easier to see and, for the first time, added a line for **Added Sugars** with a percent Daily Value. Large companies had to use the new label by 2020.

How they figured it out. The new line followed the *Dietary Guidelines for Americans*, which advise keeping added sugars to less than 10 percent of a day's food energy. For a standard 2,000-calorie day, that is 50 grams, so the FDA set the Daily Value for added sugars at 50 grams. Health groups set a lower target for young people: the American Heart Association recommends that children and teens have less than about 25 grams (6 teaspoons) of added sugar a day. A report from the American Academy of Pediatrics in 2011 looked at sports drinks and concluded that for most

young athletes, water is the right drink before, during and after exercise, and sports drinks are rarely needed.

How your body works. A sports drink has water, sodium, potassium and sugar. In long, hard exercise in the heat, usually more than about an hour, or in several games in one day, the sugar can feed working muscles and the sodium can replace what heavy sweat carries away. But in ordinary play, a practice of an hour or less, or sitting at a desk, the body does not need that extra sugar and salt; your meals replace the salt you lose in normal sweat. A typical 20-ounce sports drink contains about 30 to 36 grams of sugar, much of it added, and a 12-ounce can of regular soda about 39 grams. Sugary drinks also feed the mouth bacteria that cause cavities. Water hydrates just as well for everyday activity, with no added sugar at all.

Think it through. Read the serving size first. If a 20-ounce bottle says “servings per container: 2.5,” then every number on the label must be multiplied by 2.5 for the whole bottle. Since 2020, many single bottles show two columns, “per serving” and “per container,” which makes this easier. Treats have their place, and a sweet drink at a celebration is a good gift. The everyday drink is water.

Try it. This week you will run a label lab on common drinks, display their sugar in teaspoons, and plan your drinks for an ordinary day and for a hot, all-day tournament.

PICTURE STUDY



The Copper Drinking Fountain, Jean-Baptiste-Siméon Chardin, c. 1734 · Oil on wood · Musée du Louvre, Paris

Image: [Wikimedia Commons](#), public domain

Jean-Baptiste-Siméon Chardin painted quiet still lifes of ordinary Paris kitchens in the 1700s. Before homes had running water, families kept drinking water in a large copper urn, or cistern, filled by carrying buckets from a well or a public fountain. A jug was filled at the tap, and a ladle served the water.

Look closely

- Find the tap on the copper urn. How would someone get a drink from it?
- Find the bucket and the ladle. How do you think the urn was filled?
- Find the jug. What do you think it was for?
- Look at the light on the copper. What does Chardin want you to notice first?

Talk about it

1. For this household, every cup of water was carried in by hand. How is that different from your kitchen?
2. Families then drank mostly water and milk. How have our drink choices changed since then?
3. If you had to carry every cup of water you drank today, how many trips would it take?

Safety first. The sugar displays are for looking only; do not eat them, and keep sugar away from younger children. Check for food allergies before any tasting. In the tournament plan, remember that heat is dangerous: plan shade, rest and water, and stop and tell an adult at dizziness, headache, nausea, cramps or very heavy sweating.

ACTIVITY

The Label Lab and the Tournament Plan

You will read the labels of five or six drinks, measure their sugar in teaspoons, compare them with the Daily Value, and then plan your drinks for two very different days.

You will need

- Labels from 5 or 6 drinks: water, plain milk, chocolate milk, 100% juice, a sports drink and a regular soda (labels or the companies' online pictures are fine)
- Measuring spoons, a bowl of sugar and clear cups (for display only)
- A calculator and your fitness journal
- A pitcher of water and sliced fruit such as lemon, orange, cucumber or berries

Steps

1. **Build your table.** Columns: Drink, Serving size, Servings per container, Total sugars (g), Added sugars (g), Sodium (mg), and for the whole container: Added sugars (g), Teaspoons, % of 50 g Daily Value.
2. **Read each label.** Fill in the per-serving numbers. Then multiply by the servings per container to find the whole-container numbers. Example: a bottle with 2.5 servings of 14 g added sugar $\rightarrow 14 \times 2.5 = 35$ g.
3. **Convert.** Teaspoons = grams $\div 4$. Percent of Daily Value = grams $\div 50 \times 100$. Example: $35 \text{ g} \div 4 \approx 8.75$, about $8\frac{3}{4}$ teaspoons; $35 \div 50 \times 100 = 70$ percent of the Daily Value.
4. **Build the display.** For each drink, measure its whole-container added sugar in level teaspoons into a clear cup and set the cup in front of its label. For milk and 100% juice, which have only natural sugars, put a card that says "0 tsp added."
5. Compare your guess from the warm-up with the real number. Which drink surprised you most? Which drinks would use up half or more of a young person's 25-gram limit by themselves?

6. **Fruit water.** Add sliced fruit to a pitcher of cold water and let it sit 20 minutes. Taste it beside plain water. Many people find it an easy everyday drink with no added sugar.
7. **Session 3: two drink plans.** Plan (a) an ordinary school day with one hour of active play and (b) a hot, all-day tournament with three 1-hour games. For each, list every drink, the amount in ounces, and the time. Use your sweat rate from Lesson 2.1. In plan (b), decide whether a sports drink makes sense, and when.
8. **Active test.** Do a 45-minute active session (a game, a run-walk, or three rounds of the Lesson 2.1 circuit) following plan (a) with water only. Record thirst, effort and urine color, and write whether water was enough.

Tips

- “Zero sugar” drinks often use sweeteners instead. Water is still the simplest everyday choice.
- Plain milk and 100% juice contain natural sugars and real nutrients such as calcium, protein and vitamin C; the label shows them with 0 g added sugars. Juice is still best in small glasses, about 4 to 8 ounces a day.
- Ingredients are listed from most to least by weight; look for sugar, syrups and words ending in “-ose.”

Check your work

- ☐ I can find serving size, added sugars and sodium on a label and work out the numbers for a whole container.
- ☐ I can turn grams of sugar into teaspoons and a percent of the Daily Value.
- ☐ I can explain when a sports drink makes sense and why water is the everyday drink.

FITNESS JOURNAL

1. Copy your label-lab table and make a bar graph of teaspoons of added sugar per container for each drink, with a line at 6 teaspoons (25 g).
2. Write your two drink plans side by side.
3. Draw a Nutrition Facts label from memory, labeling serving size, servings per container, added sugars, sodium and % Daily Value.

4. Write a paragraph for a younger sibling: when to drink water and when a sports drink might help.

From history. The 1990 law behind the label was the Nutrition Labeling and Education Act. The black-and-white box designed for it in the early 1990s, with its bold “Nutrition Facts” heading, became so familiar that it has been called one of the most widely seen printed designs in the world.

COMMON MISTAKES

- Reading the numbers for one serving and forgetting the bottle holds two or more.
- Thinking sports drinks hydrate better than water for ordinary play. For most activities under an hour, they do not.
- Confusing total sugars with added sugars. Plain milk has sugar, but none of it is added.
- Thinking “natural” or “vitamin” on the front means low sugar. Read the label on the back.

Make it a game · Label Reading Blitz. Choose two drinks from the pantry. In ninety seconds find serving size, servings per container, total and added sugars, sodium and percent Daily Value. Convert added sugars into the share of fifty grams. Your parent checks your math. Pick the better drink for a long game and defend it.

HYDRATION

About 60 percent of your body is water, and every hard workout sends some of it out through your skin as sweat. In this unit you will learn how much that matters: losing even a small share of your body's water makes your heart work harder, raises your body temperature and slows you down. You will hear how a team of scientists led by Edward Adolph studied men walking and working in the deserts of southern California in the 1940s and learned that people cannot be trained to do without water. Then, with a parent, you will measure how much fluid you lose in a workout and make a drinking plan to match it.

Next you will look hard at the drinks on store shelves. Sports drinks were made for long, hard exercise in the heat, but many young people drink them every day. You will learn how the Nutrition Facts label changed in 2016 to show added sugars, measure the sugar and sodium in common drinks, and decide when water is the right choice (almost always) and when a sports drink makes sense.

PREREQUISITES

- Knows the four jobs of water in the body and the signs of dehydration (earlier grades)
- Can convert cups and ounces (1 cup = 8 fluid ounces $\approx$ 240 mL)
- Can work with percents and divide decimals

MASTERY CHECKLIST

- ☐ I can explain how losing body water affects the heart, body temperature and performance.
- ☐ I can tell how Edward Adolph's desert studies showed that people need water and cannot train themselves to need less.
- ☐ I can measure my fluid loss in a workout with a parent and make a drinking plan to match it.
- ☐ I can read a Nutrition Facts label for a drink, find added sugars and sodium, and turn grams of sugar into teaspoons and a percent of the Daily Value.
- ☐ I can explain when water is the best drink and when a sports drink makes sense.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“How to Understand and Use the Nutrition Facts Label” (U.S. Food and Drug Administration)**: Free. The FDA’s own guide to every line of the label, including added sugars and percent Daily Value. For Lesson 2.2.
- **A reusable water bottle with ounce or milliliter marks**: Optional, but it makes the drinking plans in this unit easy. Any cup and a measuring cup work just as well.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1 Water and Performance

3 sessions of 40–45 minutes

2.2 Sports Drinks, Water and Labels

3 sessions of 40–45 minutes

UNIT 2 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Explain step by step how losing water in sweat makes your heart beat faster during exercise.

2. **5 pts**

Why does body temperature rise when you are low on water?

3. **5 pts**

What did Edward Adolph’s team study in the 1940s, and name two things they learned.

4. **5 pts**

In a sweat check, a student’s fluid lost was 1.5 pounds, and he drank 8 ounces during the 45-minute workout. How many ounces of fluid did he lose in total? What was his sweat rate in ounces per hour?

5. (5 pts)

Give a sensible drinking plan for before, during and after a 1-hour soccer practice on a warm day.

6. (5 pts)

A 20-ounce sports drink has 2.5 servings, each with 13 g of added sugar. How many grams of added sugar are in the bottle? How many teaspoons? What percent of the 50 g Daily Value?

7. (5 pts)

What changed on the Nutrition Facts label in 2016, and why does it help shoppers?

8. (5 pts)

When does a sports drink make sense, and when is water the better choice?

9. (5 pts)

Plain milk lists 12 g of total sugars and 0 g of added sugars. Explain how that can be.

10. (5 pts)

In three or four sentences, explain to a teammate why you bring water to practice instead of a soda or sports drink, using at least two facts from this unit.

ANSWER KEY

1. Sweat comes from blood plasma, so blood volume drops. With less blood returning to the heart, each beat pumps less (lower stroke volume), so the heart must beat faster to deliver the same blood and oxygen.
2. With less blood volume, less blood can be sent to the skin to release heat, and you may sweat less, so heat builds up inside the body.
3. How men lived and worked in desert heat near Indio, California (and in a hot room in Rochester). They learned: men could sweat about a quart an hour or more; without enough water their heart rate and temperature rose and they tired or collapsed; thirst alone often did not make them drink enough; people cannot be trained to do without water.
4. $1.5 \times 16 = 24$ ounces from the scale difference, + 8 ounces drunk = 32 ounces lost. Sweat rate = $32 \div 45 \times 60 \approx 42.7$ ounces per hour (about 43 oz/hour).
5. About 1–2 cups of water in the 1–2 hours before; about 4–8 ounces (a few big gulps) every 15–20 minutes during; enough afterward to bring urine back to pale. Water is the drink; no forcing huge amounts.
6. $13 \times 2.5 = 32.5$ g. $32.5 \div 4 \approx 8.1$ teaspoons. $32.5 \div 50 \times 100 = 65\%$ of the Daily Value.
7. The FDA added a line for Added Sugars with a % Daily Value (and made serving size and calories easier to read). It lets shoppers tell sugar added at the factory apart from natural sugar in milk and fruit.
8. A sports drink can make sense in long, hard exercise in the heat (usually more than about an hour) or several games in a day, to replace sodium and supply sugar for fuel. For everyday life, ordinary play and practices of an hour or less, water is better.
9. The sugar in plain milk is lactose, which is naturally present in milk. None was added during processing, so added sugars are 0 g.
10. Answers vary. Full credit for clear reasoning using facts such as: water hydrates as well as sports drinks for practices under an hour; a 20-oz sports drink has about 30–36 g of sugar and a 12-oz soda about 39 g; the AHA recommends under 25 g added sugar a day for young people; the AAP says water is the right drink for most young athletes; sugary drinks feed cavity-causing bacteria.

UNIT CHALLENGE: MY GAME-DAY HYDRATION PLAN

Create a complete hydration plan for a real or imagined game day or long hot day of work or play. Include your sweat-check results (or your no-scale observations) with your sweat rate, a timeline from waking up to bedtime showing every drink with amounts in ounces, shade and rest breaks, the warning signs of dehydration and heat illness and what to do, and a short label comparison of three drinks you might be offered. Then follow your plan on an active day, log it, and write what worked and what you would change.

LOOK FOR	WHAT IT MEANS
Measured basis	The plan uses your own sweat-check numbers or observations, with the calculation shown.
Complete timeline	Drinks before, during and after activity with amounts and times, water as the main drink, and rest and shade breaks.
Label smarts	Three drinks compared correctly by serving size, added sugars (grams, teaspoons and % DV) and sodium.
Safety	At least five warning signs of dehydration or heat illness and the right response, including telling an adult.
Test and reflection	The plan was followed on a real day, logged honestly, and improved with at least one specific change.

NUTRITION

Food is a gift from God and the fuel for everything your body does: growing, thinking, playing and training. In this unit you will follow two expeditions racing to the South Pole in 1911 and 1912. Roald Amundsen of Norway and Robert Falcon Scott of Britain were both brave and determined, but their plans for food, fuel and hauling were very different, and so were the results. You will learn what food energy is, how carbohydrates, proteins and fats each fuel the body, and why careful planning matters, and then you will haul a loaded sledge of your own and plan the food for an active day.

Next you will see how Americans have been taught to build a balanced day of meals, from Caroline Hunt's five food groups of 1916 to MyPlate, introduced in 2011. You will learn how much of each food group a person your age needs, plan a full day of meals and snacks, shop for it with a parent, help cook it, and then check how your real day compared with your plan.

PREREQUISITES

- Knows the five MyPlate food groups and the jobs of carbohydrates, proteins and fats (earlier grades)
- Can read a Nutrition Facts label (Lesson 2.2)
- Can multiply and add decimals

MASTERY CHECKLIST

- ☐ I can tell the story of Amundsen and Scott and explain how food, fuel and planning shaped each expedition.
- ☐ I can explain food energy and say how much energy a gram of carbohydrate, protein and fat provides.
- ☐ I can name the food groups and about how much of each a person my age needs in a day.
- ☐ I can plan a balanced day of meals and snacks and help cook one of the meals safely.
- ☐ I can give thanks for food and practice self-control and enjoyment at the table.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“MyPlate Food Guide” (Nemours KidsHealth for Teens):** Free. A clear teen article on the five food groups and how to build a balanced plate. For Lesson 3.2.
- ***The Last Place on Earth*, by Roland Huntford:** Optional, for parents and strong older readers. A detailed adult history comparing Scott’s and Amundsen’s expeditions. Preview first; it is long and frank in its judgments.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Amundsen and Scott: Food for the South Pole

3 sessions of 40–45 minutes

3.2 Planning a Balanced Day of Meals

3 sessions of 40–45 minutes

UNIT 3 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Give the dates when Amundsen and Scott each reached the South Pole, and say what happened to each party on the return.

2. **5 pts**

Name three differences in how Amundsen and Scott planned for hauling, food and depots.

3. **5 pts**

If Scott’s men ate about 4,500 calories a day but used about 7,000, what was the daily shortfall? Over 30 days?

4. **5 pts**

A granola bar has 24 g carbohydrate, 4 g protein and 7 g fat. How much food energy comes from each, and in total?

5. (5 pts)

Why did polar explorers value fat so highly? Why do growing, active young people need plenty of food energy?

6. (5 pts)

List the USDA food guides from 1916 to today in order, with their years.

7. (5 pts)

Name the five MyPlate food groups and one important nutrient each provides.

8. (5 pts)

A student's plan has 2 slices of whole-wheat toast at breakfast, a sandwich on white bread (2 slices) at lunch, and 1 cup of brown rice at dinner. How many ounce-equivalents of grains is that, and is at least half whole? (1 cup cooked rice = 2 oz-eq)

9. (5 pts)

Plan one balanced lunch that includes at least four food groups, and name each group.

10. (5 pts)

In two or three sentences, explain what 1 Corinthians 10:31 has to do with how we eat.

ANSWER KEY

1. Amundsen: December 14, 1911; all five men returned safely in January 1912.
Scott: January 17, 1912; all five men died on the return journey, the last three in late March about 11 miles from a food depot.
2. Any three: Amundsen used dogs to pull while his men skied; Scott's men mostly man-hauled; Amundsen laid large depots marked with long lines of flags across the route; Amundsen carried plenty of food; Scott's rations (about 4,400–4,500 calories) were far below what man-hauling burned (close to 7,000); some of Scott's fuel had leaked from depot cans; Amundsen learned fur clothing and dog travel from Arctic peoples.
3. $7,000 - 4,500 = 2,500$ calories a day. $2,500 \times 30 = 75,000$ calories over 30 days.
4. Carbohydrate $24 \times 4 = 96$; protein $4 \times 4 = 16$; fat $7 \times 9 = 63$. Total = 175 calories.
5. Fat gives about 9 calories per gram, more than twice carbohydrate or protein, so it packs the most energy into the least weight. Young people need energy for growth, for their organs, for school and for play and training.
6. Caroline Hunt's five groups (1916), Basic Seven (1943), Basic Four (1956), Food Guide Pyramid (1992), MyPlate (2011). (MyPyramid, 2005, also earns credit.)
7. Fruits (vitamin C, potassium, fiber); vegetables (vitamins A and C, potassium, fiber); grains (carbohydrate, B vitamins, iron, fiber); protein foods (protein, iron, zinc); dairy (calcium, vitamin D, protein). Other correct nutrients earn credit.
8. Toast 2 + sandwich 2 + rice 2 = 6 oz-eq. Whole: toast 2 + brown rice 2 = 4 of 6, which is more than half. Yes.
9. Sample: turkey and cheese on whole-wheat bread (protein, dairy, grains), carrot sticks (vegetable), an apple (fruit), water or milk. Any reasonable lunch with four or more groups earns credit.
10. Answers vary. Full credit for linking eating and drinking to giving thanks to God, enjoying food as His gift, caring for the body He made, and practicing self-control rather than fear or excess.

UNIT CHALLENGE: A PLANNED AND COOKED DAY OF MEALS

Plan, shop for and help cook a full balanced day of meals and snacks for your family, including at least one breakfast, lunch or dinner that you cook with a parent supervising. Include your planning grid with food-group totals checked against MyPlate, your shopping list, the recipe of the meal you cooked, a photo or drawing of the plate, and your real-day record compared with the plan. Finish with a short paragraph on what you learned from the race to the Pole and from MyPlate about planning fuel for an active life.

LOOK FOR	WHAT IT MEANS
Balanced plan	Every food group close to the MyPlate amounts for your age and activity, at least half grains whole, a fruit or vegetable at every meal, and water planned.
Shopping and cooking	An organized shopping list and a meal cooked safely with a parent, recipe written clearly.
Honest comparison	A real-day record with amounts, compared with the plan using the color ratings.
Reflection	A paragraph connecting the polar story and MyPlate to your own planning, with two specific changes for next time.

3.1 AMUNDSEN AND SCOTT: FOOD FOR THE SOUTH POLE

OBJECTIVES

- Tell the story of Amundsen’s and Scott’s journeys to the South Pole in 1911–12 and how food, fuel and hauling shaped them.
- Explain food energy and use 4, 4 and 9 calories per gram for carbohydrate, protein and fat as a unit of energy, not a number to count or restrict.
- Explain why harder work needs more fuel and why planning food matters for any long effort.
- Complete a sledge-haul workout and plan the food and water for an active day.

Warm-up. Walk briskly in place for 1 minute, then do 10 walking lunges, 10 squats, 10 arm swings across your body and 20 seconds of fast feet. Hold a heavy book at your chest and walk a slow lap of the room. Think about it: if you had to pull your food, tent and fuel across 800 miles of ice, what food would you choose, and why?

WATCH

The dangerous race for the South Pole - Elizabeth Leane

TED-Ed • 4:48

<https://www.youtube.com/watch?v=Ts3LlirgDbU>

WHEN TO WATCH

After the story paragraph. Follow both teams on the map and notice how Amundsen used dogs while Scott’s men hauled their own sledges.

Note: A TED-Ed animation in quiet, shadowy colors. It opens with words from Scott’s last journal and tells plainly that his party died on the return; nothing is shown in detail.

KEY TERMS

food energy

The energy stored in food that your body uses for every activity. It is measured in calories (on labels, a “calorie” is really a kilocalorie).

calorie

A unit of energy, the way an inch is a unit of length. Carbohydrate and protein give about 4 calories per gram; fat gives about 9.

pemmican

A dense food of dried, ground meat mixed with fat, carried by explorers because it packs a lot of energy into little weight.

depot

A store of food and fuel left along a route so travelers do not have to carry everything from the start.

energy expenditure

How much energy the body uses in a day. Hard physical work raises it greatly.

CORE IDEAS

The story. In 1911 two expeditions set out from the coast of Antarctica for the South Pole, about 800 miles away across ice shelves, glaciers and a high, freezing plateau. Roald Amundsen of Norway left on October 20 with four companions, sledges and dogs. The men skied, and the dogs pulled. On December 14, 1911, they reached the Pole, planted the Norwegian flag and turned for home. All five returned safely to their base in January 1912. Captain Robert Falcon Scott of Britain set out on November 1 with ponies, motor sledges and dogs, but for most of the journey his men pulled their own sledges, which is called **man-hauling**. Scott and four companions reached the Pole on January 17, 1912, and found Amundsen's tent already there. On the long return, weakened by cold, hunger and exhaustion, all five men died; the last three died in their tent in late March, only about eleven miles from a large depot of food.

How they figured it out. Both leaders were brave, and both planned carefully, but in different ways. Amundsen had learned from the Netsilik people of the Arctic about fur clothing and dog travel. He laid down large depots of food in the autumn before his journey and marked each one with a long line of flags set out sideways across his route, so he could find it even if he drifted off course. His dogs did the heavy pulling, so his men burned less energy, and he carried plenty of food. Scott's men hauled heavy sledges for hundreds of miles, often on soft snow at high altitude. Their sledging ration gave each man about 4,400 to 4,500 calories a day. In 2012 two scientists, Lewis Halsey and Mike Stroud, used measurements from modern polar expeditions to estimate that man-hauling like Scott's burns close to 7,000 calories a day. Day after day, Scott's men used far more energy than their food supplied. Some

of their fuel cans at the depots had also leaked, leaving less oil to melt snow for drinking water and to cook.

How your body works. Your body uses food energy for everything: keeping your heart beating, growing, thinking and moving. **Carbohydrates** (in grains, fruits, vegetables, beans and milk) give about 4 calories per gram and are the quickest fuel for hard work. **Proteins** (in meat, fish, eggs, beans, nuts and dairy) give about 4 calories per gram and are used mainly to build and repair muscle and other tissues. **Fats** (in nuts, oils, butter, cheese and meat) give about 9 calories per gram, more than twice as much, which is why explorers prized pemmican and butter. Calories are just a unit for measuring that energy, like miles for distance. Growing, active young people need plenty of food energy every day, and a good plan simply makes sure you have enough fuel of the right kinds, at the right times, for the work in front of you.

Think it through. The polar journeys were extreme, but the lesson applies to an ordinary Saturday of hiking, ball games or farm work: hard work needs more food and water, and a wise person plans ahead. Scripture points to the ant, which “provideth her meat in the summer” (Proverbs 6:8).

Try it. This week you will pull a loaded “sledge” across the yard in a timed workout, and plan, pack and eat the food and water for an active day.

PICTURE STUDY



Captain Scott's Birthday Dinner, 6 June 1911, Herbert Ponting, 1911 · Photograph · Taken in the expedition hut at Cape Evans, Antarctica
Image: [Wikimedia Commons](#), public domain

Herbert Ponting was the expedition's photographer, one of the first professional photographers in Antarctica. He took this picture during the dark Antarctic winter, months before the journey to the Pole, when Scott's men gathered in their hut at Cape Evans to celebrate their leader's forty-third birthday with a special dinner.

Look closely

- Count the men at the table. How many people did the expedition need to feed every day?
- Look at their clothes. What does that tell you about the temperature, even indoors?
- Find the dishes on the table, such as the bowl of peas. Why might a feast matter so much during months of darkness?
- Look at the flags hanging from the ceiling. Each sledging party had its own flag. Why might a team want a flag?

Talk about it

1. In the hut the men ate well. Why was eating enough so much harder out on the trail?

2. How does eating a meal together help a team stay strong together?
3. If you were planning food for this hut for a whole year, what would you need to think about?

Safety first. Pull the sledge on grass or a smooth, clear path, never near a street, stairs or a slope, and keep the load light enough that you can walk upright with good posture (start with about 10 pounds). Hold the rope with both hands, walk forward or backward slowly, and keep loops of rope away from your neck and hands. Check for food allergies before packing or tasting foods, and stop and tell an adult at dizziness, chest pain or sharp pain.

ACTIVITY

The Sledge Haul and the Fuel Plan

You will feel a little of what Scott's men felt by hauling a load, measure your effort, and then plan food and water so you have the fuel you need, the way Amundsen planned his depots.

You will need

- A “sledge”: a sturdy plastic laundry basket, a cardboard box or an old blanket
- A load: books, cans or a water jug, about 10 pounds to start (up to about 20 pounds as you get stronger)
- A rope or old belt about 6 feet long, tied firmly to the sledge
- Chalk or cones to mark a 20-yard course on grass, a timer, a water bottle and your fitness journal
- Foods for an active day and some Nutrition Facts labels

Steps

1. **Warm up (5 minutes):** brisk walk, 10 walking lunges, 10 squats, 10 arm circles each way and 3 easy 20-yard jogs.
2. **The sledge haul.** Mark a 20-yard course on grass. Holding the rope in both hands over one shoulder or at your waist, lean slightly forward with a straight back and walk the sledge to the far line in short, strong steps. Time it. Walk back without the sledge as your rest. That is one length.
3. Do 6 lengths. After lengths 2, 4 and 6, record your time and your effort (1–10). Rest 1 minute and drink water after length 3.
4. **Backward pull.** Then do 2 lengths facing the sledge, walking backward slowly with the rope held at your waist (a helper watches the path behind you). This works the fronts of your thighs.
5. **Cool down:** walk for 3 minutes and stretch your thighs, calves, back and shoulders for 20 seconds each.
6. **The fuel plan.** Plan the food and water for an active day of about 3 hours of hiking, sport or yard work. Include a breakfast, two packed snacks and a

lunch, with foods from at least four food groups and a carbohydrate food at every meal and snack. Plan at least 8 cups of water through the day.

7. **Energy as a unit.** For one packed food, read its label and work out where its energy comes from: grams of carbohydrate $\times$ 4, grams of protein $\times$ 4, and grams of fat $\times$ 9. Example: a peanut-butter sandwich with 35 g carbohydrate, 12 g protein and 16 g fat $\rightarrow 140 + 48 + 144 = 332$ calories. Which nutrient gives the most energy per gram? (This is a science exercise, not counting.)
8. **Session 3: the active day and the retest.** Eat your planned breakfast, live out your active day, and eat your snacks and lunch on schedule. Before the end of the day, repeat the sledge haul with the same load and course. Record times and effort, and compare them with Session 2.
9. If the haul felt easy, add about 2 pounds for next time. If it felt very hard (effort 9–10), keep the same load until it feels better.

Tips

- Step short and quick, and push through your whole foot. Leaning too far forward strains the back.
- Foods that travel well: whole-grain sandwiches, fruit, cheese sticks, trail mix with nuts and raisins (if no allergies), carrot sticks, hard-boiled eggs kept cold.
- Eat a snack about every 2 to 3 hours on an active day, before you feel empty.

Check your work

- ☐ I can tell how food, fuel and hauling shaped Amundsen's and Scott's journeys.
- ☐ I can explain 4, 4 and 9 calories per gram and use them for one food.
- ☐ I hauled, planned, lived my fuel plan and retested, and recorded everything.

FITNESS JOURNAL

1. Draw a simple map of Antarctica from the coast to the Pole and mark both routes, the dates each team reached the Pole, and where depots were laid.
2. Record your sledge-haul times and effort ratings for both days in a table and a bar graph.
3. Write your fuel plan as a timeline from breakfast to evening, with food groups and water.

4. Write a paragraph: what three lessons about food and planning would you take from the race to the Pole on your next long hike or game day?

From history. The men who found Scott's tent in November 1912 also found his journals, which told the story of the return journey. Amundsen later wrote about his own expedition in *The South Pole*. The scientific work of Scott's expedition, including rocks, fossils and weather records, was carried home and studied for years afterward.

COMMON MISTAKES

- Skipping breakfast or snacks before a long, active day. Hard work needs fuel.
- Thinking calories are something to fear. They are simply a measure of the energy your body needs to grow and work.
- Packing only sweets for a hike. Mix in protein, fat, fruit and whole grains for steady energy.
- Forgetting water. Scott's men struggled for drinking water when their fuel ran short.

Make it a game · Sledge Haul Debate. Tell the stories of Amundsen and Scott as a sports commentator would, in three minutes. Name what each team ate and hauled. Then pick three foods and multiply grams by four, four and nine to find food energy, treating the number as fuel, not a score. Your parent judges the story and the math.

Scripture. "Go to the ant, thou sluggard; consider her ways, and be wise: Which having no guide, overseer, or ruler, Provideth her meat in the summer, and gathereth her food in the harvest." (Proverbs 6:6-8, KJV)

The ant gathers food ahead of time without anyone telling her to. Planning your fuel before a hard day is the same kind of wisdom.

3.2 PLANNING A BALANCED DAY OF MEALS

OBJECTIVES

- Tell how USDA food guides changed from Caroline Hunt’s five groups (1916) to MyPlate (2011).
- State about how much of each food group a person ages 12–13 needs in a day.
- Plan a balanced day of meals and snacks, shop for it with a parent, and help cook one meal safely.
- Compare a planned day with what was actually eaten, and improve the plan.

Warm-up. Do 1 minute of jumping jacks, 10 squats, 10 push-ups at your level, 10 lunges on each leg and a 30-second plank. Then, from memory, draw a plate and divide it into the MyPlate sections. Think about it: what did your plate look like at dinner last night?

WATCH

Choosing a Healthy Eating Style

WisconsinDPI • 5:38

https://www.youtube.com/watch?v=ll8eU_jcrMo

WHEN TO WATCH

After the “How your body works” paragraph. Watch for the MyPlate food groups and the subgroups of vegetables.

Note: Made by the Wisconsin Department of Public Instruction for school nutrition classes.

BACKUP VIDEO

MyPlate, MyWins: What’s Your Healthy Eating Style?

USDA • 1:46

<https://www.youtube.com/watch?v=j7CcaUZrUoE>

Before you plan your meals, for quick ideas for each food group.

KEY TERMS

food group

A set of foods that provide similar nutrients. MyPlate uses five: fruits, vegetables, grains, protein foods and dairy.

nutrient-dense

Describes foods with many vitamins, minerals, fiber or protein for their energy, such as vegetables, fruits, whole grains, beans, eggs, fish and milk.

Dietary Guidelines for Americans

Advice on healthy eating published by the U.S. government every five years, on which MyPlate is based.

ounce-equivalent

MyPlate's unit for grains and protein foods. One slice of bread or ½ cup of cooked rice is 1 ounce-equivalent of grains; one egg or 1 tablespoon of peanut butter is 1 ounce-equivalent of protein.

whole grain

A grain food made from the entire kernel, including the bran and germ, such as oatmeal, brown rice and 100% whole-wheat bread. MyPlate suggests making at least half your grains whole.

CORE IDEAS

The story. In 1916 Caroline Hunt, a nutrition specialist at the U.S. Department of Agriculture, wrote a booklet for parents called *Food for Young Children*. In it she sorted foods into five groups: milk and meat; cereals (grains); vegetables and fruits; fats and fatty foods; and sugars and sugary foods. It was the first USDA food guide built on food groups. Over the next century the guide changed many times as scientists learned more: the “Basic Seven” in 1943, the “Basic Four” in 1956, the Food Guide Pyramid in 1992, and finally **MyPlate**, introduced on June 2, 2011, a simple picture of a dinner plate with a glass of milk beside it.

How they figured it out. Each new guide came from new research about vitamins, minerals, fiber and what helps people stay healthy over a lifetime. Hunt's guide came only a few years after vitamins were first described. Later guides added more attention to whole grains, vegetables and fruits, and to limiting added sugars. The plate was chosen because it shows what you actually do: fill a plate. About half of it is

fruits and vegetables, a little more than a quarter is grains, a little less than a quarter is protein, and dairy sits on the side.

How your body works. Each food group brings different gifts. **Vegetables and fruits** supply vitamins A and C, potassium and fiber. **Grains**, especially whole grains, supply carbohydrates for energy, B vitamins, iron and fiber. **Protein foods** (meat, poultry, fish, eggs, beans, nuts and seeds) supply protein for growing muscles, plus iron and zinc. **Dairy** (milk, yogurt, cheese, or calcium-fortified soy milk) supplies calcium and vitamin D for bones, which are building their strength fastest during your teen years. For a typical active 12- or 13-year-old, MyPlate's 2,000-calorie pattern suggests about 2 cups of fruit, 2½ cups of vegetables, 6 ounce-equivalents of grains (at least half whole), 5½ ounce-equivalents of protein foods and 3 cups of dairy a day. Real needs vary with age, growth and activity; very active, fast-growing young people often need more, and the free MyPlate Plan on the USDA's MyPlate website gives amounts for you.

Think it through. Eating well is not about perfect days or forbidden foods. It is about a steady pattern: mostly nutrient-dense foods, with treats enjoyed in their place, and meals eaten together with thanks. “Whether therefore ye eat, or drink, or whatsoever ye do, do all to the glory of God” (1 Corinthians 10:31). Self-control at the table means stopping when you are satisfied; gratitude means enjoying God's gifts.

Try it. This week you will plan a balanced day of meals and snacks, make a shopping list, help cook one meal, and then check your real day against your plan.

PICTURE STUDY



A Day's Pattern for Good Eating, from the "Basic 7", U.S. Department of Agriculture, 1940s · Printed poster · U.S. Department of Agriculture
Image: [Wikimedia Commons](#), public domain

During the 1940s, the U.S. government encouraged every family to eat from the "Basic 7" food groups every day. Charts and posters like this one were printed for schools, kitchens and community centers to show what a balanced day looked like.

Look closely

- Find all seven groups. Which ones match MyPlate's groups today?
- Find a group that MyPlate no longer lists on its own. Why might it have been dropped?
- Look for how the poster suggests spreading foods across breakfast, lunch and supper.
- Look at the foods pictured. Which ones are on your table this week?

Talk about it

1. What has stayed the same from the 1940s to MyPlate, and what has changed?
2. Why might a simple picture help a family plan meals better than a long list?
3. If you designed a poster for your family's kitchen, what would it show?

Safety first. Wash your hands before handling food and after touching raw meat or eggs. A parent supervises all knife work and the stove; use a cutting board, curl your fingertips under, and turn pot handles inward. Check for food allergies in your family before planning and tasting, and follow any special eating plan a doctor has given.

ACTIVITY

My Balanced Day

You will plan a whole day of eating like a real meal planner: food groups, amounts, a shopping list and a cooked meal. Then you will see how close your real day came to your plan.

You will need

- Your fitness journal and colored pencils
- The MyPlate amounts from this lesson (or your own MyPlate Plan)
- Measuring cups for checking portions
- Groceries for the day, bought with a parent, and kitchen tools for one meal

Steps

1. **Make a planning grid.** Rows: Breakfast, Morning snack, Lunch, Afternoon snack, Dinner. Columns: Fruits (cups), Vegetables (cups), Grains (oz-eq), Protein (oz-eq), Dairy (cups), Water (cups).
2. **Plan the day.** Fill in each meal and snack with real foods your family likes, and write the amounts. Use these equivalents: 1 cup of raw leafy greens = $\frac{1}{2}$ cup vegetables; 1 medium apple $\approx$ 1 cup fruit; 1 slice of bread = 1 oz-eq grains; 1 egg = 1 oz-eq protein; 1 cup of milk or yogurt = 1 cup dairy.
3. **Total each column.** Check your totals against the MyPlate amounts (or your own MyPlate Plan). Adjust until every group is close to its target, at least half your grains are whole, and there is a vegetable or fruit at every meal.
4. **Make a shopping list** organized by store section (produce, bakery, dairy, meat, pantry) and check it against what is already at home. Go shopping with a parent if you can, and compare two products' labels for one item.
5. **Cook one meal.** With a parent supervising, cook one meal from your plan, such as a vegetable omelet with whole-wheat toast and fruit, or chicken and vegetable stir-fry with brown rice. Wash produce, cut safely, and clean up as you go.

6. Serve the meal to your family, give thanks together, and ask each person to name one thing they liked.
7. **Session 3: the real day.** Live your planned day. In a second grid, record what you actually ate and drank, with amounts (use measuring cups for a few portions to train your eye).
8. Compare the two grids. Color each group green if you were on target, yellow if close, orange if far off. Write two changes that would make your next planned day easier to follow, and plan a second, improved day.

Tips

- Breakfast is an easy place to add fruit and whole grains: oatmeal with berries, or whole-grain cereal with milk and a banana.
- Frozen and canned vegetables and fruits count too and keep well. Choose fruits canned in juice or water.
- Plan leftovers. Tonight's extra rice and vegetables can be tomorrow's lunch.

Check your work

- ☐ I can name the five food groups and the amounts suggested for my age.
- ☐ I planned a balanced day, shopped and cooked one meal safely.
- ☐ I compared my real day with my plan and improved it.

FITNESS JOURNAL

1. Copy your planning grid and your real-day grid side by side, with the colored ratings.
2. Draw your dinner from the cooked meal as a MyPlate, labeling each section with the foods and amounts.
3. Make a timeline of USDA food guides: 1916, 1943, 1956, 1992, 2011, with one sentence about each.
4. Write the recipe for the meal you cooked so a sibling could make it, with safety notes.

From history. Caroline Hunt (1865–1927) was one of the first nutrition specialists hired by the USDA. Her five food groups grew from earlier work by Wilbur O. Atwater, a chemist who in the 1890s measured the energy in foods and published some of the first U.S. advice on what people should eat.

COMMON MISTAKES

- Planning a day with no vegetables until dinner. Spread vegetables and fruits across the day.
- Counting all grains as whole grains. Check for the word “whole” first in the ingredient list.
- Thinking a balanced day means no treats. Treats fit in their place within a pattern of nutrient-dense foods.
- Guessing portions without ever measuring. Measure a few times so your eye learns what a cup looks like.

Make it a game · Balanced Day Builder. Gather food labels or draw cards for each food group. Build one balanced day on paper with the right ounce-equivalents for a person aged twelve to thirteen. Your parent plays a hungry athlete and orders from your plan. Beat the clock to fill a day in five minutes. Tell how food guides changed from 1916 to MyPlate.

Scripture. “Whether therefore ye eat, or drink, or whatsoever ye do, do all to the glory of God.” (1 Corinthians 10:31, KJV)

Even something as ordinary as planning breakfast can be done to the glory of God, with thanks for His gifts and care for the body He gave.

NUTRITION

Food is a gift from God and the fuel for everything your body does: growing, thinking, playing and training. In this unit you will follow two expeditions racing to the South Pole in 1911 and 1912. Roald Amundsen of Norway and Robert Falcon Scott of Britain were both brave and determined, but their plans for food, fuel and hauling were very different, and so were the results. You will learn what food energy is, how carbohydrates, proteins and fats each fuel the body, and why careful planning matters, and then you will haul a loaded sledge of your own and plan the food for an active day.

Next you will see how Americans have been taught to build a balanced day of meals, from Caroline Hunt's five food groups of 1916 to MyPlate, introduced in 2011. You will learn how much of each food group a person your age needs, plan a full day of meals and snacks, shop for it with a parent, help cook it, and then check how your real day compared with your plan.

PREREQUISITES

- Knows the five MyPlate food groups and the jobs of carbohydrates, proteins and fats (earlier grades)
- Can read a Nutrition Facts label (Lesson 2.2)
- Can multiply and add decimals

MASTERY CHECKLIST

- ☐ I can tell the story of Amundsen and Scott and explain how food, fuel and planning shaped each expedition.
- ☐ I can explain food energy and say how much energy a gram of carbohydrate, protein and fat provides.
- ☐ I can name the food groups and about how much of each a person my age needs in a day.
- ☐ I can plan a balanced day of meals and snacks and help cook one of the meals safely.
- ☐ I can give thanks for food and practice self-control and enjoyment at the table.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“MyPlate Food Guide” (Nemours KidsHealth for Teens):** Free. A clear teen article on the five food groups and how to build a balanced plate. For Lesson 3.2.
- ***The Last Place on Earth*, by Roland Huntford:** Optional, for parents and strong older readers. A detailed adult history comparing Scott’s and Amundsen’s expeditions. Preview first; it is long and frank in its judgments.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Amundsen and Scott: Food for the South Pole

3 sessions of 40–45 minutes

3.2 Planning a Balanced Day of Meals

3 sessions of 40–45 minutes

UNIT 3 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Give the dates when Amundsen and Scott each reached the South Pole, and say what happened to each party on the return.

2. **5 pts**

Name three differences in how Amundsen and Scott planned for hauling, food and depots.

3. **5 pts**

If Scott’s men ate about 4,500 calories a day but used about 7,000, what was the daily shortfall? Over 30 days?

4. **5 pts**

A granola bar has 24 g carbohydrate, 4 g protein and 7 g fat. How much food energy comes from each, and in total?

5. (5 pts)

Why did polar explorers value fat so highly? Why do growing, active young people need plenty of food energy?

6. (5 pts)

List the USDA food guides from 1916 to today in order, with their years.

7. (5 pts)

Name the five MyPlate food groups and one important nutrient each provides.

8. (5 pts)

A student's plan has 2 slices of whole-wheat toast at breakfast, a sandwich on white bread (2 slices) at lunch, and 1 cup of brown rice at dinner. How many ounce-equivalents of grains is that, and is at least half whole? (1 cup cooked rice = 2 oz-eq)

9. (5 pts)

Plan one balanced lunch that includes at least four food groups, and name each group.

10. (5 pts)

In two or three sentences, explain what 1 Corinthians 10:31 has to do with how we eat.

ANSWER KEY

1. Amundsen: December 14, 1911; all five men returned safely in January 1912.
Scott: January 17, 1912; all five men died on the return journey, the last three in late March about 11 miles from a food depot.
2. Any three: Amundsen used dogs to pull while his men skied; Scott's men mostly man-hauled; Amundsen laid large depots marked with long lines of flags across the route; Amundsen carried plenty of food; Scott's rations (about 4,400–4,500 calories) were far below what man-hauling burned (close to 7,000); some of Scott's fuel had leaked from depot cans; Amundsen learned fur clothing and dog travel from Arctic peoples.
3. $7,000 - 4,500 = 2,500$ calories a day. $2,500 \times 30 = 75,000$ calories over 30 days.
4. Carbohydrate $24 \times 4 = 96$; protein $4 \times 4 = 16$; fat $7 \times 9 = 63$. Total = 175 calories.
5. Fat gives about 9 calories per gram, more than twice carbohydrate or protein, so it packs the most energy into the least weight. Young people need energy for growth, for their organs, for school and for play and training.
6. Caroline Hunt's five groups (1916), Basic Seven (1943), Basic Four (1956), Food Guide Pyramid (1992), MyPlate (2011). (MyPyramid, 2005, also earns credit.)
7. Fruits (vitamin C, potassium, fiber); vegetables (vitamins A and C, potassium, fiber); grains (carbohydrate, B vitamins, iron, fiber); protein foods (protein, iron, zinc); dairy (calcium, vitamin D, protein). Other correct nutrients earn credit.
8. Toast 2 + sandwich 2 + rice 2 = 6 oz-eq. Whole: toast 2 + brown rice 2 = 4 of 6, which is more than half. Yes.
9. Sample: turkey and cheese on whole-wheat bread (protein, dairy, grains), carrot sticks (vegetable), an apple (fruit), water or milk. Any reasonable lunch with four or more groups earns credit.
10. Answers vary. Full credit for linking eating and drinking to giving thanks to God, enjoying food as His gift, caring for the body He made, and practicing self-control rather than fear or excess.

UNIT CHALLENGE: A PLANNED AND COOKED DAY OF MEALS

Plan, shop for and help cook a full balanced day of meals and snacks for your family, including at least one breakfast, lunch or dinner that you cook with a parent supervising. Include your planning grid with food-group totals checked against MyPlate, your shopping list, the recipe of the meal you cooked, a photo or drawing of the plate, and your real-day record compared with the plan. Finish with a short paragraph on what you learned from the race to the Pole and from MyPlate about planning fuel for an active life.

LOOK FOR	WHAT IT MEANS
Balanced plan	Every food group close to the MyPlate amounts for your age and activity, at least half grains whole, a fruit or vegetable at every meal, and water planned.
Shopping and cooking	An organized shopping list and a meal cooked safely with a parent, recipe written clearly.
Honest comparison	A real-day record with amounts, compared with the plan using the color ratings.
Reflection	A paragraph connecting the polar story and MyPlate to your own planning, with two specific changes for next time.

STRENGTH

Why can some people sprint like a shot but tire quickly, while others can run for an hour? Part of the answer is inside your muscles. In 1873 the French scientist Louis Ranvier noticed that red muscles and white muscles behave differently, and a century later scientists found the same two kinds of fibers in the legs of runners and sprinters. In this unit you will learn how slow and fast muscle fibers work, how your nervous system calls on them, and how training changes them. You will test your own speed, power and endurance, and watch your fast fibers tire in a fatigue test.

Then you will plan your own strength training. For years many people believed that strength training was dangerous for young people or would stunt their growth. Careful research, much of it led by Avery Faigenbaum and the National Strength and Conditioning Association, showed that well-planned, supervised training with good form is safe and good for growing bodies. You will learn the principle of progressive overload and build a four-week plan using body weight, a backpack with books, water jugs and an optional resistance band, with a retest at the end.

PREREQUISITES

- Knows good form for the squat, push-up, lunge and plank (earlier grades)
- Knows that muscles grow stronger with work, rest, food and sleep (Lesson 1.1)
- Can make a table and compute a percent change

MASTERY CHECKLIST

- ☐ I can describe slow-twitch and fast-twitch muscle fibers and which activities use each.
- ☐ I can tell how Ranvier and later scientists discovered the two kinds of fibers.
- ☐ I can explain progressive overload and how to make a workout a little harder each week.
- ☐ I can explain why supervised strength training with good form is safe for young people.
- ☐ I can follow a four-week strength plan with good form and compare my before and after numbers.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **A light resistance band (loop or tube with handles):** Optional, for rows and presses in Lesson 4.2. Choose a light or medium band. A backpack with books does most of the same jobs.
- **“Strength Training” (Nemours KidsHealth for Teens):** Free. A clear teen article on how strength training works, safety and supervision. Read it with Lesson 4.2.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1 Fast and Slow Muscle Fibers

3 sessions of 40–45 minutes

4.2 Progressive Overload: A Four-Week Plan

3 sessions of 40–45 minutes

UNIT 4 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. 5 pts

Compare slow-twitch and fast-twitch muscle fibers in speed, force, fatigue and how they make energy.

2. 5 pts

What did Louis Ranvier find in 1873, and how did Jonas Bergström’s needle help later scientists?

3. 5 pts

Why is turkey leg meat darker than breast meat?

4. 5 pts

A student’s squat-jump counts in a fatigue test were 14, 12, 10 and 8. What was the percent drop from round 1 to round 4? What does it show?

5. (5 pts)

Explain the size principle: in what order does the nervous system recruit motor units?

6. (5 pts)

What is progressive overload? Name four ways to make a workout gradually harder.

7. (5 pts)

What did researchers such as Avery Faigenbaum find about strength training for young people, and what makes it safe?

8. (5 pts)

Using double progression with a range of 8–15 reps, a student did 2 sets of 15 backpack squats with good form at 8 pounds. What should she do next workout?

9. (5 pts)

A student did 12 push-ups on test day and 18 at the retest four weeks later. What is the percent increase?

10. (5 pts)

In two or three sentences, explain why this course measures strength with a set of good reps instead of a one-rep maximum.

ANSWER KEY

1. Slow-twitch (Type I): slower, less force, resist fatigue, use oxygen (many mitochondria, capillaries, myoglobin). Fast-twitch (Type II): faster, more force, tire quickly, rely on quick energy that does not need oxygen.
2. Ranvier found that red muscles in rabbits and rays twitched more slowly and white muscles faster. Bergström's needle biopsy (1960s) let scientists take tiny muscle samples from living people, so they could count fiber types in athletes.
3. The legs work all day walking and standing, so they have more slow-twitch fibers with red myoglobin; the breast muscles are used for short bursts of flapping and are mostly pale fast-twitch fibers.
4. $(14 - 8) \div 14 \times 100 \approx 42.9\%$, about 43%. It shows the fast-twitch fibers tiring quickly in repeated all-out efforts.
5. For light efforts it turns on small motor units of slow-twitch fibers first; as effort increases it adds larger units, and fast-twitch fibers are recruited last for the hardest efforts (Henneman, 1957).
6. Gradually increasing the demand on the body so it keeps adapting. Ways: more reps, more sets, more resistance (load), a harder exercise version; also less rest or slower reps.
7. Supervised, well-designed training makes young people stronger and does not harm growth plates or stunt growth. Safety comes from adult supervision, good form, sensible loads added gradually, rest days, and no maximum-lift testing; most injuries came from accidents, poor form and no supervision.
8. Add a little resistance (about 2 pounds, for 10 pounds total) and drop back to about 8–10 reps per set, then build up again.
9. $(18 - 12) \div 12 \times 100 = 50\%$ increase.
10. Answers vary. Full credit for: a one-rep max puts a very heavy load on growing bones, joints and form and raises injury risk; a set of 8–15 good reps with a moderate load measures progress safely and still shows improvement.

UNIT CHALLENGE: FOUR WEEKS STRONGER

Complete your four-week strength plan and present it. Include your written plan with exercises, sets, reps, rest and progression rule; a log of every workout with reps, loads and effort; your before and after test with percent changes; a line graph of one exercise across the four weeks; and a parent's note confirming good form at the retest. Add your fast-and-slow test results from Lesson 4.1 and a paragraph on what you learned about your own muscle fibers, overload and rest.

LOOK FOR	WHAT IT MEANS
Sound plan	Six exercises covering the whole body, 2–3 non-consecutive days a week, 8–15 reps, clear rest periods and a written progression rule.
Faithful training	About 12 workouts logged in four weeks with dates, reps, loads and effort, with rest days between.
Good form and safety	A parent confirms good form at the retest; loads were added only in small steps; no maximum lifts.
Fair retest	The same exercises, loads or levels and warm-up as test day, with honest numbers and percent changes.
Reflection	A paragraph explaining what improved and why, using the words progressive overload, recovery and muscle fibers. Effort and improvement count, not the size of the numbers.

4.1 FAST AND SLOW MUSCLE FIBERS

OBJECTIVES

- Describe slow-twitch and fast-twitch muscle fibers: speed, power, endurance and fuel.
- Tell how Louis Ranvier (1873) and later scientists discovered the two kinds of fibers.
- Explain how the nervous system recruits fibers from slow to fast as effort rises.
- Test speed, power and endurance, and record a fatigue curve.

Warm-up. Jog in place for 1 minute, then do 10 bodyweight squats, 10 walking lunges, 10 leg swings on each leg, 10 arm circles each way and 3 gentle jumps in place, landing softly. Think about it: at Thanksgiving, why is turkey leg meat darker than breast meat? What does a turkey do with its legs all day, and with its wings?

WATCH

Types of muscle fibres - fast twitch, slow twitch (GCSE PE)

Teach PE • 2:26

<https://www.youtube.com/watch?v=8x8H-GFtwyU>

WHEN TO WATCH

After the “How your body works” paragraph. Copy the three fiber types into your journal as you watch.

Note: A short revision video from Teach PE, made for British secondary-school PE students, with simple cartoons and a photo of marathon runners.

BACKUP VIDEO

The surprising reason our muscles get tired - Christian Moro

TED-Ed • 4:25

<https://www.youtube.com/watch?v=rLsimrBoYXc>

After the fatigue curve, to see what happens inside a tiring muscle.

KEY TERMS

muscle fiber

A single long muscle cell. A muscle is made of thousands of fibers bundled together.

fast-twitch fiber (Type II)

A fiber that contracts quickly and powerfully but tires sooner. It relies more on quick energy that does not need oxygen.

motor unit

One nerve cell and all the muscle fibers it controls. The brain turns on more motor units for harder efforts.

slow-twitch fiber (Type I)

A fiber that contracts more slowly and with less force but resists tiring. It is red with myoglobin and uses oxygen to make energy.

myoglobin

A red protein in muscle that stores oxygen, like hemoglobin in blood. It makes slow-twitch muscle look darker.

CORE IDEAS

The story. In 1873 Louis Ranvier, a French scientist who studied the fine structure of nerves and muscles under the microscope, reported an experiment on rabbits and rays. Some of their muscles were dark red and some were pale. When he stimulated them with electricity, he found that the red muscles twitched more slowly and needed fewer pulses each second to hold a steady contraction, while the white muscles twitched faster. Later scientists noticed the red muscles also resisted tiring. You can see the same thing at a dinner table: a turkey walks and stands all day on its dark-meat legs, while its pale breast muscles power only short bursts of flapping.

How they figured it out. For decades scientists could study these fibers mostly in animals. Then in the 1960s a Swedish doctor, Jonas Bergström, brought back a hollow needle that could take a sample of muscle about the size of a grain of rice from a living person. Scientists stained very fine slices of these samples so slow and fast fibers showed up as different colors and counted them. In the 1970s researchers such as the American physiologist D. L. Costill, at Ball State University in Indiana, sampled the leg muscles of track athletes. Champion distance runners had mostly

slow-twitch fibers in their calf muscles; sprinters had many more fast-twitch fibers. Most people are somewhere in between, with roughly half of each in many muscles.

How your body works. Slow-twitch (Type I) fibers are packed with tiny power plants called mitochondria, surrounded by many capillaries and colored red by myoglobin. They use oxygen to make energy steadily, so they keep working for a long time: holding your posture, walking, jogging. **Fast-twitch (Type II) fibers** are larger and contract two to three times faster with more force, using quick energy stores that do not need oxygen. They power sprints, jumps and heavy lifts, but they tire within seconds to a minute or two. Your brain calls on them in order: for an easy task it turns on small motor units of slow fibers; as effort rises it adds more and larger units, and the fast fibers join last. Scientists call this the **size principle**; the American physiologist Elwood Henneman described it in 1957.

Think it through. The mix of fibers you were born with is part of how God made you, and it helps explain why one person loves sprinting and another loves long runs. But training matters a great deal. Endurance training helps all your fibers use oxygen better, and strength and speed training make fast fibers bigger and stronger. Every body can improve, whatever its mix.

Try it. This week you will test speed and power (fast fibers) and endurance (slow fibers), and record a fatigue curve to watch your fast fibers tire.

PICTURE STUDY



The Biglin Brothers Racing, Thomas Eakins, 1872 · Oil on canvas · National Gallery of Art, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

Thomas Eakins of Philadelphia loved rowing and rowed on the Schuylkill River himself. John and Barney Biglin were famous professional rowers from New York. In 1872 they raced on the Schuylkill in a two-man boat, and Eakins painted them in the middle of a stroke. He studied rowing so carefully that he drew the boats with the exactness of an engineer.

Look closely

- Look at the brothers' arms, backs and legs. Which muscles are working right now?
- Look at the faces. Are the brothers sprinting or settled into a steady rhythm?
- Find the steamboats and the crowd along the far bank. What does that tell you about the race?
- Find the oars and the ripples. What do they tell you about how hard the rowers are pulling?

Talk about it

1. A rowing race of a few miles takes many minutes. Would it rely more on slow-twitch or fast-twitch fibers? What about the final sprint to the line?
2. Why would two rowers need to train together to move in exact time?

3. What kind of training would you plan for a rower?

Safety first. Jump only on grass or a non-slip floor in good shoes, and land softly with bent knees that stay in line with your toes. Rest fully (at least 1 to 2 minutes) between all-out efforts, and stop if you feel sharp pain, dizziness or chest pain. Wall sits and fatigue tests should feel hard in the muscles, never painful in the joints.

ACTIVITY

Fast Fibers, Slow Fibers: The Test Day

Which of your abilities depend on fast fibers, and which on slow? You will measure both, watch how quickly fast fibers tire, and retest to see what practice and pacing can do.

You will need

- A tape measure and chalk or tape
- A 20-yard course on grass or a safe path, and a stopwatch
- A wall, a timer, a helper and your fitness journal

Steps

1. **Warm up (8 minutes).** Use your dynamic warm-up from Lesson 1.2, finishing with 3 build-up runs and 3 easy jumps. Fast-fiber tests need a thorough warm-up.
2. **Fast test 1: Standing long jump.** Stand with toes behind a line, feet hip-width apart. Swing your arms back, bend your knees, then swing forward and jump as far as you can, landing on both feet with bent knees. Measure from the line to the back of your nearest heel. Take 3 jumps with 1 minute of rest between; record the best.
3. **Fast test 2: 20-yard sprint.** From a standing start, sprint 20 yards while your helper times you. Walk back and rest 2 minutes. Do 2 sprints; record the better time.
4. **Slow test: Wall sit.** With your back flat against the wall, slide down until your knees are bent at about a right angle, knees over your ankles, arms crossed. Hold as long as you can with good form (stop at 3 minutes). Record the time.
5. **The fatigue curve.** Rest 3 minutes. Then do as many good-form squat jumps as you can in 15 seconds (jump up, land softly, sink into the next squat). Rest only 15 seconds, and repeat for 4 rounds. Your helper counts each round. Record all four counts.
6. **Graph your fatigue curve.** Plot the four counts on a line graph. The drop from round 1 to round 4 shows fast fibers tiring. Work out the percent drop: $(\text{round 1} - \text{round 4}) \div \text{round 1} \times 100$.

7. **Cool down.** Walk 3 minutes, then hold stretches for your thighs, hamstrings, calves and hips for 20–30 seconds each.
8. **Session 3: retest.** Repeat every test in the same order, with the same warm-up and rests. This time, think about technique: a bigger arm swing on the long jump, a lower, faster start on the sprint, and steady breathing in the wall sit. Record and compare.
9. Write which tests improved and which stayed the same, and whether you think the change came from your muscles or from better technique and pacing.

Tips

- Fast-fiber tests are short and all-out, with long rests. Endurance tests are steady and long. That difference is the whole point of the lesson.
- During the wall sit, breathe normally. Holding your breath raises blood pressure and makes it harder.
- Your numbers are for comparing with yourself next time, not with anyone else.

Check your work

- ☐ I can explain how slow-twitch and fast-twitch fibers differ and give an activity for each.
- ☐ I tested speed, power and endurance and drew my fatigue curve.
- ☐ I retested and explained what changed and why.

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1. Copy your test table (long jump, sprint, wall sit, fatigue counts) for both days.
2. Draw your fatigue curve and write the percent drop.
3. Make a two-column chart, “Slow-twitch” and “Fast-twitch,” with at least five facts and three sports or chores in each.
4. Draw a motor unit: one nerve cell branching to several muscle fibers. Label the nerve, the fibers and the direction of the signal.

From history. Louis-Antoine Ranvier (1835–1922) is better known for discovering the small gaps in the insulation along nerve fibers, which are still called the nodes of Ranvier. Those gaps let nerve signals jump quickly from point to point, which is part of how your brain can call on your muscles so fast.

COMMON MISTAKES

- Thinking you are “just a slow person” or “just a sprinter.” Everyone has both kinds of fiber, and all of them respond to training.
- Doing all-out tests with too little rest. Fast fibers need minutes to recover their quick energy.
- Landing jumps with straight, stiff legs or knees caving inward.
- Thinking lactic acid is the reason muscles are sore the next day. Next-day soreness comes from small strains in the muscle fibers as they adapt.

Make it a game • Fiber Type Duel. Test a fast and slow fiber activity: ten explosive jumps in ten seconds, then a wall sit as long as you can. Record both results. Explain fast-twitch and slow-twitch fibers, myoglobin and motor units. Tell how Ranvier found two fiber kinds. Your parent quizzes you with four terms and scores correct answers.

4.2 PROGRESSIVE OVERLOAD: A FOUR-WEEK PLAN

OBJECTIVES

- Explain the principle of progressive overload and the ways to make a workout gradually harder.
- Explain how research changed the old belief that strength training is unsafe for young people, and what makes it safe.
- Design a four-week strength plan with exercises, sets, reps, rest and progression rules.
- Train with good form and compare before and after numbers.

Warm-up. March for 1 minute, then do 10 arm circles each way, 10 squats, 5 inchworms (bend, walk your hands out to a plank, walk your feet up to your hands), 10 glute bridges and 10 push-ups at an easy level. Think about it: if you did exactly the same workout every day for a year, would you keep getting stronger? Why or why not?

WATCH

What is Strength Training and is it Safe for Kids?

NationwideChildrens · 2:04

<https://www.youtube.com/watch?v=EU-tfq3Z08>

WHEN TO WATCH

After the story paragraph. This is Avery Faigenbaum himself explaining why young people can train safely.

Note: From Nationwide Children's Hospital. A short talk by Dr. Faigenbaum with a few photos of young athletes.

KEY TERMS

progressive overload

Making training gradually harder over time (more reps, more sets, more load or a harder version) so the body keeps adapting.

repetition (rep)

One complete movement of an exercise, such as one squat.

set

A group of reps done in a row before resting, such as 2 sets of 12.

resistance

The force a muscle works against: body weight, a backpack, a water jug or an elastic band.

double progression

A simple plan: add reps until you reach the top of your rep range with good form, then add a little resistance and start again at the bottom of the range.

CORE IDEAS

The story. For much of the 1900s, many coaches, parents and even doctors believed that strength training was dangerous for children and young teens. People said it would damage the growth plates near the ends of the bones, stunt growth, or simply would not work before the teen years. In the 1980s and 1990s researchers began to test those beliefs with careful studies. One of the best known is Avery Faigenbaum, an American exercise scientist who, with colleagues, ran supervised strength programs for children and young teens and measured what happened. The National Strength and Conditioning Association issued its first statement on youth strength training in 1985 and updated it as the evidence grew, most fully in 2009 with Faigenbaum as lead author.

How they figured it out. In study after study, young people who trained two or three times a week with good form and an adult watching grew measurably stronger, often within eight to twelve weeks. Researchers found no evidence that supervised training harmed growth plates or slowed growth. They also found that most strength-training injuries among young people came from accidents with home equipment, horseplay, poor form and no supervision, not from the training itself. Today the NSCA, the American Academy of Pediatrics and the American College of Sports Medicine all say that well-designed, supervised strength training is safe and beneficial for children and teens. It builds stronger muscles and bones, better balance and coordination, and fewer sports injuries.

How your body works. Your body adapts to the demands you give it. A new exercise is a challenge; your nervous system learns to recruit more motor units and coordinate them, and your muscle fibers repair a little stronger during rest. After a

few weeks the same workout is no longer a challenge, so the body stops adapting. **Progressive overload** keeps the challenge going, a little at a time, by adding **reps**, then **sets**, then a little **resistance**, or by moving to a harder version (from incline push-ups to floor push-ups). In your early teens, much of your first strength gain comes from the nervous system getting better at using the muscles you have, which is why good form and practice matter so much. Guidelines for young people suggest 2 or 3 non-consecutive days a week, 1 to 3 sets of about 8 to 15 reps of each exercise, and adding resistance only when form stays perfect.

Good form. Strength is built on form. Move slowly, about 2 seconds down and 1 second up. Breathe out as you push or stand, and never hold your breath. Keep your back flat and your knees in line with your toes. Stop a set when your form starts to break, not when you collapse. In this course we never test how much you can lift once (a “one-rep max”); we measure how many good reps you can do with a moderate load instead.

Try it. This week you will find your starting numbers, write a four-week plan with clear progression rules, and begin training. In week four you will retest. Scripture says, “A wise man is strong; yea, a man of knowledge increaseth strength” (Proverbs 24:5): knowing how to train lets you grow stronger safely.

PICTURE STUDY



The Wood Sawyers, Jean-François Millet, c. 1850–1852 · Oil on canvas · Victoria and Albert Museum, London

Image: [Wikimedia Commons](#), public domain

Jean-François Millet grew up on a farm in Normandy and spent much of his life in the village of Barbizon, beside the Forest of Fontainebleau, painting the people who worked the fields and woods. Here woodsmen cut a great log into lengths, stroke after stroke, while another chops wood behind them.

Look closely

- Look at the near woodsman's legs and back. How is he standing to pull with the most strength and the least strain?
- Find the second man at the far end of the log. How do the two share the work?
- Find the man with the axe in the background. Which muscles does chopping use?
- Look at the log. How many strokes do you think it will take to cut through?

Talk about it

1. A woodsman's strength was built day by day, log by log. How is that like progressive overload?
2. Why would good form matter for someone who saws all day, every day?

3. Which exercises in your plan use the same muscles as sawing?

Safety first. Train with a parent nearby, on a clear, non-slip floor, in good shoes. Use only light household loads (a backpack with a few books, a water jug you can hold steadily) or a light band, and add load in small steps only when every rep has good form. Anchor a band only to something solid, such as a closed door with a door anchor on the hinge side, and check it for nicks before each use. Never try a one-rep maximum, never hold your breath, rest at least one day between workouts for the same muscles, and stop at sharp pain or joint pain.

ACTIVITY

My Four-Week Strength Plan

You will design and begin a real training plan, the way coaches do: test, plan, train, progress and retest. The goal is not a big number but steady, faithful improvement with good form.

You will need

- A backpack and books (start with 5 to 10 pounds; a kitchen scale or bathroom scale can weigh the backpack)
- One or two water jugs (a half-gallon of water weighs about 4 pounds, a gallon about 8 pounds)
- A sturdy chair against a wall, a bottom stair, a towel or mat, a timer
- Optional: a light resistance band with a door anchor
- Your fitness journal

Steps

1. **Choose six exercises.** (1) Backpack squat: wear the backpack on both shoulders, feet shoulder-width apart, sit back and down until thighs are about level, chest up, knees over toes. (2) Push-up at your level: incline (hands on a chair against the wall), knee or full. (3) Row: band row from a door anchor, or a one-arm backpack row with one hand and knee on a sturdy bench or chair and a flat back. (4) Backpack step-up onto the bottom stair, holding the rail. (5) Glute bridge, holding a water jug on your hips. (6) Suitcase carry: walk 20 yards holding a water jug in one hand, standing tall, then switch hands.
2. **Find your starting numbers (Session 2).** After a 5-minute warm-up, choose a load or level for each exercise that lets you do about 10 to 12 good reps (carry: 20 yards each hand). Do 1 test set of each and record the reps, load or level, and effort (1–10). This is your “before” test. Rest 2 minutes between exercises.
3. **Write your plan.** Make a table for 4 weeks $\times$ 3 workouts (for example Monday, Wednesday, Friday). Each workout: warm-up, then 2 sets of each exercise, 8 to 15 reps, 60–90 seconds of rest between sets, then a cool-down.

4. **Write your progression rule (double progression).** Start at the bottom of your range with your test load. Each workout, try to add 1 rep to each set. When you can do 2 sets of 15 with good form, add a little resistance (one more book, about 2 pounds, or the next push-up level) and drop back to 8 to 10 reps. In week 3, add a third set if you are recovering well.
5. **Workout 1 (Session 3).** Warm up, then do your first workout exactly as planned. Log every set: reps, load and effort. A parent watches at least one set of each exercise and checks form.
6. **Weeks 1–4.** Train 3 non-consecutive days a week. On the other days, play, walk or ride a bike, and sleep well. If you feel unusually sore or tired, repeat the last workout instead of progressing.
7. **Week 4: retest.** At the end of week 4, after the same warm-up, repeat the “before” test with the same load or level as on test day: 1 set of as many good reps as you can, up to 25 (carry: time how long you can hold the jug while walking, up to 60 seconds each hand). Record the reps and effort.
8. **Compare.** For each exercise, compute the percent change in reps: $(\text{after} - \text{before}) \div \text{before} \times 100$. Also note how much your training load went up over the four weeks.
9. **Cool down after every workout:** walk 2 minutes, then stretch thighs, hips, chest, back and shoulders for 20–30 seconds each.

Tips

- Write your next workout’s target reps in your journal before you start. A plan on paper keeps you honest.
- A loaded backpack should sit snugly on both shoulders, high on the back, with heavier books closest to your spine.
- Strength gains slow down after the first weeks. Small, steady progress is still progress.

Check your work

- ☐ I can explain progressive overload and double progression.
- ☐ I can explain why supervised strength training with good form is safe for young people.

- I wrote a four-week plan, trained with good form and recorded every workout.

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1. Copy your four-week plan as a neat table and fill it in after every workout.
2. Draw a line graph of your squat reps (or total reps) workout by workout over the four weeks.
3. Record your before and after test with the percent change for each exercise.
4. Write a form card for each exercise with two cues, such as “chest up” and “knees over toes.”

From history. The idea of adding resistance a little at a time was put into a formal method in 1945 by Thomas DeLorme, an American army doctor who used it to help injured soldiers regain strength. His method of sets with gradually heavier loads is the ancestor of nearly every strength plan used today, including yours.

COMMON MISTAKES

- Adding load before form is solid. Reps with good form come first; load comes last.
- Training the same muscles hard every day. Muscles grow stronger during rest.
- Holding your breath or rushing the reps. Breathe out on the push, and lower slowly.
- Comparing your numbers with a friend's. Your plan is about your own progress.

Make it a game • Overload Plan Coach. Design a four-week plan for one bodyweight exercise. Show three ways to make it harder: reps, sets or slower tempo. Present it to your parent as a coach, who asks why each week changes. Defend with double progression. Explain how research proved strength training can be safe for young people. She grades it.

Scripture. “A wise man is strong; yea, a man of knowledge increaseth strength.” (Proverbs 24:5, KJV)

Knowledge and wisdom help strength grow. Training with a plan, good form and rest is wise stewardship of the body God gave you.

STRENGTH

Why can some people sprint like a shot but tire quickly, while others can run for an hour? Part of the answer is inside your muscles. In 1873 the French scientist Louis Ranvier noticed that red muscles and white muscles behave differently, and a century later scientists found the same two kinds of fibers in the legs of runners and sprinters. In this unit you will learn how slow and fast muscle fibers work, how your nervous system calls on them, and how training changes them. You will test your own speed, power and endurance, and watch your fast fibers tire in a fatigue test.

Then you will plan your own strength training. For years many people believed that strength training was dangerous for young people or would stunt their growth. Careful research, much of it led by Avery Faigenbaum and the National Strength and Conditioning Association, showed that well-planned, supervised training with good form is safe and good for growing bodies. You will learn the principle of progressive overload and build a four-week plan using body weight, a backpack with books, water jugs and an optional resistance band, with a retest at the end.

PREREQUISITES

- Knows good form for the squat, push-up, lunge and plank (earlier grades)
- Knows that muscles grow stronger with work, rest, food and sleep (Lesson 1.1)
- Can make a table and compute a percent change

MASTERY CHECKLIST

- ☐ I can describe slow-twitch and fast-twitch muscle fibers and which activities use each.
- ☐ I can tell how Ranvier and later scientists discovered the two kinds of fibers.
- ☐ I can explain progressive overload and how to make a workout a little harder each week.
- ☐ I can explain why supervised strength training with good form is safe for young people.
- ☐ I can follow a four-week strength plan with good form and compare my before and after numbers.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **A light resistance band (loop or tube with handles):** Optional, for rows and presses in Lesson 4.2. Choose a light or medium band. A backpack with books does most of the same jobs.
- **“Strength Training” (Nemours KidsHealth for Teens):** Free. A clear teen article on how strength training works, safety and supervision. Read it with Lesson 4.2.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1 Fast and Slow Muscle Fibers

3 sessions of 40–45 minutes

4.2 Progressive Overload: A Four-Week Plan

3 sessions of 40–45 minutes

UNIT 4 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Compare slow-twitch and fast-twitch muscle fibers in speed, force, fatigue and how they make energy.

2. **5 pts**

What did Louis Ranvier find in 1873, and how did Jonas Bergström’s needle help later scientists?

3. **5 pts**

Why is turkey leg meat darker than breast meat?

4. **5 pts**

A student’s squat-jump counts in a fatigue test were 14, 12, 10 and 8. What was the percent drop from round 1 to round 4? What does it show?

5. (5 pts)

Explain the size principle: in what order does the nervous system recruit motor units?

6. (5 pts)

What is progressive overload? Name four ways to make a workout gradually harder.

7. (5 pts)

What did researchers such as Avery Faigenbaum find about strength training for young people, and what makes it safe?

8. (5 pts)

Using double progression with a range of 8–15 reps, a student did 2 sets of 15 backpack squats with good form at 8 pounds. What should she do next workout?

9. (5 pts)

A student did 12 push-ups on test day and 18 at the retest four weeks later. What is the percent increase?

10. (5 pts)

In two or three sentences, explain why this course measures strength with a set of good reps instead of a one-rep maximum.

ANSWER KEY

1. Slow-twitch (Type I): slower, less force, resist fatigue, use oxygen (many mitochondria, capillaries, myoglobin). Fast-twitch (Type II): faster, more force, tire quickly, rely on quick energy that does not need oxygen.
2. Ranvier found that red muscles in rabbits and rays twitched more slowly and white muscles faster. Bergström's needle biopsy (1960s) let scientists take tiny muscle samples from living people, so they could count fiber types in athletes.
3. The legs work all day walking and standing, so they have more slow-twitch fibers with red myoglobin; the breast muscles are used for short bursts of flapping and are mostly pale fast-twitch fibers.
4. $(14 - 8) \div 14 \times 100 \approx 42.9\%$, about 43%. It shows the fast-twitch fibers tiring quickly in repeated all-out efforts.
5. For light efforts it turns on small motor units of slow-twitch fibers first; as effort increases it adds larger units, and fast-twitch fibers are recruited last for the hardest efforts (Henneman, 1957).
6. Gradually increasing the demand on the body so it keeps adapting. Ways: more reps, more sets, more resistance (load), a harder exercise version; also less rest or slower reps.
7. Supervised, well-designed training makes young people stronger and does not harm growth plates or stunt growth. Safety comes from adult supervision, good form, sensible loads added gradually, rest days, and no maximum-lift testing; most injuries came from accidents, poor form and no supervision.
8. Add a little resistance (about 2 pounds, for 10 pounds total) and drop back to about 8–10 reps per set, then build up again.
9. $(18 - 12) \div 12 \times 100 = 50\%$ increase.
10. Answers vary. Full credit for: a one-rep max puts a very heavy load on growing bones, joints and form and raises injury risk; a set of 8–15 good reps with a moderate load measures progress safely and still shows improvement.

UNIT CHALLENGE: FOUR WEEKS STRONGER

Complete your four-week strength plan and present it. Include your written plan with exercises, sets, reps, rest and progression rule; a log of every workout with reps, loads and effort; your before and after test with percent changes; a line graph of one exercise across the four weeks; and a parent's note confirming good form at the retest. Add your fast-and-slow test results from Lesson 4.1 and a paragraph on what you learned about your own muscle fibers, overload and rest.

LOOK FOR	WHAT IT MEANS
Sound plan	Six exercises covering the whole body, 2–3 non-consecutive days a week, 8–15 reps, clear rest periods and a written progression rule.
Faithful training	About 12 workouts logged in four weeks with dates, reps, loads and effort, with rest days between.
Good form and safety	A parent confirms good form at the retest; loads were added only in small steps; no maximum lifts.
Fair retest	The same exercises, loads or levels and warm-up as test day, with honest numbers and percent changes.
Reflection	A paragraph explaining what improved and why, using the words progressive overload, recovery and muscle fibers. Effort and improvement count, not the size of the numbers.

AEROBIC TRAINING

When you jog, your heart and lungs deliver oxygen to your muscles and you can keep going for a long time. When you sprint, your muscles need energy faster than oxygen can arrive, and soon you are gasping. In this unit you will meet A. V. Hill, a British scientist who won a Nobel Prize in 1922 and who, in the early 1920s, ran laps of a small grass track himself while his colleagues collected every breath he breathed out. From his experiments came the ideas of maximal oxygen uptake and oxygen debt, and a clearer picture of aerobic and anaerobic energy. You will repeat a simple version of his experiment with your pulse, your breathing and the talk test.

Then you will meet Emil Zátopek of Czechoslovakia, a factory worker turned soldier who trained by running fast laps again and again with short jogs between them, and who in one week at the 1952 Olympic Games in Helsinki won the 5,000 metres, the 10,000 metres and the marathon, a feat no one has matched. You will learn how interval training works, run an interval session of your own with a retest, and finish the quarter by planning and leading a family fitness day.

PREREQUISITES

- Can take a pulse for 15 seconds and multiply by 4 to find beats per minute
- Knows fast-twitch and slow-twitch fibers (Lesson 4.1)
- Can mark a measured course and time laps

MASTERY CHECKLIST

- ☐ I can explain aerobic and anaerobic energy and give an activity that depends mostly on each.
- ☐ I can tell how A. V. Hill measured oxygen use while running and what he discovered.
- ☐ I can use heart rate, breathing rate, the talk test and an effort scale to judge how hard I am working.
- ☐ I can tell the story of Emil Zátopek's training and his three gold medals in 1952.
- ☐ I can plan and run an interval session safely, record my splits and heart rate, and lead a family fitness day.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“How to Measure Physical Activity Intensity” (Centers for Disease Control and Prevention):** Free. The CDC’s explanation of moderate and vigorous activity, the talk test and the 0-to-10 effort scale. For Lessons 5.1 and 5.2.
- **A stopwatch with a lap button:** Optional. Makes interval splits easy. A phone stopwatch with a lap button works the same way.
- **A jump rope:** Optional. Good for indoor intervals on rainy days and for a family fitness day station. Size it so the handles reach your armpits when you stand on the middle.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 A. V. Hill and Oxygen

3 sessions of 40–45 minutes

5.2 Emil Zátopek and Interval Training

3 sessions of 40–45 minutes

UNIT 5 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Explain the difference between aerobic and anaerobic energy and give one activity that depends mostly on each.

2. **5 pts**

Describe A. V. Hill’s running experiment: what he did, what was measured, and what he found.

3. **5 pts**

What does the talk test tell you? Describe how talking changes from easy to all-out effort.

4. 5 pts

A student counted 34 beats in 15 seconds right after an interval. What is her heart rate in beats per minute?

5. 5 pts

Estimate the maximum heart rate and the vigorous range (70–85% of maximum) for a 13-year-old. Why should the student also use the talk test?

6. 5 pts

What did Emil Zátopek win at the 1952 Olympic Games, and what made it unique?

7. 5 pts

How did Zátopek train, and why does interval training work?

8. 5 pts

A runner's six 200-metre splits were 48, 47, 49, 50, 52 and 54 seconds. Find the average split. What advice would you give for the retest?

9. 5 pts

What is oxygen debt (EPOC), and how can you see it in your own body?

10. 5 pts

In three or four sentences, explain how a wise young athlete should fit interval training into a week, and connect it to 1 Corinthians 9:25.

ANSWER KEY

1. Aerobic energy uses oxygen to break down carbohydrates and fats completely; it is slower to start but lasts a long time (jogging, hiking, swimming laps easily). Anaerobic energy comes quickly without oxygen but lasts only seconds to a minute or two and makes lactate (sprinting, jumping, a final kick).
2. In the early 1920s Hill ran laps of a small grass track at increasing speeds while the air he breathed out was collected and measured. His oxygen use rose with speed until it reached a ceiling (maximal oxygen uptake, $\text{VO}_2 \text{ max}$). Above that, extra energy came without oxygen, and after stopping he kept breathing hard to repay an oxygen debt.
3. It estimates effort: at an easy or moderate pace you can talk in full sentences; at a vigorous pace only a few words; all-out, you cannot talk. It shows the shift from mostly aerobic to strongly anaerobic work.
4. $34 \times 4 = 136$ beats per minute.
5. $220 - 13 = 207$. $207 \times 0.70 \approx 145$; $207 \times 0.85 \approx 176$. Vigorous range $\approx 145\text{--}176$ bpm. The formula is only a rough estimate and can be far off for an individual, so the talk test checks it.
6. The 10,000 metres (July 20), the 5,000 metres (July 24) and the marathon (July 27), his first marathon, all in Olympic-record times. No one else has won all three at one Olympic Games.
7. He ran fast 400-metre repeats again and again with slow jogs of about 200 metres between, building up to dozens a day. Breaking a fast pace into short pieces with rests lets you run much more total distance at racing speed; it trains both the aerobic and anaerobic systems and makes the heart and muscles stronger.
8. $48 + 47 + 49 + 50 + 52 + 54 = 300$; $300 \div 6 = 50$ seconds. The splits slowed by 7 seconds from the fastest, so the runner started too fast; aim for even splits near 50 seconds.
9. The extra oxygen taken in after hard exercise while the body recovers, refills quick energy stores and clears lactate. You see it as hard breathing and a high heart rate that take several minutes to come back down after a sprint.
10. Answers vary. Full credit for: most training easy and steady, intervals only once or twice a week, a warm-up and cool-down, an easy or rest day after each hard session; and self-control (temperance) meaning hard work on hard days, rest on easy days, for a lasting prize.

UNIT CHALLENGE: MY INTERVAL PLAN AND THE FAMILY FITNESS DAY

Put together your aerobic training record and your family fitness day. Include your Hill's-track data and graphs from both trials, your heart-rate range calculation, both interval sessions with splits, heart rates, average splits and graphs, and a two-week plan that fits one interval session a week among easy runs, play and rest. Then plan, lead and record a family fitness day with stations from all five units, a warm-up and cool-down you lead, water for everyone and a meal or snack you help cook. Finish with a one-page report on the day, how your interval session changed from first try to retest, and one fitness goal you will keep after this course.

LOOK FOR	WHAT IT MEANS
Aerobic records	Both Hill's-track trials and both interval sessions recorded with numbers, graphs and calculations shown.
Wise training plan	A two-week plan with one interval session a week, mostly easy activity, warm-ups and cool-downs, and rest or easy days after hard ones.
Family fitness day	Stations from all five units, a warm-up and cool-down led by the student, water and a healthy snack or meal, with everyone moving at his or her own pace.
Reflection	A one-page report naming what improved, what the family enjoyed, and one specific goal for the future. Effort and improvement count, not speed.

5.1 A. V. HILL AND OXYGEN

OBJECTIVES

- Tell how A. V. Hill measured his own oxygen use while running in the early 1920s and what he discovered.
- Explain aerobic and anaerobic energy, maximal oxygen uptake and oxygen debt in simple terms.
- Measure heart rate, breathing rate, talk-test level and effort at three running speeds and during recovery.
- Graph the results and compare a second trial.

Warm-up. Walk briskly for 1 minute, then jog easily for 2 minutes. Count your breaths for 30 seconds and take your pulse for 15 seconds. Now do 20 seconds of fast high knees and count again. Think about it: why do you breathe so much harder after only 20 seconds of high knees than after 2 minutes of easy jogging?

WATCH

GCSE Biology - Exercise & Oxygen Debt (2027/28 exams)

Cognito · 3:45

<https://www.youtube.com/watch?v=3QlvixsepLI>

WHEN TO WATCH

After the “How your body works” paragraph. Watch for what happens to breathing and heart rate during exercise and why oxygen debt builds up.

Note: A Cognito revision cartoon made for British secondary-school biology students. Ignore the exam dates in the title.

BACKUP VIDEO

Respiration: Aerobic vs Anaerobic

Science Sauce · 3:22

<https://www.youtube.com/watch?v=n0uABIlfj44>

For a second explanation of the aerobic and anaerobic equations.

KEY TERMS

aerobic

Using oxygen. Aerobic energy comes from breaking down carbohydrates and fats with oxygen; it is slower to start but can last a long time.

maximal oxygen uptake (VO₂ max)

The most oxygen your body can take in and use in a minute during hard exercise. It is one measure of aerobic fitness.

lactate

A substance made when muscles break down sugar quickly without enough oxygen. The body clears it and reuses it as fuel.

anaerobic

Without oxygen. Anaerobic energy comes quickly from stored fuel without waiting for oxygen, but it lasts only seconds to a minute or two.

oxygen debt

Hill's name for the extra oxygen you keep breathing in after hard exercise, while your body recovers and refills its quick energy stores. Scientists today often call it EPOC.

talk test

A simple way to judge effort: if you can talk in sentences, the activity is moderate; if you can say only a few words, it is vigorous.

CORE IDEAS

The story. Archibald Vivian Hill, called A. V. Hill, was a British scientist who studied how muscles turn fuel into work and heat. In 1922 he shared the Nobel Prize in Physiology or Medicine with the German scientist Otto Meyerhof for discoveries about the chemistry and heat of working muscle. Hill was also a keen runner, and in the early 1920s, at the University of Manchester, he and his colleague Hartley Lupton decided to measure what happens to oxygen in a running human being. The runner was Hill himself.

How they figured it out. Hill ran laps of a small grass track, less than 100 metres around, at a steady speed for several minutes at a time, then repeated the test at faster and faster speeds. Through a mouthpiece, all the air he breathed out was collected in a large bag, so the scientists could measure how much oxygen he had used. As he ran faster, his oxygen use rose, until at a certain speed it would rise no more: his heart, lungs and blood were delivering all the oxygen they could. Hill called that ceiling the maximum oxygen intake, now known as **VO₂ max**. Running

faster than that was still possible for a short time, but the extra energy had to come from processes that did not use oxygen. After he stopped, he kept breathing hard for minutes, taking in extra oxygen, which Hill called the **oxygen debt**. Hill and Lupton published their results in 1923, and tests built on their method are still used in sports laboratories today.

How your body works. Your muscles run on a molecule called ATP, and they keep only a few seconds' supply. They rebuild it in two main ways. **Aerobic** energy uses oxygen to break down carbohydrates and fats completely into carbon dioxide and water, releasing a large amount of energy. It is a little slow to start, but it can power you for hours, and it relies mostly on your slow-twitch fibers. **Anaerobic** energy breaks down sugar quickly without waiting for oxygen. It powers sprints, jumps and the final kick of a race, mostly in fast-twitch fibers, but it yields much less energy and makes lactate and acid that build up faster than they can be cleared, so you must soon slow down. Lactate is not waste: your heart and other muscles use it as fuel. Most activities mix both systems; the harder and shorter the effort, the larger the anaerobic share.

Think it through. Your breathing, your pulse and your ability to talk are windows into this. At an easy pace you can chat, your heart rate is steady, and aerobic energy does nearly all the work. At a hard pace you can say only a few words. All-out, you cannot talk at all, and afterward you breathe hard for several minutes while your body repays Hill's oxygen debt. Training raises the speed you can hold aerobically, so the same pace feels easier.

Try it. This week you will repeat a simple version of Hill's experiment: run at three speeds, record your heart rate, breathing and talk test at each, add a short all-out sprint, and measure your recovery.

PICTURE STUDY



Paavo Nurmi in the Olympic Cross-Country Race, Agence Rol (French news photo agency), July 12, 1924

· Photograph · Stade de Colombes, Paris

Image: [Wikimedia Commons](#), public domain

Paavo Nurmi of Finland was the greatest distance runner of the 1920s, and he trained with a stopwatch to learn exact pacing. At the Paris Olympics in 1924 he won five gold medals. This news photograph shows him during the 10,000-metre cross-country race, run on a blazing hot afternoon. The heat was so fierce that fewer than half of the runners who started were able to finish. Nurmi, running at an even pace he had practiced for years, won easily.

Look closely

- Find Nurmi. How would you describe his posture and arm swing?
- Look for clues about the weather and the ground. Why would a long race in this heat be so hard?
- Look at the men in suits and straw hats watching. How close are they to the course, and what does their clothing tell you about the weather?
- Look at his face. Does he look like he is sprinting or holding a steady pace?

Talk about it

1. A 10,000-metre race lasts more than half an hour. Is it mostly aerobic or anaerobic?

2. Why would heat make it harder for the heart and lungs to supply the muscles? (Think back to Unit 2.)
3. How might Nurmi's steady pacing have helped him finish strong when so many others could not?

Safety first. Run on a flat, safe course away from traffic, in daylight, with an adult or buddy and good running shoes; walking is always allowed. Warm up first and walk at least 3 minutes after the sprint. Stop and tell an adult right away if you feel chest pain, dizziness, faintness, trouble breathing beyond normal hard breathing, or sharp pain. Anyone with asthma should keep an inhaler nearby as the doctor directs.

ACTIVITY

Hill's Track at Home

Hill used a grass track, a bag of breath and a clock. You will use a measured loop, your pulse, your breathing and the talk test to see the change from aerobic to anaerobic work in your own body.

You will need

- A measured loop of about 100 to 200 yards on grass, a quiet path or a track
- A stopwatch, a helper, a water bottle and your fitness journal
- A chart with columns: Stage, Speed, Laps in 4 minutes, Heart rate (bpm), Breaths per minute, Talk test (sentences / words / none), Effort (1–10)

Steps

1. **Resting numbers.** Sit quietly for 3 minutes. Count your pulse for 15 seconds and multiply by 4. Have your helper count your breaths for 30 seconds and multiply by 2. Record both.
2. **Warm up (5 minutes)** with brisk walking, easy jogging and your dynamic warm-up drills.
3. **Stage 1: easy (4 minutes).** Jog at a pace where you could talk in full sentences. Count your laps. At the end, immediately take your pulse (15 seconds $\times$ 4) while your helper counts your breaths (30 seconds $\times$ 2). Say a sentence aloud to check the talk test. Record effort. Walk for 3 minutes.
4. **Stage 2: steady (4 minutes).** Run a little faster, a pace where talking takes effort. Record everything the same way. Walk for 3 minutes.
5. **Stage 3: hard (4 minutes).** Run at the fastest pace you can hold for the whole 4 minutes. Record everything. Walk for 4 minutes and drink water.
6. **Stage 4: all-out (30 seconds).** Sprint as fast as you can for 30 seconds. Then stand or walk slowly, and record your pulse and breathing at 0, 1, 2 and 3 minutes afterward. This is your oxygen debt being repaid.
7. Cool down with 5 minutes of walking and stretches for calves, thighs, hips and hamstrings.

8. **Graph it.** Make one line graph of heart rate and one of breathing rate across rest, stages 1–3 and the 30-second sprint, and a second graph of your recovery after the sprint. At which stage did talking become hard?
9. **Session 3: second trial.** On another day, repeat the whole experiment on the same loop. Try to run the same laps in stages 1 and 2 and compare heart rates. Is your recovery after the sprint any faster? Write what changed.

Tips

- Count your pulse at the wrist with two fingertips, not your thumb. Start counting within 5 seconds of stopping, because the heart slows quickly.
- Your helper can count breaths by watching your shoulders or chest rise.
- The $220 - \text{age}$ formula gives only a rough estimate of maximum heart rate. Many healthy people are well above or below it.

Check your work

- ☐ I can explain what Hill measured and what VO_2 max and oxygen debt mean.
- ☐ I recorded heart rate, breathing, talk test and effort at every stage and during recovery.
- ☐ I can point to where my work changed from mostly aerobic to strongly anaerobic.

FITNESS JOURNAL

1. Copy your data chart for both trials.
2. Draw your heart-rate and breathing graphs, labeling the easy, steady, hard and all-out stages.
3. Draw your recovery graph after the sprint and shade the area that shows Hill's oxygen debt.
4. Make a T-chart of activities that are mostly aerobic and mostly anaerobic, with at least five in each.

From history. A. V. Hill (1886–1977) also studied the world records for running and swimming at different distances, and in 1925 he gave a well-known lecture on the body science behind athletic records. During the 1930s he worked hard to help scientists who had been forced out of their jobs in Germany find work in Britain and elsewhere.

COMMON MISTAKES

- Starting stage 3 too fast and having to walk. Choose a pace you can hold for all 4 minutes.
- Counting your pulse too late after stopping. Start within a few seconds.
- Thinking lactate is a poison or the cause of next-day soreness. The body reuses it as fuel, and soreness comes from small strains in the muscle.
- Treating 220 – age as an exact number. It is only a rough guide.

Make it a game • Hill's Track Test. Run laps at an easy pace for two minutes while you can still talk, then speed up until you cannot. Record laps for each. Explain aerobic, anaerobic and oxygen debt to your parent. Tell how A. V. Hill measured himself. Retest tomorrow and see if you cover more distance on the same effort.

Scripture. “But they that wait upon the LORD shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; and they shall walk, and not faint.” (Isaiah 40:31, KJV)

Training can help us run farther without tiring, but Isaiah reminds us that true and lasting strength comes from trusting the Lord.

5.2 EMIL ZÁTOPEK AND INTERVAL TRAINING

OBJECTIVES

- Tell the story of Emil Zátopek's training and his three gold medals at the 1952 Olympic Games in Helsinki.
- Explain how interval training works and why it improves both aerobic and anaerobic fitness.
- Estimate a heart-rate range for vigorous exercise and use it with the talk test.
- Run an interval session with splits and heart rates, retest it, and plan and lead a family fitness day.

Warm-up. Jog easily for 2 minutes, then do 10 walking lunges, 10 leg swings on each leg, 20 high knees, 20 butt kicks, 2 lengths of skipping and 3 build-up runs of about 30 yards. Think about it: would you get fitter running one mile at a steady pace, or running four quarter-miles fast with a short walk between each? Why might the second way work?

WATCH

Emil Zátopek Wins 5,000m, 10,000m & Marathon Gold - Helsinki 1952 Olympics

Olympic Games · 2:55

<https://www.youtube.com/watch?v=3c4Z8cbcliA>

WHEN TO WATCH

After the story paragraph. Watch Zátopek's famous style in the 10,000 metres, the sprint finish of the 5,000 and the marathon.

Note: From the Olympics' official channel, with film from Helsinki in 1952. In the marathon footage, one exhausted runner is shown lying on the grass being helped by officials.

BACKUP VIDEO

A Breathtaking finish between Emil Zátopek and Gaston Reiff in the 5,000m - London 1948 Olympics

Olympic Games · 3:11

https://www.youtube.com/watch?v=KvEBEK8_vqc

To see Zátopek four years earlier, chasing Gaston Reiff in the rain at London in 1948.

KEY TERMS

interval training

Training made of repeated hard efforts (work intervals) separated by easier recovery periods.

work interval

The fast part of an interval session, such as 200 metres or 45 seconds at a hard pace.

recovery interval

The easy part between work intervals, such as a walk or slow jog, which lets breathing and heart rate come partly down.

split

The time for one part of a run, such as one lap or one work interval.

maximum heart rate

The fastest your heart can beat. A rough estimate is 220 minus your age.

CORE IDEAS

The story. Emil Zátopek was born in 1922 in Kopřivnice, in what was then Czechoslovakia. As a teenager he worked in a shoe factory in the town of Zlín, and in 1941 the factory entered him in a race he did not even want to run. He came in second, and he began to wonder what he could do with training. He later joined the army and trained in all weather, summer and winter. He ran with his head rolling and his face twisted as if in pain, and people called him “the Czech Locomotive.” At the 1948 Olympics in London he won the 10,000 metres and took silver in the 5,000. Then came Helsinki in 1952. On July 20 he won the 10,000 metres. On July 24 he won the 5,000 metres with a furious sprint on the last lap; that same day his wife, Dana Zátopková, won the gold medal in the javelin. On July 27 he ran the marathon, a race he had never run before, and won it by about two and a half minutes. He set Olympic records in all three, and no one else has ever won all three at one Olympic Games.

How they figured it out. Zátopek did not invent interval training, but he took it further than anyone before him. Instead of only long, steady runs, he ran fast laps of 400 metres over and over, with a slow jog of about 200 metres between them to recover. Over the years he built up to sessions of dozens of repeats in one day. His reasoning was simple: a racer needs to practice racing speed. By breaking a hard

pace into short pieces with rests, he could run far more total distance at racing speed than he could in one continuous effort, and his body adapted to that speed.

How your body works. During each fast interval, your heart rate and breathing climb high and your fast-twitch fibers and anaerobic energy help power you. During each recovery, your heart keeps pumping hard while you slow down, delivering oxygen, clearing lactate and refilling quick energy stores. Repeating this trains both systems: your heart grows stronger and pumps more blood with each beat, your muscles grow more capillaries and mitochondria, and you learn to hold a faster pace with less strain. A rough estimate of maximum heart rate is 220 minus your age; for a 12-year-old that is about 208 beats per minute. The American Heart Association describes vigorous exercise as about 70 to 85 percent of maximum, which for a 12-year-old is roughly 146 to 177 beats per minute. Because the estimate can be far off for any one person, use it together with the talk test: in a vigorous interval you can say only a few words.

Think it through. Intervals are hard, and they are only one part of good training. Most of a young runner's training should still be easy, steady running and active play, with intervals once or twice a week at most and a rest or easy day after each. Paul wrote that "every man that striveth for the mastery is temperate in all things" (1 Corinthians 9:25): self-control in training means working hard on hard days and resting on easy ones.

Try it. This week you will run an interval session of your own, record each split and heart rate, retest it a few days later, and then plan and lead a family fitness day to finish the quarter.

PICTURE STUDY



Emil Zátopek in the 5,000 Metres, Helsinki, Photographer unknown (Lehtikuva news agency), July 24, 1952 · Photograph · Olympic Stadium, Helsinki, Finland

Image: [Wikimedia Commons](#), public domain

This photograph was taken by a Finnish news agency during the 5,000-metre final at the 1952 Olympic Games, the race Zátopek won with a famous sprint around the last bend. Finland loved distance running; its own champion Paavo Nurmi had lit the Olympic flame at the opening ceremony a few days earlier.

Look closely

- Find Zátopek, number 903. How would you describe his face and his running form compared with the runners behind him?
- Look at the track surface and the runners' shoes. How is this different from a modern track?
- Look at the crowd. What does it tell you about how much people cared about this race?
- Look at the runners' arms and legs. Who looks relaxed, and who looks as if he is straining?

Talk about it

1. A 5,000-metre race takes about 14 minutes for top runners. Is it mostly aerobic or anaerobic? What about the last lap?

2. How might Zátopek's fast 400-metre repeats have helped him in a sprint finish?
3. What would you have to change in your own training to run a faster last lap?

Safety first. Run in daylight on a flat, safe course or track away from traffic, with an adult or buddy and good running shoes; on hot days run early or late and bring water. Warm up for at least 8 minutes before intervals and cool down for at least 5 minutes after. Do no more than two interval sessions a week, with an easy or rest day after each. Stop and tell an adult right away at chest pain, dizziness, faintness, unusual trouble breathing or sharp pain.

ACTIVITY

The Zátópek Session and the Family Fitness Day

You will train the way Zátópek did, on a small scale: short fast repeats with easy recoveries, every split recorded. Then you will put the whole quarter together in a family fitness day that you plan and lead.

You will need

- A measured course of 200 metres (about 220 yards; half a lap of a standard track) or a 100-yard stretch run out and back
- A stopwatch with a lap button, a helper, water and your fitness journal
- For the family fitness day: everything from your favorite activities in each unit, water, cups, and a healthy snack or meal

Steps

1. **Find your heart-rate range.** Compute $220 - \text{your age}$, then 70% and 85% of that number. Example for age 12: $208 \times 0.70 \approx 146$ and $208 \times 0.85 \approx 177$. Write your range in your journal, and remember it is only a rough guide.
2. **Warm up (8–10 minutes):** easy jogging, your dynamic warm-up and 3 build-up runs.
3. **The session.** Run 6 work intervals of 200 metres at a hard but controlled pace (effort 7–8 out of 10, able to say only a few words). After each, walk or jog slowly 200 metres back to the start (about 2 minutes) as your recovery.
4. Your helper presses the lap button at the end of each work interval. Right away, take your pulse for 15 seconds $\times 4$. Record the split and the heart rate. Take your pulse again at the end of each recovery.
5. **Aim for even splits.** Try to run every repeat within 2 or 3 seconds of your first one. If your splits get much slower, you started too fast.
6. **Cool down (5 minutes):** easy jogging or walking, then stretches for calves, thighs, hamstrings and hips. Drink water.
7. **Session 3: the retest.** At least two days later, repeat the session on the same course. Choose one goal: add a 7th repeat, or keep 6 repeats and make your splits more even and slightly faster. Record everything and compare.

8. **Plan the family fitness day.** Write a schedule with: a warm-up you lead (your Lesson 1.2 warm-up), a balance challenge (Unit 1), a water table with each person's drink plan and a label quiz (Unit 2), a family sledge haul and a balanced meal or snack you help cook (Unit 3), strength stations with good-form coaching (Unit 4), and a family interval relay where each person runs short repeats at his or her own pace (Unit 5).
9. **Lead the day.** Explain each station, keep everyone safe and moving at his or her own pace, record a few numbers, and finish with a cool-down walk and a prayer of thanks for strong bodies and good food.

Tips

- On rainy days, do intervals indoors: 30 seconds of jumping rope or high knees, then 60 seconds of marching, 8 times.
- Relax your shoulders and hands on the fast repeats. Tension wastes energy.
- At the family fitness day, the goal is joy and everyone moving, not a competition.

Check your work

- ☐ I can tell how Zátopek trained and what he won at Helsinki in 1952.
- ☐ I ran an interval session with recorded splits and heart rates, and retested it.
- ☐ I planned and led a family fitness day with stations from all five units.

FITNESS JOURNAL

1. Record your splits and heart rates for both sessions in a table, and draw a bar graph of the splits.
2. Calculate your average split for each session and the difference between your fastest and slowest repeat.
3. Draw a line graph of heart rate during one session, showing the rise in each repeat and the fall in each recovery.
4. Write your family fitness day schedule and, afterward, a short report: what went well, what your family enjoyed, and one fitness goal you will keep after this course.

From history. Emil and Dana Zátopek were born on the same day, September 19, 1922. Emil Zátopek was known around the world for his friendliness toward other runners, chatting with rivals in several languages, even during races.

COMMON MISTAKES

- Running the first repeat all-out and fading badly. Even splits are the goal.
- Cutting the recovery short. The rest is part of the training.
- Doing intervals every day. Hard days need easy days after them.
- Skipping the warm-up before fast running, when muscles are most likely to strain.

Make it a game • Zatopek Interval Session. Do an interval session: fifteen seconds hard, forty-five easy, repeated six times. Your parent times you and counts pulse after each recovery. Explain work and recovery intervals and why this trains both aerobic and anaerobic systems. Tell Emil Zatopek's Helsinki story. Beat your recovery pulse next time.

Scripture. “And every man that striveth for the mastery is temperate in all things. Now they do it to obtain a corruptible crown; but we an incorruptible.” (1 Corinthians 9:25, KJV)

Athletes train with self-control for a medal that fades. Paul says Christians run for a prize that lasts forever, so self-control matters in every part of life.

AEROBIC TRAINING

When you jog, your heart and lungs deliver oxygen to your muscles and you can keep going for a long time. When you sprint, your muscles need energy faster than oxygen can arrive, and soon you are gasping. In this unit you will meet A. V. Hill, a British scientist who won a Nobel Prize in 1922 and who, in the early 1920s, ran laps of a small grass track himself while his colleagues collected every breath he breathed out. From his experiments came the ideas of maximal oxygen uptake and oxygen debt, and a clearer picture of aerobic and anaerobic energy. You will repeat a simple version of his experiment with your pulse, your breathing and the talk test.

Then you will meet Emil Zátopek of Czechoslovakia, a factory worker turned soldier who trained by running fast laps again and again with short jogs between them, and who in one week at the 1952 Olympic Games in Helsinki won the 5,000 metres, the 10,000 metres and the marathon, a feat no one has matched. You will learn how interval training works, run an interval session of your own with a retest, and finish the quarter by planning and leading a family fitness day.

PREREQUISITES

- Can take a pulse for 15 seconds and multiply by 4 to find beats per minute
- Knows fast-twitch and slow-twitch fibers (Lesson 4.1)
- Can mark a measured course and time laps

MASTERY CHECKLIST

- ☐ I can explain aerobic and anaerobic energy and give an activity that depends mostly on each.
- ☐ I can tell how A. V. Hill measured oxygen use while running and what he discovered.
- ☐ I can use heart rate, breathing rate, the talk test and an effort scale to judge how hard I am working.
- ☐ I can tell the story of Emil Zátopek's training and his three gold medals in 1952.
- ☐ I can plan and run an interval session safely, record my splits and heart rate, and lead a family fitness day.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“How to Measure Physical Activity Intensity” (Centers for Disease Control and Prevention):** Free. The CDC’s explanation of moderate and vigorous activity, the talk test and the 0-to-10 effort scale. For Lessons 5.1 and 5.2.
- **A stopwatch with a lap button:** Optional. Makes interval splits easy. A phone stopwatch with a lap button works the same way.
- **A jump rope:** Optional. Good for indoor intervals on rainy days and for a family fitness day station. Size it so the handles reach your armpits when you stand on the middle.

Not required. Every activity in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 A. V. Hill and Oxygen

3 sessions of 40–45 minutes

5.2 Emil Zátopek and Interval Training

3 sessions of 40–45 minutes

UNIT 5 REVIEW

Answer each question. Show your work for the calculations. The review is worth 50 points.

1. **5 pts**

Explain the difference between aerobic and anaerobic energy and give one activity that depends mostly on each.

2. **5 pts**

Describe A. V. Hill’s running experiment: what he did, what was measured, and what he found.

3. **5 pts**

What does the talk test tell you? Describe how talking changes from easy to all-out effort.

4. (5 pts)

A student counted 34 beats in 15 seconds right after an interval. What is her heart rate in beats per minute?

5. (5 pts)

Estimate the maximum heart rate and the vigorous range (70–85% of maximum) for a 13-year-old. Why should the student also use the talk test?

6. (5 pts)

What did Emil Zátopek win at the 1952 Olympic Games, and what made it unique?

7. (5 pts)

How did Zátopek train, and why does interval training work?

8. (5 pts)

A runner's six 200-metre splits were 48, 47, 49, 50, 52 and 54 seconds. Find the average split. What advice would you give for the retest?

9. (5 pts)

What is oxygen debt (EPOC), and how can you see it in your own body?

10. (5 pts)

In three or four sentences, explain how a wise young athlete should fit interval training into a week, and connect it to 1 Corinthians 9:25.

ANSWER KEY

1. Aerobic energy uses oxygen to break down carbohydrates and fats completely; it is slower to start but lasts a long time (jogging, hiking, swimming laps easily). Anaerobic energy comes quickly without oxygen but lasts only seconds to a minute or two and makes lactate (sprinting, jumping, a final kick).
2. In the early 1920s Hill ran laps of a small grass track at increasing speeds while the air he breathed out was collected and measured. His oxygen use rose with speed until it reached a ceiling (maximal oxygen uptake, $\text{VO}_2 \text{ max}$). Above that, extra energy came without oxygen, and after stopping he kept breathing hard to repay an oxygen debt.
3. It estimates effort: at an easy or moderate pace you can talk in full sentences; at a vigorous pace only a few words; all-out, you cannot talk. It shows the shift from mostly aerobic to strongly anaerobic work.
4. $34 \times 4 = 136$ beats per minute.
5. $220 - 13 = 207$. $207 \times 0.70 \approx 145$; $207 \times 0.85 \approx 176$. Vigorous range $\approx 145\text{--}176$ bpm. The formula is only a rough estimate and can be far off for an individual, so the talk test checks it.
6. The 10,000 metres (July 20), the 5,000 metres (July 24) and the marathon (July 27), his first marathon, all in Olympic-record times. No one else has won all three at one Olympic Games.
7. He ran fast 400-metre repeats again and again with slow jogs of about 200 metres between, building up to dozens a day. Breaking a fast pace into short pieces with rests lets you run much more total distance at racing speed; it trains both the aerobic and anaerobic systems and makes the heart and muscles stronger.
8. $48 + 47 + 49 + 50 + 52 + 54 = 300$; $300 \div 6 = 50$ seconds. The splits slowed by 7 seconds from the fastest, so the runner started too fast; aim for even splits near 50 seconds.
9. The extra oxygen taken in after hard exercise while the body recovers, refills quick energy stores and clears lactate. You see it as hard breathing and a high heart rate that take several minutes to come back down after a sprint.
10. Answers vary. Full credit for: most training easy and steady, intervals only once or twice a week, a warm-up and cool-down, an easy or rest day after each hard session; and self-control (temperance) meaning hard work on hard days, rest on easy days, for a lasting prize.

UNIT CHALLENGE: MY INTERVAL PLAN AND THE FAMILY FITNESS DAY

Put together your aerobic training record and your family fitness day. Include your Hill's-track data and graphs from both trials, your heart-rate range calculation, both interval sessions with splits, heart rates, average splits and graphs, and a two-week plan that fits one interval session a week among easy runs, play and rest. Then plan, lead and record a family fitness day with stations from all five units, a warm-up and cool-down you lead, water for everyone and a meal or snack you help cook. Finish with a one-page report on the day, how your interval session changed from first try to retest, and one fitness goal you will keep after this course.

LOOK FOR	WHAT IT MEANS
Aerobic records	Both Hill's-track trials and both interval sessions recorded with numbers, graphs and calculations shown.
Wise training plan	A two-week plan with one interval session a week, mostly easy activity, warm-ups and cool-downs, and rest or easy days after hard ones.
Family fitness day	Stations from all five units, a warm-up and cool-down led by the student, water and a healthy snack or meal, with everyone moving at his or her own pace.
Reflection	A one-page report naming what improved, what the family enjoyed, and one specific goal for the future. Effort and improvement count, not speed.