

GRADE 6 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 and heat, food, strength, and the heart and lungs. Each lesson is built around a real person or moment: George Williams gathering eleven young drapers in a London room in 1844 to found the YMCA, Pehr Henrik Ling's gymnastics institute in Stockholm, Sydney Ringer's frog heart that kept beating because of London tap water, the Marine Corps doctors who learned to measure dangerous heat, Wilbur Atwater's chamber for measuring food energy, Giovanni Borelli's drawings of muscles and bones as levers, Walter Camp's "Daily Dozen," and Kenneth Cooper's 12-minute run.

Every lesson follows the same path. First comes **the story**. Then **how they figured it out**: the question they faced, what they tried and what they measured. Then **how your body works**, explained for a sixth grader with real vocabulary and a little arithmetic: heart rate in beats per minute, grams on a label, ounces in a water log, sets and reps in a training table. Last, **try it**: the student plans and does a real workout, tests heat and shade with a thermometer, reads labels and prepares food, or runs a timed course, 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. Calories appear only as a unit of food energy, never as something to count or cut. The old Latin saying *Fabricando fit faber*, "by making, one becomes a maker," fits here too: strength and endurance are built by practice, a little more each week. The quarter ends with a family fitness day that the student plans and leads.

Most videos come from children's hospitals and health teachers:

Nemours, Cincinnati Children's, a pediatric sports-medicine doctor,

TED-Ed, SciShow, Amoeba Sisters, Osmosis and Calvin University, plus a few smaller teaching channels and archive films chosen lesson by lesson. Every video was previewed for accuracy and for modest dress. A few were made for older students or for parents; the lesson notes say so. Some channels end with an invitation to subscribe or a link to their own courses; you can stop the video when the teaching ends.

Start with Lesson 1.1 →

WHO IT IS FOR

Written for students in grade 6 (about ages 11–12) who read independently, can multiply and divide, work with percentages and make bar and line 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, a thermometer, measuring cups and a timer.

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 activity in play, chores, sport and walking.
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 are written for the student to read, with a parent reading along. The paragraphs marked *The story* and *How they figured it out* tell what happened; *How your body works* explains the science; *Try it* explains the activity. After each paragraph, ask the student to explain it back in his or her own words, and to work any numbers aloud.

4. **Picture study.** Each lesson has one public-domain painting or historic photograph chosen for what it shows about play, work, food, water, heat or rest. 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 planned, done, recorded and done again: sets, reps, seconds, laps, cups, grams, heartbeats. Date every page. Write how it felt (a 1–10 effort rating is useful) and what you will change 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 weigh children (the one exception is a before-and-after sweat check in Unit 2, done only with a parent, which measures water lost, not body weight). Calories are taught only as a unit of energy in food; we never count or restrict them. Foods are “nutrient-dense foods” and “treat foods,” never “bad” or “junk,” and feasts and treats are good gifts in their place. Grades come from effort, consistency and personal improvement, never from comparing one child with another.
7. **Optional books and gear.** Some units list a free government or children’s-hospital web page, 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 worth 50 points, with one or two worked calculations and a short written answer, and a unit challenge: a two-week FITT activity plan, a heat-safety plan with a water log, a planned and prepared lower-sugar breakfast, a two-week strength program with before-and-after numbers, or a training week in the heart-rate zone. 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 a few books, water jugs or a light resistance band, always with good form. Outdoors, run with a buddy or adult, away from traffic, in daylight, with water and shade on warm days. 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, the student plans and leads a family fitness day: a dynamic warm-up, stations from every unit, a water and shade station, a lower-sugar snack the student prepares, a family 12-minute walk-run and a cool-down. Everyone moves at his or her own pace.

SCOPE AND SEQUENCE

UNIT 1 • WEEKS 1–2

Keeping Active

George Williams and the founding of the YMCA in 1844, the spirit-mind-body triangle and the FITT principle, with a fitness baseline and a weekly plan; and Pehr Henrik Ling’s gymnastics, flexibility, and dynamic warm-ups versus static stretches.

1.1 George Williams and the YMCA: Spirit, Mind and Body

1.2 Flexibility and the Warm-up: Ling’s Gymnastics

UNIT 3 • WEEKS 5–6

Nutrition

Wilbur Atwater’s food-energy chamber and the macronutrients by the gram (4, 4 and 9 calories per gram as units of energy, never for counting); and added sugar on the Nutrition Facts label, with a label lab and a lower-sugar breakfast.

3.1 Macronutrients by the Gram: Wilbur Atwater’s Chamber

3.2 Added Sugar and the Nutrition Facts Label

UNIT 2 • WEEKS 3–4

Hydration

Sydney Ringer’s beating frog heart and the electrolytes sodium and potassium, with a food-label hunt and a workout; and heat safety: heat exhaustion, heat stroke, the heat index and the Marine Corps doctors who measured dangerous heat.

2.1 Electrolytes: Sydney Ringer and the Beating Heart

2.2 Heat Safety: Shade, Rest, Water and the Heat Index

UNIT 4 • WEEKS 7–8

Strength

Giovanni Borelli and the body’s levers: muscles, tendons and the biceps as a third-class lever; and Walter Camp’s Daily Dozen, sets, reps and rest, with a two-week bodyweight and backpack plan.

4.1 Muscles, Tendons and Levers: Borelli’s Machine

4.2 Sets, Reps and Rest: Walter Camp’s Daily Dozen

UNIT 5 • WEEKS 9–10

Aerobic Training

Kenneth Cooper, *Aerobics* (1968) and the 12-minute run, with a test and a retest; and target heart rate, simply, with a training week in the zone and the family fitness day.

5.1 Kenneth Cooper and the 12-Minute Run

5.2 Target Heart Rate, Simply

WEEKLY PACING CALENDAR

WEEK	PLAN
1	• Session 1: Lesson 1.1 George Williams and the YMCA: Spirit, Mind and Body: 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 Flexibility and the Warm-up: Ling’s Gymnastics: 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 Electrolytes: Sydney Ringer and the Beating Heart: 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 Heat Safety: Shade, Rest, Water and the Heat Index: 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
5	• Session 1: Lesson 3.1 Macronutrients by the Gram: Wilbur Atwater’s Chamber: warm-up, video, teaching and picture study

WEEK	PLAN
	- 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 Added Sugar and the Nutrition Facts Label: 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 Muscles, Tendons and Levers: Borelli's Machine: 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 Sets, Reps and Rest: Walter Camp's Daily Dozen: 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 Kenneth Cooper and the 12-Minute Run: 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 Target Heart Rate, Simply: 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: plans, logs, tables of sets and reps, heart-rate charts, water logs, label tables, graphs and reflections.

A timer or stopwatch (a phone timer works)

For timed holds, rest periods, pulse counts and the 12-minute run.

Good athletic shoes and comfortable, modest clothes for exercise

Every activity lesson.

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, dips and stretches.

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

For light loads in Unit 4. Start light; good form comes first.

A reusable water bottle and a measuring cup

For the water logs and drinking plans in Unit 2.

Two thermometers (kitchen, outdoor or aquarium), or one used twice

For the sun-and-shade test in Lesson 2.2.

Food and drink labels, measuring spoons, a kitchen scale if you have one

For the label labs in Units 2 and 3. Labels from the pantry or pictures online work.

Simple breakfast foods: plain yogurt or oatmeal, fruit, eggs, whole-grain bread, milk

For the lower-sugar breakfast in Lesson 3.2.

A ruler, a large rubber band, string and tape

For the lever model in Lesson 4.1.

Sidewalk chalk or a few cones (cups or shoes work), and a measured loop

To mark laps for the 12-minute run and stations for the family fitness day.

Colored pencils and graph paper

For bar graphs and line graphs of heart rate, temperature, reps and laps.

GRADING

Grades come mostly from the activities and the fitness journal, because fitness is learned by planning, doing, recording and doing again. A student who tries 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 plans, 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 children.
- A journal page earns full marks when it has a date, a plan, the numbers with units (sets, reps, seconds, laps, cups, grams, beats per minute), an effort rating, a sentence about how it felt and a sentence about what to change next time.
- Unit reviews may be done orally for a student who writes slowly; the parent writes down the answers. Calculations should show every step.
- A child 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 counter, the spotter of good form and the encourager. Do the workouts alongside your child when you can. Children copy what they see, and a parent doing step-ups and planks on the living-room floor teaches more than any speech.

At this age many children begin to notice and compare bodies. Keep the talk on what bodies can do and how to care for them. Praise effort, good form and honest records, not numbers alone. If a sibling or friend is faster or stronger, steer back to the journal: “Did you beat your own number from last week?” 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.

Two lessons deal with real dangers, and they are told plainly but briefly. Lesson 2.2 explains heat stroke, a medical emergency that has caused deaths in athletes and military recruits, so that your child will recognize it and act. Lesson 2.1 includes an optional before-and-after sweat check that must be done with a parent; the number is water lost in sweat, not body weight, and it is recorded that way.

UNIT 1

KEEPING ACTIVE

In 1844 a young shop assistant named George Williams looked around London and saw thousands of young men working long hours behind shop counters, with little rest, little fresh air and much temptation. He gathered eleven friends in a room at the shop where he worked and started the Young Men's Christian Association. Within fifty years the YMCA had built gymnasiums, running tracks and swimming pools around the world, and its leaders drew a triangle to show what they cared about: spirit, mind and body together. In this unit you will learn how much activity young people need, measure your own starting point with a five-station baseline, and use the FITT principle (frequency, intensity, time and type) to plan two weeks of training.

Then you will visit Stockholm, where a minister's son named Pehr Henrik Ling opened a gymnastics institute in 1813 and taught whole classes to bend, reach, swing and balance. You will learn what flexibility is, why muscles and tendons stretch, and why scientists now recommend moving, "dynamic" stretches before exercise and still, "static" stretches afterward. You will run a fair test of your own: jump and reach after two different warm-ups and see what the numbers say.

PREREQUISITES

- Can find a pulse and count beats for 15 seconds, then multiply by 4
- Can read a stopwatch and a ruler in inches or centimeters
- Can make a table and a bar graph

MASTERY CHECKLIST

- ☐ I can tell how George Williams founded the YMCA in 1844 and what its triangle of spirit, mind and body means.
- ☐ I can state how much activity young people ages 6–17 need, including vigorous, muscle-strengthening and bone-strengthening activity.
- ☐ I can explain the FITT principle and use it to write a training plan.
- ☐ I can explain the difference between dynamic and static stretching and when to use each.
- ☐ I can lead a ten-move dynamic warm-up and a five-stretch cool-down with good form.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **Physical Activity Guidelines for Americans, 2nd edition** (U.S. Department of Health and Human Services): Free. The official guidelines behind Lesson 1.1; the chapter on children and adolescents is short and readable for a parent.
- **“Stretching”** (Nemours TeensHealth): Free. A clear article on why and how to stretch safely. Fits Lesson 1.2.
- **A stopwatch or phone timer with a lap button:** Optional. Handy for timed holds and rest periods all quarter.

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 George Williams and the YMCA: Spirit, Mind and Body 3 sessions of 40–45 minutes

1.2 Flexibility and the Warm-up: Ling’s Gymnastics 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

Who founded the YMCA, in what year and city, and what was its purpose?

2. 5 pts

What do the three sides of the YMCA triangle stand for, and who drew it?

3. 5 pts

State the activity guidelines for ages 6–17, including the three kinds of activity that should happen at least 3 days a week.

4. 5 pts

Explain the talk test. Give one example each of moderate and vigorous activity.

5. 5 pts

Name the four parts of the FITT principle and give an example of each for a jogging plan.

6. 5 pts

During a 15-second pulse count after the step test, Sam counted 31 beats. What is his heart rate in beats per minute? A week later, after 1 minute of rest, he counted 52 beats in 30 seconds. What is that rate, and what does a lower recovery number tell him?

7. 5 pts

Maya's activity log shows 45, 70, 30, 90, 60, 55 and 80 minutes for one week. What is her daily average? On how many days did she meet the 60-minute guideline?

8. 5 pts

What is the difference between dynamic and static stretching? Which belongs before exercise and which after, and why?

9. **5 pts**

Who was Pehr Henrik Ling, and what did he contribute to physical education?

10. **5 pts**

Short answer: In three or four sentences, explain why your fitness grade in this course is based on your own improvement and not on comparing you with others. Include one sentence about how 1 Timothy 4:8 fits.

ANSWER KEY

1. George Williams, a young draper's assistant, with eleven friends in London on June 6, 1844. Its purpose was to help young working men grow in faith through prayer and Bible study, and to improve themselves; later YMCAs added gymnasiums to strengthen the body too.
2. Spirit, mind and body. Dr. Luther Gulick, head of physical education at the YMCA training school in Springfield, Massachusetts.
3. At least 60 minutes of physical activity every day, mostly moderate or vigorous. At least 3 days a week should include vigorous activity, muscle-strengthening activity and bone-strengthening activity.
4. If you can talk but not sing, the activity is moderate; if you can say only a few words before taking a breath, it is vigorous. Moderate: brisk walking, easy biking. Vigorous: running, jumping rope, soccer.
5. Frequency (4 days a week), Intensity (moderate, can talk but not sing), Time (20 minutes), Type (jogging). Any sensible example for each earns credit.
6. $31 \times 4 = 124$ beats per minute. $52 \times 2 = 104$ beats per minute. A lower heart rate one minute after exercise means his heart is recovering faster, a sign of improving fitness.
7. $45 + 70 + 30 + 90 + 60 + 55 + 80 = 430$ minutes; $430 \div 7 \approx 61$ minutes a day. She met 60 minutes on 4 days (70, 90, 60, 80).
8. Dynamic stretches are controlled moving stretches (leg swings, lunges); static stretches are held still for 15–30 seconds. Dynamic stretches belong in the warm-up because they raise heart rate and warm the muscles without the short drop in jumping and sprinting power that long static holds can cause. Static stretches belong after exercise, when muscles are warm, to improve flexibility.
9. A Swede who founded the Royal Central Gymnastics Institute in Stockholm in 1813. He studied anatomy, designed planned exercises for whole classes (Swedish gymnastics or free exercises), and designed equipment such as wall bars and the balance beam.
10. Answers will vary. A good answer says that people start at different places and grow at different rates; that comparing yourself with your own baseline shows real progress and encourages faithfulness; that bodies are gifts to care for, not to show off; and that 1 Timothy 4:8 teaches that exercise has some value but godliness has more.

UNIT CHALLENGE: MY TWO-WEEK FITT PLAN AND LOG

Follow the two-week FITT plan you wrote in Lesson 1.1, with the Ling Ten warm-up and the five-stretch cool-down every time you train. Keep a daily log: activity, minutes, moderate or vigorous, effort rating and how you felt. At the end of the two weeks, retest your five-station baseline and make a bar graph comparing Day 1 with the final retest for each station. Finish with a one-page reflection: what you changed in your plan and why (name the FITT letter), which numbers improved, and what your plan will be for the next two weeks.

LOOK FOR	WHAT IT MEANS
Plan	The plan uses all four FITT letters, meets the 60-minute guideline, includes vigorous, muscle- and bone-strengthening activity on at least 3 days, and has a rest day.
Complete log	Fourteen days recorded honestly with activity, minutes, intensity and an effort rating.
Warm-up and cool-down	The log shows the dynamic warm-up and static cool-down used each training day.
Retest and graph	All five stations retested with the same rules, and a neat, labeled bar graph comparing the results.
Reflection	A thoughtful page naming what changed, which FITT letter was adjusted and the plan for the next two weeks.

1.1 GEORGE WILLIAMS AND THE YMCA: SPIRIT, MIND AND BODY

OBJECTIVES

- Tell how George Williams and eleven friends founded the YMCA in London in 1844, and explain the spirit-mind-body triangle.
- State the activity guidelines for ages 6–17 and tell moderate from vigorous activity with the talk test.
- Explain the FITT principle (frequency, intensity, time, type) and use it to write a two-week plan.
- Measure a five-station fitness baseline, record it honestly, and retest it.

Warm-up. March in place for 1 minute, then do 10 arm circles forward and 10 backward, 10 jumping jacks, 10 slow squats and 30 seconds of jogging in place. Find your pulse at your wrist and count for 15 seconds; multiply by 4. Think about it: George Williams worked behind a shop counter from early morning until late at night. What happens to a body that stands or sits in one place all day?

WATCH

How to exercise with a fitness plan using F.I.T.T. principles | Kinesiology | Dr. Kerri Berends

Calvin University · 2:29

<https://www.youtube.com/watch?v=08ryXxjaF1o>

WHEN TO WATCH

After the “How your body works” paragraph. Write the four letters F, I, T, T in your journal and fill in what each one means as she explains it.

Note: A short explanation by the chair of the kinesiology (exercise science) department at Calvin University, a Christian university in Grand Rapids, Michigan. It is aimed at adults, but the ideas are exactly the ones in this lesson.

KEY TERMS

YMCA

The Young Men's Christian Association, founded in London in 1844 by George Williams to help young working men grow in faith, learning and health.

vigorous activity

Activity hard enough that you can say only a few words before taking a breath: running, fast swimming, soccer, jumping rope.

baseline

Your starting measurements, recorded so you can see later how much you have improved.

moderate activity

Activity that makes you breathe harder and your heart beat faster, but you can still talk (not sing): brisk walking, easy biking, raking leaves.

FITT principle

A way to plan training by choosing four things: Frequency (how often), Intensity (how hard), Time (how long) and Type (what kind of exercise).

CORE IDEAS

The story. George Williams was born on a farm in Somerset, England, in 1821. As a young man he went to work for a draper (a cloth merchant) and in 1841 moved to London to work at Hitchcock & Rogers, a large drapery shop near St Paul's Cathedral. Shop assistants like George often worked from early morning until late at night, six days a week, and slept in rooms above the shop. Many young men who had come to the city from the country had no family nearby and spent their few free hours in taverns. George had become a Christian as a teenager, and he wanted something better for them. On June 6, 1844, he gathered eleven fellow drapers in his room at the shop. Together they started a society for prayer, Bible study and "mutual improvement," and one of them, Christopher Smith, suggested the name: the Young Men's Christian Association.

How they figured it out. The YMCA spread fast: by the end of 1851 there were associations in Montreal and Boston, and by the time George Williams died in 1905 YMCAs had spread to many countries, with hundreds of thousands of members. Its leaders soon noticed that young men needed more than meetings. Clerks who sat or stood at counters all day came in tired and weak, so the YMCAs began building

gymnasiums, running tracks and later swimming pools. At the YMCA training school in Springfield, Massachusetts, the head of physical education, Dr. Luther Gulick, designed a triangle emblem to explain the idea: each side stood for one part of a person, **spirit, mind and body**, and all three were meant to grow together. Gulick also asked a young instructor named James Naismith to invent an indoor game for the winter; in 1891 Naismith invented basketball. George Williams was knighted by Queen Victoria in 1894 for his work.

How your body works. Your muscles, bones, heart and lungs grow stronger when you use them and weaker when you do not. The U.S. *Physical Activity Guidelines* (2018) say that children and teens ages 6–17 need **at least 60 minutes of physical activity every day**. Most of it should be moderate or vigorous, and on **at least 3 days a week** it should include **vigorous** activity, **muscle-strengthening** activity (push-ups, climbing, carrying) and **bone-strengthening** activity (running, jumping, skipping). Use the **talk test**: if you can talk but not sing, you are working at a moderate level; if you can say only a few words before you must breathe, it is vigorous. Your heart rate rises too: an average resting heart rate for someone your age is about 70 to 100 beats per minute, and during vigorous play it may go well over 150.

Plan it with FITT. Trainers plan exercise with four letters. **Frequency**: how many days a week. **Intensity**: how hard (the talk test, an effort rating from 1 to 10, or your heart rate). **Time**: how many minutes. **Type**: what kind (running, biking, push-ups, a sport). To improve, you change one letter at a time, a little at a time: add a day, add five minutes, or work a little harder. Changing everything at once is the fastest way to get sore, hurt or discouraged.

Think it through. The YMCA's founders believed that caring for the body is part of serving God, but not the most important part. Paul wrote to Timothy that bodily exercise “profiteth little,” meaning it has some value, while godliness is valuable in every way. We train our bodies because they are a gift to care for, not to show off and not to beat other people.

Try it. This week you will measure a five-station baseline (push-ups, wall sit, plank, sit-and-reach and a three-minute step test), then write a two-week FITT plan and retest at the end of the week.

PICTURE STUDY



Physical Fitness Class, Gymnasium and Balcony Track, YMCA of Warren, Pennsylvania, Unknown photographer (copied for the Historic American Buildings Survey), About 1945 · Black-and-white photograph · Library of Congress, Washington, D.C.

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

By the twentieth century nearly every YMCA in an American town had a gymnasium like this one, in Warren, Pennsylvania. The photograph was copied by the Historic American Buildings Survey, a government project that records important buildings. It shows a boys' physical fitness class standing ready for the next exercise.

Look closely

- Find the running track. Where is it, and why might builders put a track on a balcony instead of on the floor?
- Find the wall bars and the basketball hoop. What kinds of strength or skill would each one train?
- Find the boy with the triangle on his shirt. What three words did the triangle stand for?
- How are the boys standing? What exercise do you think comes next, and how could the leader see whether everyone's form was good?

Talk about it

1. This gym was built so that boys who sat in school or worked all day could move. Which parts of your week are mostly sitting, and where could you add movement?
2. How does a class like this one use frequency, intensity, time and type?
3. Why did the YMCA's founders think a gymnasium belonged in a Christian association?

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

My Baseline and My FITT Plan

Before a coach writes a training plan, he finds out where the athlete is starting. You will measure five things your body can do today, write a two-week plan using FITT, and retest at the end of the week. These numbers belong to you alone; you will compare them only with your own later numbers.

You will need

- A timer or stopwatch, and a helper to time and count
- A towel or mat on a flat, non-slip floor, a smooth wall and a ruler or yardstick
- The bottom stair or a sturdy step about 8 inches high
- Fitness journal with a table: station, Day 1, retest
- A cup of water

Steps

1. **Warm up (5 minutes).** March in place 1 minute, 10 arm circles each way, 10 jumping jacks, 10 slow squats, 5 walking lunges on each leg and 30 seconds of easy jogging in place. Take your resting pulse first: sit quietly for 2 minutes, count for 30 seconds and multiply by 2.
2. **Station 1: Push-ups (up to 60 seconds).** Choose wall, knee or full push-ups and use the same kind at every retest. Body straight as a board from head to knees or heels, hands a little wider than the shoulders, lower until the chest is about a fist from the wall or floor, push back up. Count only good-form reps. Rest 1 minute.
3. **Station 2: Wall sit (up to 90 seconds).** Back flat against the wall, slide down until your knees are bent to about a right angle, knees over ankles, arms crossed on your chest. Your helper stops the clock when you stand up or slide down. Rest 1 minute.
4. **Station 3: Plank (up to 90 seconds).** Forearms and toes (or forearms and knees), elbows under shoulders, body in a straight line, eyes on the floor, breathing normally. The clock stops when the hips sag or lift. Rest 1 minute.

5. **Station 4: Sit-and-reach.** Sit on the floor with legs straight and feet flat against the bottom stair or a box. Lay a ruler on top so the 0 is at your toes. Reach forward slowly with one hand on top of the other, exhale, and hold for 2 seconds. Do not bounce. Record the best of three reaches in inches before (minus) or past (plus) your toes.
6. **Station 5: Three-minute step test.** Step up and down on the step for 3 minutes to a steady beat: up-right, up-left, down-right, down-left, about 24 full steps a minute (your helper can count “up, up, down, down”). Hold the rail if there is one. Then sit down at once, wait 1 minute, and count your pulse for 30 seconds; multiply by 2. A lower recovery number on the retest means your heart is recovering faster.
7. **Cool down (5 minutes).** Walk slowly for 2 minutes, then hold gentle stretches for 20–30 seconds each: calves, thighs, hamstrings, chest and shoulders. Drink water. Write an effort rating (1–10) and one sentence about how you felt.
8. **Write your FITT plan.** Make a two-week calendar. For each day write F (yes or rest), I (moderate or vigorous, or an effort number), T (minutes) and T (type). Include at least 60 active minutes every day, vigorous activity on at least 3 days, muscle-strengthening on at least 3 days (the five stations make a good circuit), jumping or running on at least 3 days, and one full day of rest from hard training.
9. **Session 3: Retest.** After following your plan for at least four days, warm up the same way and repeat all five stations in the same order, with the same rests and the same kind of push-up. Record the retest column, circle every number that improved, and write one change you will make to your plan for next week.

Tips

- Good form is worth more than a big number. A slow, honest rep counts; a sloppy one does not.
- Breathe out as you push or stand; never hold your breath during a hard effort.
- If a station is hard today, that is exactly what a baseline is for. The point is to know where you are starting.

Check your work

- ☐ I can tell the story of George Williams and the YMCA and explain the spirit-mind-body triangle.
- ☐ I measured an honest baseline and retested it with the same rules.
- ☐ I wrote a two-week plan that uses all four letters of FITT and meets the activity guidelines.

FITNESS JOURNAL

1. Copy your baseline table with Day 1 and retest columns, and draw a small bar graph for each station.
2. Draw the YMCA triangle and write under each side one thing you will do this week to grow in spirit, mind and body.
3. Keep an activity log for the week: date, activity, minutes, moderate or vigorous, and an effort rating. Add up your minutes each day.
4. Write two sentences: Which station improved most? What will you change in your FITT plan next week, and which letter does it change?

From history. George Williams later became a partner in the shop where he had started as an assistant, and he married the owner's daughter. When he died in 1905 he was buried in St Paul's Cathedral, a few steps from the shop where the YMCA began.

COMMON MISTAKES

- Changing every part of FITT at once (more days, longer and harder all in the same week). Change one letter at a time.
- Counting sloppy reps to get a bigger number. Your baseline is useful only if it is honest.
- Forgetting rest. A rest day is part of a training plan, not a sign of laziness.
- Thinking only sports count. Chores, walking, biking and active play all count toward your 60 minutes.

Make it a game • Triangle Teach-Back. Draw the spirit-mind-body triangle and teach it to your parent as George Williams would to his eleven friends. She asks three questions and sneaks in one wrong date or fact; catch it. Then do ninety seconds of activity and use the talk test to label it moderate or vigorous. Write a FITT line for next week.

Scripture. “For bodily exercise profiteth little: but godliness is profitable unto all things, having promise of the life that now is, and of that which is to come.” (1 Timothy 4:8, KJV)

Exercise has some real value for this life; godliness has value for this life and the next. The YMCA’s triangle tried to keep both in their proper place.

1.2 FLEXIBILITY AND THE WARM-UP: LING’S GYMNASTICS

OBJECTIVES

- Tell how Pehr Henrik Ling founded the Royal Central Gymnastics Institute in Stockholm in 1813 and taught exercise to whole classes.
- Define flexibility and range of motion, and explain what happens in muscles and tendons when you stretch.
- Explain the difference between dynamic and static stretching and when to use each.
- Run a fair test comparing two warm-ups, and lead a ten-move dynamic warm-up and a cool-down.

Warm-up. Stand tall and slowly reach both arms overhead, then let them swing down and back 10 times. Do 10 marching knee lifts, then 10 leg swings forward and back on each side holding a chair. Now try to touch your toes without bending your knees and notice how far you get. Think about it: does a muscle stretch farther when it is cold or when it is warm?

WATCH

How stretching actually changes your muscles - Malachy McHugh

TED-Ed • 5:03

<https://www.youtube.com/watch?v=g1pb2aK2we4>

WHEN TO WATCH

After the “How your body works” paragraph. Listen for what happens inside a muscle when you hold a stretch, and why the effect wears off.

Note: An animated lesson by a sports-medicine researcher. Some of the words (sarcomere, viscoelastic) are advanced; the lesson’s key terms explain the important ones.

BACKUP VIDEO

Brooke Pengel, MD - Dynamic vs. Static Stretching

HCA HealthONE • 1:53

<https://www.youtube.com/watch?v=Db9oiN0iIEI>

Before the activity, to hear a pediatric sports-medicine doctor explain which kind of stretching to do before a game.

KEY TERMS

flexibility

How far your joints can move through their full range without pain.

Flexibility can be improved with regular stretching.

dynamic stretching

Moving stretches done with control through a full range of motion, such as leg swings, walking lunges and arm circles. Best before exercise.

tendon

A strong, cord-like band of tissue that attaches a muscle to a bone.

range of motion

The full distance a joint can move, for example how far your knee can bend and straighten.

static stretching

Holding a stretch still for a set time, usually 15–30 seconds. Best after exercise, when muscles are warm.

calisthenics

Exercises done with your own body weight and little or no equipment, such as squats, push-ups, bends and reaches. Ling helped make them popular.

CORE IDEAS

The story. Pehr Henrik Ling was born in 1776 in southern Sweden, the son of a minister. As a young man he traveled through Denmark, Germany, France and England, studying languages and poetry and learning to fence. He suffered from painful joints, and he noticed that his daily fencing practice and exercise made his body work better. When he came home he studied anatomy and physiology so that he would understand why. In 1813 the Swedish government let him open the Royal Central Gymnastics Institute in Stockholm, and he became its first head. Ling designed equipment still found in gyms today, such as wall bars and the balance beam, and he taught “free exercises” that needed no equipment at all: bends, reaches, swings, lunges and balances that a whole class could do together on command.

How they figured it out. Ling’s idea was that exercise should be planned with knowledge of the body, starting gently and working through every joint. His students carried “Swedish gymnastics” to schools in Europe and America, and by 1900 many

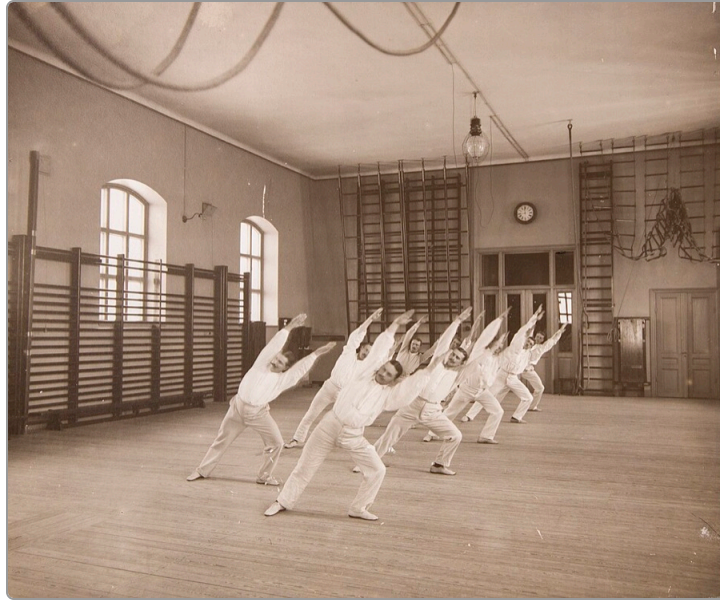
schoolchildren began the day with a few minutes of drills like the ones in this lesson's photograph. Later scientists asked a sharper question: what is the best way to get ready for hard exercise? In many studies, athletes who held long static stretches (a minute or more on one muscle) just before sprinting or jumping were often a little slower or jumped a little lower for a short time afterward. Athletes who warmed up with easy jogging and moving, dynamic stretches did as well or better. So today most coaches and sports doctors recommend a **dynamic warm-up before** exercise and **static stretches after**, when muscles are warm.

How your body works. A muscle is made of long fibers bundled together and wrapped in connective tissue, and its ends become tough **tendons** that pull on your bones. When you stretch, the muscle and its wrappings lengthen, and over time your nervous system learns to allow a larger **range of motion** before it signals "enough." A warm muscle stretches more easily than a cold one, the way warm taffy bends while cold taffy snaps. A warm-up raises your heart rate, sends more blood to your muscles and literally warms them up, so they contract faster and are ready to work. Regular static stretching after exercise, a few days a week, slowly improves flexibility. Stretching should feel like gentle tension, never sharp pain.

Good form. Dynamic stretches are controlled, not wild: swing a leg as high as is comfortable, not as high as you can fling it. Static stretches are held still for 15 to 30 seconds while you breathe slowly; bouncing in a stretch can strain a muscle. Stretch both sides evenly. Do not force a joint past where it wants to go, and never push on someone else to make them stretch farther.

Try it. This week you will learn a ten-move dynamic warm-up, then run a fair test: on one day you will warm up with static stretches only, on another with the dynamic warm-up, and each time you will measure a standing long jump and a sit-and-reach. You will finish each session with a five-stretch cool-down.

PICTURE STUDY



Swedish Gymnastics at the Royal Central Gymnastics Institute, Stockholm, Unknown photographer, About 1900 · Photograph · Swedish School of Sport and Health Sciences (GIH), Stockholm
Image: [Wikimedia Commons](#), public domain

This photograph was taken around 1900 in the gymnasium of the institute Pehr Henrik Ling founded in Stockholm in 1813. Ling had died long before, but his students were still teaching his system: exercises done together, on command, that move every joint through its range of motion.

Look closely

- What are the men doing with their arms, backs and legs? Which muscles are being stretched?
- Are they all moving the same way at the same moment? Why would a teacher want that?
- Find the wall bars and the ropes. Which of these did Ling himself design?
- Look at their feet and legs. How wide is their stance, and why would that help their balance in a side bend?

Talk about it

1. Is this a dynamic stretch or a static stretch? How could you tell from a single photograph, and what would you need to see?
2. Ling studied anatomy before he designed his exercises. Why does knowing how the body works make a better exercise plan?

3. How is a class like this one like the warm-up you will lead this week?

Safety first. Warm up before stretching and never bounce or force a stretch; stop at gentle tension, not pain. For the long jump, use a non-slip surface such as grass or a carpeted floor with plenty of space, land softly with bent knees, and stop if anything hurts. Tell an adult right away about sharp pain, dizziness or trouble breathing.

ACTIVITY

The Warm-up Fair Test

Ling designed exercises by studying the body; modern scientists test them with measurements. You will do both: learn a dynamic warm-up and test it fairly against a static-stretch warm-up, measuring your jump and your reach.

You will need

- A tape measure or yardstick, and tape or chalk to mark a start line
- A grassy area or carpeted room with at least 10 feet of clear space
- A step or box and a ruler for the sit-and-reach
- A timer, a helper and your fitness journal with a results table

Steps

1. **Learn the Ling Ten (dynamic warm-up, about 6 minutes).** Do each move for 30 seconds or 10 reps: (1) march with high knees, (2) arm circles forward and back, (3) walking lunges with a reach overhead, (4) leg swings forward and back holding a chair, (5) leg swings side to side, (6) hip circles, (7) inchworm walk-outs (bend, walk the hands out to a plank, walk them back), (8) butt kicks, (9) side shuffles, (10) easy skipping. Move smoothly and stay in control.
2. **Day A: static warm-up.** Walk easily for 3 minutes, then hold five stretches for 45 seconds each: hamstrings, thighs, calves, hips and shoulders. Then go straight to the tests.
3. **Test 1: standing long jump.** Stand with toes behind the line, feet hip-width apart. Swing your arms back, bend your knees, and jump forward as far as you can, landing on both feet with bent knees. Measure from the line to the back of your nearest heel. Do 3 jumps with 30 seconds' rest between them and record all three.
4. **Test 2: sit-and-reach.** Measure as in Lesson 1.1: three slow reaches, no bouncing, record the best in inches before or past your toes.
5. **Day B: dynamic warm-up.** On a different day, at about the same time of day, walk easily for 3 minutes and then do the Ling Ten. Repeat both tests exactly the same way.

6. **Make it fair.** Same shoes, same surface, same measuring person, same time of day, and the same number of jumps. If you can, have a family member do the test too, doing Day B first and Day A second, so the order does not decide the result.
7. **Cool down after every session.** Walk for 2 minutes, then hold five static stretches for 20–30 seconds each, breathing slowly: calf (hands on wall, back leg straight), thigh (hold a chair, heel toward your seat), hamstring (one leg out straight on a low step, hinge forward from the hips), chest (hands clasped behind your back) and shoulder (arm across the chest).
8. **Compare.** Find your average jump on each day (add the three and divide by 3). Make a bar graph with two bars for the jump and two for the reach. Write what you found, and whether it matches what the scientists found.
9. **Session 3: lead it.** Teach the Ling Ten to a family member, calling out each move and watching their form. Then do 20 minutes of active play together and finish with the cool-down.

Tips

- A difference of an inch or two in one test may just be chance. Scientists repeat tests many times; you can repeat yours next week.
- Keep your back long in the inchworm and lunges. Bend from the hips, not by rounding your back.
- Breathe out slowly as you settle into a static stretch; a relaxed muscle stretches more easily.

Check your work

- ☐ I can tell the story of Pehr Henrik Ling and his gymnastics institute.
- ☐ I can explain when to use dynamic stretches and when to use static stretches, and why.
- ☐ I ran a fair test with the same rules both days and recorded my results honestly.

FITNESS JOURNAL

1. Copy your results table (Day A and Day B: three jumps, average jump, best reach) and draw your bar graph.
2. List the Ling Ten in order with a small stick-figure drawing of each move.

3. Draw a muscle attached to two bones by tendons, and label muscle, tendon, bone and joint.
4. Write a short paragraph: Did your results agree with the research? What would you change to make your test even fairer?

From history. Ling's system spread across the world in the 1800s. In America, schools and YMCAs adopted Swedish gymnastics, and many teachers trained at the Stockholm institute, which still exists today as the Swedish School of Sport and Health Sciences.

COMMON MISTAKES

- Holding long static stretches right before sprinting or jumping. Save them for afterward.
- Bouncing in a stretch. Hold still and breathe instead.
- Skipping the warm-up because you are short on time. Even 5 minutes makes a difference.
- Stretching to the point of pain. Gentle tension is enough; pain means stop.

Make it a game • Stretch Fair Test. Test one stretch two ways: static first, then dynamic. Measure how far you reach with a tape measure after each. Tell Ling's Stockholm story and explain what happens in muscle and tendon. Your parent records both numbers and declares the winner. Repeat tomorrow and see if the results match. Which warm-up won?

UNIT 1

KEEPING ACTIVE

In 1844 a young shop assistant named George Williams looked around London and saw thousands of young men working long hours behind shop counters, with little rest, little fresh air and much temptation. He gathered eleven friends in a room at the shop where he worked and started the Young Men's Christian Association. Within fifty years the YMCA had built gymnasiums, running tracks and swimming pools around the world, and its leaders drew a triangle to show what they cared about: spirit, mind and body together. In this unit you will learn how much activity young people need, measure your own starting point with a five-station baseline, and use the FITT principle (frequency, intensity, time and type) to plan two weeks of training.

Then you will visit Stockholm, where a minister's son named Pehr Henrik Ling opened a gymnastics institute in 1813 and taught whole classes to bend, reach, swing and balance. You will learn what flexibility is, why muscles and tendons stretch, and why scientists now recommend moving, "dynamic" stretches before exercise and still, "static" stretches afterward. You will run a fair test of your own: jump and reach after two different warm-ups and see what the numbers say.

PREREQUISITES

- Can find a pulse and count beats for 15 seconds, then multiply by 4
- Can read a stopwatch and a ruler in inches or centimeters
- Can make a table and a bar graph

MASTERY CHECKLIST

- ☐ I can tell how George Williams founded the YMCA in 1844 and what its triangle of spirit, mind and body means.
- ☐ I can state how much activity young people ages 6–17 need, including vigorous, muscle-strengthening and bone-strengthening activity.
- ☐ I can explain the FITT principle and use it to write a training plan.
- ☐ I can explain the difference between dynamic and static stretching and when to use each.
- ☐ I can lead a ten-move dynamic warm-up and a five-stretch cool-down with good form.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **Physical Activity Guidelines for Americans, 2nd edition** (U.S. Department of Health and Human Services): Free. The official guidelines behind Lesson 1.1; the chapter on children and adolescents is short and readable for a parent.
- **“Stretching”** (Nemours TeensHealth): Free. A clear article on why and how to stretch safely. Fits Lesson 1.2.
- **A stopwatch or phone timer with a lap button:** Optional. Handy for timed holds and rest periods all quarter.

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 George Williams and the YMCA: Spirit, Mind and Body 3 sessions of 40–45 minutes

1.2 Flexibility and the Warm-up: Ling’s Gymnastics 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

Who founded the YMCA, in what year and city, and what was its purpose?

2. 5 pts

What do the three sides of the YMCA triangle stand for, and who drew it?

3. 5 pts

State the activity guidelines for ages 6–17, including the three kinds of activity that should happen at least 3 days a week.

4. 5 pts

Explain the talk test. Give one example each of moderate and vigorous activity.

5. 5 pts

Name the four parts of the FITT principle and give an example of each for a jogging plan.

6. 5 pts

During a 15-second pulse count after the step test, Sam counted 31 beats. What is his heart rate in beats per minute? A week later, after 1 minute of rest, he counted 52 beats in 30 seconds. What is that rate, and what does a lower recovery number tell him?

7. 5 pts

Maya's activity log shows 45, 70, 30, 90, 60, 55 and 80 minutes for one week. What is her daily average? On how many days did she meet the 60-minute guideline?

8. 5 pts

What is the difference between dynamic and static stretching? Which belongs before exercise and which after, and why?

9. **5 pts**

Who was Pehr Henrik Ling, and what did he contribute to physical education?

10. **5 pts**

Short answer: In three or four sentences, explain why your fitness grade in this course is based on your own improvement and not on comparing you with others. Include one sentence about how 1 Timothy 4:8 fits.

ANSWER KEY

1. George Williams, a young draper's assistant, with eleven friends in London on June 6, 1844. Its purpose was to help young working men grow in faith through prayer and Bible study, and to improve themselves; later YMCAs added gymnasiums to strengthen the body too.
2. Spirit, mind and body. Dr. Luther Gulick, head of physical education at the YMCA training school in Springfield, Massachusetts.
3. At least 60 minutes of physical activity every day, mostly moderate or vigorous. At least 3 days a week should include vigorous activity, muscle-strengthening activity and bone-strengthening activity.
4. If you can talk but not sing, the activity is moderate; if you can say only a few words before taking a breath, it is vigorous. Moderate: brisk walking, easy biking. Vigorous: running, jumping rope, soccer.
5. Frequency (4 days a week), Intensity (moderate, can talk but not sing), Time (20 minutes), Type (jogging). Any sensible example for each earns credit.
6. $31 \times 4 = 124$ beats per minute. $52 \times 2 = 104$ beats per minute. A lower heart rate one minute after exercise means his heart is recovering faster, a sign of improving fitness.
7. $45 + 70 + 30 + 90 + 60 + 55 + 80 = 430$ minutes; $430 \div 7 \approx 61$ minutes a day. She met 60 minutes on 4 days (70, 90, 60, 80).
8. Dynamic stretches are controlled moving stretches (leg swings, lunges); static stretches are held still for 15–30 seconds. Dynamic stretches belong in the warm-up because they raise heart rate and warm the muscles without the short drop in jumping and sprinting power that long static holds can cause. Static stretches belong after exercise, when muscles are warm, to improve flexibility.
9. A Swede who founded the Royal Central Gymnastics Institute in Stockholm in 1813. He studied anatomy, designed planned exercises for whole classes (Swedish gymnastics or free exercises), and designed equipment such as wall bars and the balance beam.
10. Answers will vary. A good answer says that people start at different places and grow at different rates; that comparing yourself with your own baseline shows real progress and encourages faithfulness; that bodies are gifts to care for, not to show off; and that 1 Timothy 4:8 teaches that exercise has some value but godliness has more.

UNIT CHALLENGE: MY TWO-WEEK FITT PLAN AND LOG

Follow the two-week FITT plan you wrote in Lesson 1.1, with the Ling Ten warm-up and the five-stretch cool-down every time you train. Keep a daily log: activity, minutes, moderate or vigorous, effort rating and how you felt. At the end of the two weeks, retest your five-station baseline and make a bar graph comparing Day 1 with the final retest for each station. Finish with a one-page reflection: what you changed in your plan and why (name the FITT letter), which numbers improved, and what your plan will be for the next two weeks.

LOOK FOR	WHAT IT MEANS
Plan	The plan uses all four FITT letters, meets the 60-minute guideline, includes vigorous, muscle- and bone-strengthening activity on at least 3 days, and has a rest day.
Complete log	Fourteen days recorded honestly with activity, minutes, intensity and an effort rating.
Warm-up and cool-down	The log shows the dynamic warm-up and static cool-down used each training day.
Retest and graph	All five stations retested with the same rules, and a neat, labeled bar graph comparing the results.
Reflection	A thoughtful page naming what changed, which FITT letter was adjusted and the plan for the next two weeks.

UNIT 2

HYDRATION

Your body is more than half water, and that water is not plain: it carries dissolved minerals called electrolytes, especially sodium and potassium, that let your nerves send signals and your heart and muscles contract. In 1882 a London doctor named Sydney Ringer was keeping a frog's heart beating in a dish of salt water when he discovered, almost by accident, that the kind of water made all the difference. In this unit you will learn what electrolytes do, where they come from in food, how they leave in sweat, and how your kidneys keep them in balance. You will hunt for sodium and potassium on food labels and, with a parent, measure how much water you lose in sweat during a workout.

Then you will learn to respect heat. In the 1950s doctors at the Marine Corps training base at Parris Island, South Carolina, were treating recruits who collapsed in the heat during training. They invented a better way to measure how dangerous a hot day really is. You will learn the signs of heat exhaustion and heat stroke, what to do for each, how to read the heat index, and how shade, rest, water and timing keep you safe. You will test sun and shade with thermometers and write a hot-day plan for your family.

PREREQUISITES

- Knows the 60-minute guideline, the talk test and the dynamic warm-up (Unit 1)
- Can read cups and fluid ounces, and divide and find a percentage
- Can read a thermometer and make a line graph

MASTERY CHECKLIST

- ☐ I can tell the story of Sydney Ringer's frog heart and explain what electrolytes are.
- ☐ I can name the jobs of sodium and potassium and list foods rich in potassium.
- ☐ I can read sodium and potassium on a label and find what percent of the Daily Value a serving gives.
- ☐ I can name the signs of heat exhaustion and heat stroke and tell what to do for each.
- ☐ I can read a heat index chart and plan safe outdoor activity on a hot day.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **Heat Index (National Weather Service):** Free. The official heat index chart and explanation. Use it for Lesson 2.2 and the unit challenge.
- **A reusable water bottle with ounce or milliliter marks:** Optional, but it makes the water logs and drinking plans easy. Any cup and a measuring cup work just as well.
- **An outdoor or kitchen thermometer:** Optional. A second thermometer lets you test sun and shade side by side in Lesson 2.2; one thermometer used twice also works.

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 Electrolytes: Sydney Ringer and the Beating Heart

3 sessions of 40–45 minutes

2.2 Heat Safety: Shade, Rest, Water and the Heat Index

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**

What did Sydney Ringer discover about the frog heart, and how did a mistake help him?

2. **5 pts**

What is an electrolyte? Name two electrolytes and one job of each.

3. **5 pts**

A can of soup has 920 mg of sodium per serving and 2 servings per can. What %DV of sodium is one serving? How many milligrams are in the whole can?

4. **5 pts**

Name four foods that are good sources of potassium. Why should most young people try to eat more of them?

5. (5 pts)

After a hot hour of soccer, a parent found that Ben lost $1\frac{1}{2}$ pounds of fluid. About how many ounces of fluid is that, and how much should he plan to drink over the next few hours?

6. (5 pts)

When does a sports drink make sense, and what is the best drink for ordinary exercise?

7. (5 pts)

What three things did the wet-bulb globe temperature combine, and what happened at Parris Island when training was adjusted to it?

8. (5 pts)

List three signs of heat exhaustion and three signs of heat stroke. What should you do for each?

9. (5 pts)

What would happen if you played a long game on a 92 °F day with 70% humidity and no breaks? Use what you know about sweat to explain.

10. (5 pts)

Short answer: In three or four sentences, describe a safe plan for a summer afternoon of yard work for your family.

ANSWER KEY

1. The heart kept beating for hours in saline made with London tap water, but soon weakened and stopped in pure water with table salt only. The tap water contained small amounts of dissolved minerals; by testing them he found the heart needs sodium, potassium and calcium in the right balance.
2. A mineral that dissolves in water as charged particles (ions). Sodium: holds water in the blood and helps nerves signal; potassium: keeps the heart's rhythm steady and helps muscles contract (calcium and chloride are also acceptable with a correct job).
3. $920 \div 2,300 = 0.40$, so 40% DV per serving. The whole can: $920 \times 2 = 1,840$ mg (80% DV).
4. Any four: bananas, potatoes, beans, oranges, tomatoes, spinach, milk, yogurt, raisins. Many people get plenty of sodium but too little potassium, which helps the heart, muscles and nerves work.
5. 1 pound $\approx$ 16 oz, so $1.5 \times 16 = 24$ oz lost. He should drink about 16 to 24 oz for each pound: 24 to 36 oz over the next few hours, with a normal meal.
6. For long, hard exercise, usually more than about an hour, especially in heat. For ordinary exercise, water is best, with normal meals replacing electrolytes.
7. Air temperature (dry bulb), humidity (wet bulb) and the heat of the sun (black globe), with the effect of wind. When training was changed by heat level, with more rest and water and lighter work, heat illnesses among recruits dropped sharply.
8. Heat exhaustion: heavy sweating, cool clammy skin, fast weak pulse, dizziness, headache, nausea, cramps, weakness; stop, move to shade, loosen clothes, sip water, cool wet cloths, tell an adult. Heat stroke: temperature 104 °F or higher, confusion, slurred speech, hot red skin, fainting, seizures; call 911 and cool the person at once with cold water or ice.
9. The heat index would be well over 100 °F. In humid air sweat evaporates slowly, so the body cannot cool well; body temperature rises and fluid is lost, which could lead to heat exhaustion or heat stroke. The game should be moved to a cooler time, shortened, or given frequent shade and water breaks.
10. Answers will vary. A good answer moves the work to early morning or evening, includes shade and water breaks every 15–20 minutes, light loose clothing and a hat, water before thirst, watching one another for signs of heat illness, and knowing to call 911 for confusion or fainting.

UNIT CHALLENGE: MY FAMILY HEAT-SAFETY PLAN AND WATER LOG

Keep a water log for five days in a row, including at least one active day and, if possible, one warm day: record every drink in ounces, your urine color morning and afternoon (pale straw is good), and the heat index at 3 p.m. Make a bar graph of daily ounces with a line at 56 oz (7 cups). Then finish your family hot-day plan from Lesson 2.2 as a one-page poster: safe times, break schedule, clothing, drinks and electrolyte foods, the signs of heat exhaustion and heat stroke, and what to do for each. Present it to your family.

LOOK FOR	WHAT IT MEANS
Complete log	Five days recorded honestly with times, drinks, ounces, urine color and the heat index.
Graph	A neat bar graph with a title, labeled days and ounces, and the 56-ounce line.
Accurate safety information	The poster gives the correct signs of heat exhaustion and heat stroke and the right first aid, including calling 911 and cooling at once for heat stroke.
Practical plan	Specific times, break intervals, drinks, foods and places for shade that fit the family's real week.
Presentation	The student explains the plan clearly to the family and answers questions.

2.1 ELECTROLYTES: SYDNEY RINGER AND THE BEATING HEART

OBJECTIVES

- Tell how Sydney Ringer discovered in 1882–1883 that a heart needs the right dissolved minerals to keep beating.
- Explain what electrolytes are and what sodium and potassium do in nerves, muscles and body fluids.
- Read sodium and potassium on food labels, find the percent of the Daily Value, and name potassium-rich foods.
- Follow a drinking plan in a workout and, with a parent, measure water lost in sweat.

Warm-up. Do the Ling Ten dynamic warm-up from Lesson 1.2 (about 6 minutes). Then lick your finger and touch it to your forehead after the warm-up: does it taste a little salty? Think about it: if sweat is salty, what is your body losing besides water?

WATCH

What are Electrolytes?

Homeschool Arcade • 5:57

<https://www.youtube.com/watch?v=0dDI40t9mrY>

WHEN TO WATCH

After the “How your body works” paragraph. Listen for what makes a mineral an electrolyte and when a sports drink makes sense.

Note: A small homeschool teaching channel, chosen because it explains electrolytes, osmosis and sports drinks clearly at this level. The description links to the channel’s studio equipment; you can ignore it.

BACKUP VIDEO

Sodium Potassium Pump

Amoeba Sisters • 7:01

<https://www.youtube.com/watch?v=7NY6XdPBhxo>

For students who want to go deeper: how every cell pumps sodium out and potassium in to get ready to send a signal.

KEY TERMS

electrolyte

A mineral that dissolves in water as electrically charged particles (ions), such as sodium, potassium, chloride and calcium. Electrolytes let nerves send signals and muscles contract.

potassium

The main electrolyte inside your cells. It helps your heart keep a steady rhythm and your muscles contract. Found in bananas, potatoes, beans, oranges, milk and leafy greens.

Daily Value (DV)

A reference amount on the Nutrition Facts label. For sodium it is 2,300 mg; for potassium it is 4,700 mg. The %DV shows how much of that amount one serving gives.

sodium

The main electrolyte in the fluid outside your cells and in your blood. It helps hold water in the body and is the electrolyte lost most in sweat. Table salt is sodium chloride.

milligram (mg)

One thousandth of a gram. Sodium and potassium are listed in milligrams on the Nutrition Facts label.

CORE IDEAS

The story. Sydney Ringer was a doctor and professor at University College London. In 1882 he was studying how the heart works by keeping the heart of a frog beating outside its body, hanging in a small bath of salty water called saline. A frog heart can keep beating on its own for a long time if it has the right fluid around it. In his experiments the heart kept beating strongly for hours, and Ringer published his results. Then he discovered something surprising: the saline in those experiments had not been made with pure water at all, but with ordinary London tap water from the New River Water Company. When he repeated the work with pure water and table salt only, the heart's beats soon grew weaker and stopped.

How they figured it out. Instead of hiding the mistake, Ringer treated it as a clue. London's tap water had small amounts of dissolved minerals in it. One by one he added tiny measured amounts of different salts to pure saline to see which ones kept the heart going. He found that the heart needed sodium chloride, a small amount of

potassium and a small amount of **calcium**, in the right balance. Too little calcium and the heart weakened; too much potassium and it slowed and stopped. In 1883 he published the recipe. “Ringer’s solution” and its relatives are still used in hospitals today, dripping into patients’ veins to replace lost fluid. Ringer’s honest checking of a mistake showed the world that the minerals dissolved in body fluids are not extras: life depends on them.

How your body works. When minerals such as sodium, potassium, chloride and calcium dissolve in water, they split into electrically charged particles called ions; that is why they are called **electrolytes**. Every nerve signal is a quick flow of sodium and potassium ions across the wall of a nerve cell, and every heartbeat and muscle contraction depends on them too. **Sodium** stays mostly outside your cells and helps hold water in your blood; **potassium** stays mostly inside your cells. Your **kidneys** keep the balance, saving water and salt when you are low and sending extra out in urine when you have plenty. Sweat carries water and electrolytes, mostly sodium and chloride, out through your skin, which is why it tastes salty.

Food first. For ordinary days and normal practices, food replaces the electrolytes you lose and water replaces the fluid. Most people already get plenty of sodium (the Daily Value is 2,300 mg, and many packaged and restaurant foods are high in it), but many people get too little **potassium** (Daily Value 4,700 mg). Good sources are bananas (a medium one has about 400 mg), potatoes with the skin, beans, oranges, tomatoes, spinach, milk and yogurt. Sports drinks with electrolytes are meant for long, hard exercise, usually more than about an hour, especially in heat. Drinking far more water than you need can also upset the body’s sodium balance, so drink steadily, not in huge amounts.

Try it. This week you will hunt for sodium and potassium on food labels and calculate the percent of the Daily Value, do a 30-minute workout with a drinking plan, and, with a parent, measure how much water you lose in sweat. You will refuel afterward with water and a potassium-rich snack.

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 Lhermitte grew up in a farming village in northern France and spent his life painting the people who worked its fields. Here, in the heat of the wheat harvest, a farmhand stops swinging his scythe for a long drink while a girl waits beside him with the pail she has carried out to the field.

Look closely

- Follow the man's arms and head. How thirsty does he look?
- Find the girl. What is she holding for him, and what has she carried out from the farm?
- Find the older woman. What job is she doing with the cut wheat?
- Look at the sky and the color of the field. What tells you this is a hot day of hard work?

Talk about it

1. A harvester could sweat away a great deal of water in a day. What else leaves the body in sweat besides water?
2. Sydney Ringer found that a heart needs the right balance of salts, not just water. What did farm workers of long ago eat or drink in the field that might have put back some of those salts?

3. Ringer noticed something small that others overlooked. What small details did Lhermitte notice and paint here?

Safety first. Drink water steadily before, during and after exercise, but never try to drink a huge amount at once or have drinking contests. Do the sweat check only with a parent, on a scale the parent reads; it measures water lost, not body weight. Stop and tell an adult right away if you feel dizzy, sick to your stomach, very tired or have muscle cramps or a bad headache.

ACTIVITY

Electrolyte Hunt and the Sweat Check

Ringer measured carefully and learned from what he found. You will measure too: the electrolytes in the foods your family eats, and the water you lose in a workout.

You will need

- Labels from 8 foods and drinks in your pantry or fridge (or pictures online): for example milk, a canned soup, crackers, bread, a sports drink, canned beans, orange juice, peanut butter
- A banana, an orange or a baked potato for after the workout
- Water bottle, measuring cup, timer, towel or mat
- A bathroom scale read by a parent (for the optional sweat check)
- Fitness journal with a label table: food, serving size, sodium (mg), %DV, potassium (mg), %DV

Steps

1. **Label hunt.** For each of your 8 labels, write the serving size, the sodium in milligrams and the potassium in milligrams (newer labels list potassium; if a label does not, write “not listed”).
2. Find the %DV yourself and check it against the label: sodium $\text{mg} \div 2,300 \times 100$, and potassium $\text{mg} \div 4,700 \times 100$. Example: soup with 690 mg sodium gives $690 \div 2,300 = 0.30$, or 30%.
3. Rank your foods from highest to lowest sodium, and circle the three best potassium sources. Write one sentence: which foods surprised you?
4. **Session 2: the Ringer circuit (30 minutes).** Warm up with the Ling Ten. Then do 4 rounds of: 45 seconds step-ups, 15 seconds rest; 45 seconds squats, 15 seconds rest; 45 seconds jumping jacks, 15 seconds rest; 45 seconds mountain climbers (hands under shoulders, back flat, knees driving forward one at a time), 15 seconds rest. Rest 2 minutes between rounds. Count squats in each round.
5. **Drinking plan.** Drink 1 cup (8 oz) of water 20–30 minutes before you start. During each 2-minute rest, drink 3 or 4 swallows (about 3–4 oz). Measure and

record every drink. Afterward, drink water and eat your banana, orange or potato.

6. **Optional sweat check (with a parent).** Use the bathroom first, then have a parent weigh you in your workout clothes just before the circuit, and again right after (towel off the sweat, same clothes). Subtract the drinks you had during the workout: each 16 oz you drank weighs about 1 pound. Your parent tells you only the difference. Every pound lost is about 16 oz of water lost in sweat and breath. Record it as “fluid lost,” not as a weight.
7. Use your fluid loss to plan: for each pound (16 oz) lost, drink about 16 to 24 oz of fluid over the next few hours, along with a normal meal to replace the sodium.
8. **Session 3: repeat and improve.** Do the circuit again on another day. Try to add 1 or 2 squats per round with good form, follow the drinking plan exactly, and compare how you felt.
9. Cool down: walk for 2 minutes and hold your five static stretches for 20–30 seconds each.

Tips

- Some labels list servings per container; the whole can or bottle may have two or three servings.
- On a hot or humid day you will sweat more. Do the workout in the coolest room or early in the morning.
- A pinch of salt is already in most meals. You do not need salt tablets or special drinks for ordinary exercise.

Check your work

- ☐ I can tell Sydney Ringer’s story and explain why a heart needs the right electrolytes.
- ☐ I can read sodium and potassium on a label and calculate the %DV.
- ☐ I followed a drinking plan during my workout and recorded what I drank.

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1. Copy your label table neatly and draw a bar graph of sodium (mg) for all 8 foods.
2. Record both circuits: squats per round, drinks (oz), effort rating, and, if you did it, fluid lost in ounces.

3. Draw a nerve cell with sodium (Na^+) outside and potassium (K^+) inside, and an arrow showing the signal traveling.
4. Write a plan for a long, hot Saturday of yard work or sport: what you will drink, when, and what foods will replace your electrolytes.

From history. Sydney Ringer taught medicine at University College London for nearly forty years. A blue plaque was unveiled there in 2022 to honor his work on the solution that bears his name.

COMMON MISTAKES

- Thinking a sports drink is needed for every practice. For most exercise under an hour, water and normal meals are enough.
- Drinking huge amounts of water at once. Steady drinking is safer and works better.
- Forgetting potassium. Fruits, vegetables, beans and milk supply it; many people do not eat enough of them.
- Reading the %DV for one serving and forgetting that the package holds several servings.

Make it a game • Electrolyte Hunt Duel. Race to find five foods in the kitchen with sodium or potassium listed on the label, and write the milligrams. Whoever finds the highest sodium and highest potassium food wins a round. Then tell how Sydney Ringer saved a frog heart and name two jobs of electrolytes. Add up your total milligrams.

2.2 HEAT SAFETY: SHADE, REST, WATER AND THE HEAT INDEX

OBJECTIVES

- Tell how Marine Corps doctors in the 1950s developed a better measure of heat to protect recruits in training.
- Name the signs of heat exhaustion and heat stroke and tell what to do for each.
- Read a heat index chart and explain how sun, humidity and wind change heat risk.
- Measure sun and shade temperatures and write a hot-day activity plan.

Warm-up. Indoors or in the shade, do 1 minute each of marching, arm circles, squats and side shuffles. Then hold your hand in a sunny window or patch of sunlight for 30 seconds, and in the shade for 30 seconds. Which feels hotter, even though the air is the same? Think about it: why might a thermometer in the shade not tell you the whole story about a hot day?

WATCH

Heat Related Illness and Young Athletes - Nemours Sports Medicine Advice from the Pros

Nemours · 3:49

https://www.youtube.com/watch?v=Q9f_7onF90Y

WHEN TO WATCH

After the “How your body works” paragraph. Write down the signs of heat exhaustion and of heat stroke as the doctor lists them.

Note: A pediatric orthopedic surgeon at a Nemours children’s hospital in Florida explains dehydration, heat exhaustion, heat stroke and fainting in the heat.

BACKUP VIDEO

What happens when you get heat stroke? - Douglas J. Casa

TED-Ed · 3:54

<https://www.youtube.com/watch?v=PpHM4DfPZQU>

After the activity, to see why exertional heat stroke happens and why cooling first saves lives.

KEY TERMS

heat exhaustion

An illness caused by heavy sweating and overheating. Signs include heavy sweating, cool and clammy skin, a fast weak pulse, dizziness, headache, nausea, muscle cramps and weakness.

heat stroke

A medical emergency in which the body's temperature rises to about 104 °F (40 °C) or higher and it cannot cool itself. Signs include confusion, strange behavior, slurred speech, hot red skin, fainting or seizures. Call 911 and cool the person at once.

heat index

A number from the National Weather Service that combines air temperature and humidity to show how hot it feels to the body, measured in the shade.

humidity

The amount of water vapor in the air. High humidity slows the evaporation of sweat, so the body cools more slowly.

WBGT (wet-bulb globe temperature)

A measure of heat stress that adds the effects of sun and wind to temperature and humidity. Developed for the Marine Corps in the 1950s and used today by many schools and teams.

CORE IDEAS

The story. Every summer, thousands of young recruits trained at the Marine Corps Recruit Depot at Parris Island, South Carolina, a low, hot, humid island near the coast. In the early 1950s Navy and Marine doctors there were treating many recruits who collapsed from the heat while drilling and marching, and some cases were deadly. Recruits were falling ill even on days that did not look especially dangerous by the thermometer alone. A Navy doctor, Dr. Minard, worked with Dr. Constantin Yaglou, a heat researcher at the Harvard School of Public Health, to find a better measure.

How they figured it out. They reasoned that the body feels heat from more than the air. Humid air slows sweating, bright sun beats down on the skin, and a breeze helps carry heat away. So they combined three thermometers: an ordinary one for the air, one with its bulb wrapped in a wet cloth (which cools more when air is dry and less

when air is humid), and one inside a hollow black ball set in the sun (which shows the heat of the sunshine). From these they calculated one number, the **wet-bulb globe temperature**. The base then flew colored flags to show the heat level and changed training to match, with more rest, more water and lighter work as the number rose. Heat illnesses among the recruits dropped sharply. They published their results in 1957, and today schools, teams and the military still use the WBGT and colored heat flags. The National Weather Service's **heat index**, which combines temperature and humidity, is the version you can check on any weather report.

How your body works. Your body works best near 98.6 °F (37 °C). Working muscles make a great deal of heat, and your body sheds it mainly by pumping warm blood to the skin and by sweating; as sweat evaporates, it carries heat away. When the air is hot, humid and still, or the sun is strong, evaporation slows and heat builds up. If you also lose a lot of water in sweat, your blood volume drops and your heart must work harder. **Heat exhaustion** comes first: heavy sweating, cool clammy skin, a fast weak pulse, dizziness, headache, nausea, cramps and weakness. Stop, move to shade or air-conditioning, loosen clothing, sip water, put cool wet cloths on the skin and tell an adult. If the person does not improve within about an hour, or gets worse, get medical help. **Heat stroke** is an emergency: body temperature 104 °F (40 °C) or higher, confusion or strange behavior, slurred speech, hot red skin (dry or damp), fainting or seizures. **Call 911 and cool the person at once** with cold water or ice, while help is on the way. Do not give drinks to someone who is confused or unconscious.

Plan ahead. On hot days, check the heat index. A day of 90 °F with 60% humidity has a heat index of about 100 °F, and the National Weather Service warns that full sun can add up to 15 °F more. Play early in the morning or in the evening, not in the afternoon; take breaks in the shade every 15–20 minutes; drink water before you are thirsty; wear light-colored, loose, breathable clothes and a hat; and ease into hot-weather activity over several days, because your body slowly gets better at handling heat. Never leave anyone, or a pet, in a parked car on a warm day.

Try it. This week you will measure temperatures in sun and shade and on light and dark surfaces, track the heat index for a week, write your family's hot-day plan, and do a workout scheduled and set up the safe way.

PICTURE STUDY



The Song of the Lark, Jules Breton, 1884 · Oil on canvas · The Art Institute of Chicago

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

Jules Breton grew up in a farming village in northern France and painted the people who worked its fields. Here a young farm worker has gone out to the field at dawn, sickle in hand, and stops for a moment to listen to a lark singing as the sun rises.

Look closely

- Find the sun. Is it morning or evening? How can you tell?
- Look at what she carries. What work has she come out to do so early?
- Look at the light on the field and on her face. Is it the hot, harsh light of noon or a softer light?
- Look at her clothes and head covering. How would they help her later in the day?

Talk about it

1. Why did farm workers in hot countries start work at dawn and rest in the middle of the day?
2. How could you plan your own outdoor games or chores on a hot day using the same idea?
3. What else would this worker need by noon to stay safe in the heat?

Safety first. Do the thermometer tests in the morning or evening, and do not stand in strong sun yourself while you wait; read the thermometers and return to the shade. Exercise only in the coolest part of the day, with water and shade close by and an adult nearby. Know the signs of heat illness, stop at the first ones, and call 911 at once for confusion, fainting or a very high temperature.

ACTIVITY

Sun, Shade and My Hot-Day Plan

Dr. Minard and Dr. Yaglou learned that a shade thermometer does not tell the whole story. You will find out how much sun and surfaces matter, track the heat index for a week, and turn what you learn into a plan your family can use all summer.

You will need

- Two thermometers (or one used twice), a timer and your fitness journal
- A sunny spot and a shady spot outdoors, a light-colored surface (concrete, a white towel) and a dark one (asphalt, a dark towel)
- A weather app or website that shows temperature and humidity, and the National Weather Service heat index chart
- Water bottle, towel or mat, and a shady or indoor place to work out

Steps

1. **Sun and shade test.** On a sunny day, set one thermometer in full sun on a light surface and the other in the shade nearby, both at the same height. Read and record both every 5 minutes for 20 minutes. Wait in the shade between readings.
2. **Light and dark test.** On another sunny day (or the same day, an hour later), lay one thermometer on a dark surface in the sun and one on a light surface in the sun. Read both every 5 minutes for 20 minutes.
3. Make a line graph of each test with time along the bottom and temperature up the side. Write the biggest difference you found in degrees.
4. **Heat index log.** For 7 days, at about 3 p.m., look up the temperature and the relative humidity, then use the heat index chart to find the heat index. Record all three, and write the safety level from the chart (caution, extreme caution, danger).
5. **Write your family hot-day plan.** Include: the times of day you will play outside; how often you will take shade and water breaks; what to wear; where the nearest shade, water and cool room are; the signs of heat exhaustion and of heat stroke; what to do for each; and who to call.

6. **Session 3: the safe workout.** Choose the coolest time of day or an indoor room. Do the Ling Ten warm-up, then 3 rounds of: 1 minute brisk walking or jogging, 30 seconds squats, 30 seconds push-ups at your level, 30 seconds jumping jacks, then a 1-minute shade-and-water break. Rate your effort and thirst after each round.
7. Check yourself after the workout with a partner: Is your skin warm and damp (normal) or cool and clammy, or hot and red? Do you feel clear-headed? Record your answers.
8. Cool down with 2 minutes of walking in the shade and your five static stretches. Drink water and write one change you would make if the heat index were 10 degrees higher.

Tips

- Hang a damp cloth around your neck during breaks on warm days; as it evaporates, it cools you.
- Light-colored, loose clothing reflects sunlight and lets sweat evaporate.
- Your body adjusts to heat over about one to two weeks. Start the summer with shorter, easier outdoor sessions.

Check your work

- ☐ I can tell how the Marine Corps doctors measured heat and why the sun and humidity matter.
- ☐ I can name the signs of heat exhaustion and heat stroke and what to do for each.
- ☐ I measured sun and shade temperatures, kept a heat index log and wrote a hot-day plan.

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1. Draw your two line graphs (sun and shade; light and dark) with titles, labels and the biggest difference marked.
2. Copy your 7-day heat index log as a table and color each day by its safety level.
3. Make a two-column chart: heat exhaustion signs and what to do; heat stroke signs and what to do.
4. Write your family hot-day plan neatly so it can be posted on the refrigerator.

From history. The heat index used on American weather reports grew out of work by Robert Steadman, who published his calculations of how hot humid air feels to the body in 1979. Many high schools now use WBGT meters and the same colored flag system the Marines began.

COMMON MISTAKES

- Judging a hot day by the thermometer alone. Humidity and strong sun can make it far more dangerous.
- Pushing through dizziness or confusion to finish a game. Stopping early is wise, not weak.
- Waiting to cool someone with heat stroke until help arrives. Call 911 and start cooling at once.
- Starting summer training with long, hard outdoor sessions. Build up over one to two weeks.

Make it a game • Heat Safety Scenarios. Your parent reads a hot-day scenario and you decide: heat exhaustion or heat stroke? Name the signs and the first action. Add shade, rest, water and the heat index to your plan. Score one point for each correct response in sixty seconds. Switch roles and write a scenario that is hard to answer.

Scripture. “They shall not hunger nor thirst; neither shall the heat nor sun smite them: for he that hath mercy on them shall lead them, even by the springs of water shall he guide them.” (Isaiah 49:10, KJV)

Isaiah pictures God as a shepherd who leads His people to springs of water and protects them from the heat. Planning shade and water for others on a hot day is a small way of showing the same care.

UNIT 2

HYDRATION

Your body is more than half water, and that water is not plain: it carries dissolved minerals called electrolytes, especially sodium and potassium, that let your nerves send signals and your heart and muscles contract. In 1882 a London doctor named Sydney Ringer was keeping a frog's heart beating in a dish of salt water when he discovered, almost by accident, that the kind of water made all the difference. In this unit you will learn what electrolytes do, where they come from in food, how they leave in sweat, and how your kidneys keep them in balance. You will hunt for sodium and potassium on food labels and, with a parent, measure how much water you lose in sweat during a workout.

Then you will learn to respect heat. In the 1950s doctors at the Marine Corps training base at Parris Island, South Carolina, were treating recruits who collapsed in the heat during training. They invented a better way to measure how dangerous a hot day really is. You will learn the signs of heat exhaustion and heat stroke, what to do for each, how to read the heat index, and how shade, rest, water and timing keep you safe. You will test sun and shade with thermometers and write a hot-day plan for your family.

PREREQUISITES

- Knows the 60-minute guideline, the talk test and the dynamic warm-up (Unit 1)
- Can read cups and fluid ounces, and divide and find a percentage
- Can read a thermometer and make a line graph

MASTERY CHECKLIST

- ☐ I can tell the story of Sydney Ringer's frog heart and explain what electrolytes are.
- ☐ I can name the jobs of sodium and potassium and list foods rich in potassium.
- ☐ I can read sodium and potassium on a label and find what percent of the Daily Value a serving gives.
- ☐ I can name the signs of heat exhaustion and heat stroke and tell what to do for each.
- ☐ I can read a heat index chart and plan safe outdoor activity on a hot day.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **Heat Index (National Weather Service):** Free. The official heat index chart and explanation. Use it for Lesson 2.2 and the unit challenge.
- **A reusable water bottle with ounce or milliliter marks:** Optional, but it makes the water logs and drinking plans easy. Any cup and a measuring cup work just as well.
- **An outdoor or kitchen thermometer:** Optional. A second thermometer lets you test sun and shade side by side in Lesson 2.2; one thermometer used twice also works.

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 Electrolytes: Sydney Ringer and the Beating Heart

3 sessions of 40–45 minutes

2.2 Heat Safety: Shade, Rest, Water and the Heat Index

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**

What did Sydney Ringer discover about the frog heart, and how did a mistake help him?

2. **5 pts**

What is an electrolyte? Name two electrolytes and one job of each.

3. **5 pts**

A can of soup has 920 mg of sodium per serving and 2 servings per can. What %DV of sodium is one serving? How many milligrams are in the whole can?

4. **5 pts**

Name four foods that are good sources of potassium. Why should most young people try to eat more of them?

5. (5 pts)

After a hot hour of soccer, a parent found that Ben lost $1\frac{1}{2}$ pounds of fluid. About how many ounces of fluid is that, and how much should he plan to drink over the next few hours?

6. (5 pts)

When does a sports drink make sense, and what is the best drink for ordinary exercise?

7. (5 pts)

What three things did the wet-bulb globe temperature combine, and what happened at Parris Island when training was adjusted to it?

8. (5 pts)

List three signs of heat exhaustion and three signs of heat stroke. What should you do for each?

9. (5 pts)

What would happen if you played a long game on a 92 °F day with 70% humidity and no breaks? Use what you know about sweat to explain.

10. (5 pts)

Short answer: In three or four sentences, describe a safe plan for a summer afternoon of yard work for your family.

ANSWER KEY

1. The heart kept beating for hours in saline made with London tap water, but soon weakened and stopped in pure water with table salt only. The tap water contained small amounts of dissolved minerals; by testing them he found the heart needs sodium, potassium and calcium in the right balance.
2. A mineral that dissolves in water as charged particles (ions). Sodium: holds water in the blood and helps nerves signal; potassium: keeps the heart's rhythm steady and helps muscles contract (calcium and chloride are also acceptable with a correct job).
3. $920 \div 2,300 = 0.40$, so 40% DV per serving. The whole can: $920 \times 2 = 1,840$ mg (80% DV).
4. Any four: bananas, potatoes, beans, oranges, tomatoes, spinach, milk, yogurt, raisins. Many people get plenty of sodium but too little potassium, which helps the heart, muscles and nerves work.
5. 1 pound $\approx$ 16 oz, so $1.5 \times 16 = 24$ oz lost. He should drink about 16 to 24 oz for each pound: 24 to 36 oz over the next few hours, with a normal meal.
6. For long, hard exercise, usually more than about an hour, especially in heat. For ordinary exercise, water is best, with normal meals replacing electrolytes.
7. Air temperature (dry bulb), humidity (wet bulb) and the heat of the sun (black globe), with the effect of wind. When training was changed by heat level, with more rest and water and lighter work, heat illnesses among recruits dropped sharply.
8. Heat exhaustion: heavy sweating, cool clammy skin, fast weak pulse, dizziness, headache, nausea, cramps, weakness; stop, move to shade, loosen clothes, sip water, cool wet cloths, tell an adult. Heat stroke: temperature 104 °F or higher, confusion, slurred speech, hot red skin, fainting, seizures; call 911 and cool the person at once with cold water or ice.
9. The heat index would be well over 100 °F. In humid air sweat evaporates slowly, so the body cannot cool well; body temperature rises and fluid is lost, which could lead to heat exhaustion or heat stroke. The game should be moved to a cooler time, shortened, or given frequent shade and water breaks.
10. Answers will vary. A good answer moves the work to early morning or evening, includes shade and water breaks every 15–20 minutes, light loose clothing and a hat, water before thirst, watching one another for signs of heat illness, and knowing to call 911 for confusion or fainting.

UNIT CHALLENGE: MY FAMILY HEAT-SAFETY PLAN AND WATER LOG

Keep a water log for five days in a row, including at least one active day and, if possible, one warm day: record every drink in ounces, your urine color morning and afternoon (pale straw is good), and the heat index at 3 p.m. Make a bar graph of daily ounces with a line at 56 oz (7 cups). Then finish your family hot-day plan from Lesson 2.2 as a one-page poster: safe times, break schedule, clothing, drinks and electrolyte foods, the signs of heat exhaustion and heat stroke, and what to do for each. Present it to your family.

LOOK FOR	WHAT IT MEANS
Complete log	Five days recorded honestly with times, drinks, ounces, urine color and the heat index.
Graph	A neat bar graph with a title, labeled days and ounces, and the 56-ounce line.
Accurate safety information	The poster gives the correct signs of heat exhaustion and heat stroke and the right first aid, including calling 911 and cooling at once for heat stroke.
Practical plan	Specific times, break intervals, drinks, foods and places for shade that fit the family's real week.
Presentation	The student explains the plan clearly to the family and answers questions.

UNIT 3

NUTRITION

Food is a gift from God and the fuel for everything your body does: growing, thinking, running, healing. But how do we know how much energy is in a slice of bread or a spoonful of peanut butter? In the 1890s a chemistry professor named Wilbur Atwater built a sealed room at Wesleyan University in Connecticut where a man could live for days while scientists measured every bit of food he ate and every bit of heat his body gave off. From that work came the numbers printed on every food label today: carbohydrate and protein supply about 4 calories of energy per gram, and fat about 9. In this unit you will learn what each macronutrient does, use the gram numbers to see where the energy in a meal comes from, and build a plate that fuels a growing, active body.

Then you will become a label detective. The Nutrition Facts label has been on American food packages since 1994, and since 2016 it has had a line for **added sugars**: sugars put into food when it is made, as opposed to the sugar naturally found in fruit and milk. You will learn why health experts recommend keeping added sugars low, turn grams into teaspoons, compare foods in your own pantry, and plan and prepare a lower-sugar breakfast. Treats and feasts are good gifts in their place; the goal is wisdom, not fear.

PREREQUISITES

- Can multiply and divide whole numbers and decimals, and find a percentage
- Knows how to read a serving size and %DV on a label (Lesson 2.1)
- Knows kitchen safety: wash hands, a parent supervises knives and the stove

MASTERY CHECKLIST

- ☐ I can tell how Wilbur Atwater measured the energy in food and the body.
- ☐ I can name the three macronutrients, what each does, and how many calories of energy per gram each supplies.
- ☐ I can calculate the energy from carbohydrate, protein and fat in a food from its label, and explain why we use calories as a unit of energy, not something to count.
- ☐ I can find added sugars on a label, turn grams into teaspoons and %DV, and explain the difference between added and natural sugars.
- ☐ I can plan and prepare a balanced, lower-sugar breakfast.

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 on the label. A good reference for both lessons.
- **“Added Sugars on the Nutrition Facts Label” (U.S. Food and Drug Administration)**: Free. Explains the added-sugars line and its Daily Value. Read it with Lesson 3.2.
- **“Food Labels” (Nemours TeensHealth)**: Free. A short article on reading labels, written for young people.

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 Macronutrients by the Gram: Wilbur Atwater’s Chamber

3.2 Added Sugar and the Nutrition Facts Label3 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**

What did Wilbur Atwater build at Wesleyan University, and what did his measurements prove?

2. **5 pts**

Name the three macronutrients, one job of each, and the calories of energy each supplies per gram.

3. **5 pts**

A granola bar has 20 g carbohydrate, 3 g protein and 6 g fat. Calculate the energy from each macronutrient and the total. What percent comes from carbohydrate?

4. **5 pts**

What is a calorie, and why does this course use calories only to understand food and never to count it?

5. **5 pts**

What should a pre-activity snack be mostly made of, and what should a post-activity snack include? Give an example of each.

6. **5 pts**

When did the Nutrition Facts label first appear on packages, and what new line was added in the 2016 update?

7. **5 pts**

A flavored yogurt has 18 g total sugars and 10 g added sugars. How many teaspoons of added sugar is that, and what %DV? Where did the other 8 grams come from?

8. (5 pts)

What do the Dietary Guidelines and the American Heart Association recommend about added sugars for young people?

9. (5 pts)

What would happen if a student drank two sodas a day, each with about 39 g of added sugar? Use the AHA recommendation in your answer.

10. (5 pts)

Short answer: In three or four sentences, explain how a Christian can enjoy treats and feasts and still practice self-control at the table. Use Proverbs 25:16 or Nehemiah 8:10.

ANSWER KEY

1. A sealed respiration calorimeter, a small room where a volunteer lived for days while the team measured food, oxygen, heat, carbon dioxide and wastes. It proved that the energy a person gets from food equals the energy the body gives off as heat and work; the body follows the same law of energy as the rest of creation.
2. Carbohydrate: main fuel for brain and muscles, 4 per gram. Protein: building and repairing muscle, bone, skin and blood, 4 per gram. Fat: concentrated energy store, building cells, carrying vitamins A, D, E and K, 9 per gram.
3. $20 \times 4 = 80$; $3 \times 4 = 12$; $6 \times 9 = 54$. Total = 146 calories. $80 \div 146 \approx 0.55$, about 55% from carbohydrate.
4. A unit of energy: the food calorie is the energy needed to warm 1 kg of water by 1 °C. Growing, active young people need plenty of energy and the right amount differs from person to person; hunger, fullness, growth and the doctor are better guides, so calories are a tool for understanding, not a score.
5. Before: mostly easy-to-digest carbohydrate, e.g., a banana, toast or oatmeal. After: carbohydrate plus protein, e.g., yogurt and fruit, a turkey sandwich, or eggs and toast.
6. 1994 (after the 1990 Nutrition Labeling and Education Act). The 2016 update added “Includes __ g Added Sugars” with a %Daily Value.
7. $10 \div 4 = 2\frac{1}{2}$ teaspoons; $10 \div 50 = 20\%$ DV. The other 8 g are natural sugar (lactose) from the milk.
8. The Dietary Guidelines: less than 10 percent of food energy from added sugars for ages 2 and up. The American Heart Association: less than about 25 grams (6 teaspoons) of added sugar a day for children and teens.
9. That is about 78 g of added sugar, more than three times the 25 g limit and about 156% DV. Drinks like that give energy without nutrients, can crowd out nutrient-dense foods and milk, and feed the bacteria that cause tooth decay. Water or milk would be better everyday drinks, with a soda as an occasional treat.
10. Answers will vary. A good answer says that sweet foods and feasts are good gifts from God (Nehemiah 8:10), that the proverb teaches eating what is sufficient rather than forbidding honey, and that self-control means making nutrient-dense foods the everyday habit and keeping treats in their place, with thankfulness.

UNIT CHALLENGE: MY LOWER-SUGAR BREAKFAST MENU

Plan three different balanced, lower-sugar breakfasts, each with a protein food, a whole grain, a fruit or vegetable and a calcium food. For each, write the recipe, a shopping list, the grams of carbohydrate, protein and fat for the main foods with the energy from each (4, 4 and 9), and the grams and teaspoons of added sugar. With a parent's help, prepare each breakfast at least once over two weeks and serve it to your family. Record their ratings and your own morning energy, and write a short reflection on which breakfast worked best and why.

LOOK FOR	WHAT IT MEANS
Balanced plans	Each breakfast includes a protein food, a whole grain, a fruit or vegetable and a calcium food, with little or no added sugar.
Accurate label math	Energy from each macronutrient and added sugar in grams, teaspoons and %DV are calculated correctly with work shown.
Preparation	All three breakfasts were prepared safely with a parent, with clean hands and careful knife and stove use.
Records	Family ratings and morning energy ratings are recorded for each breakfast.
Reflection	A thoughtful paragraph on what worked best, what the family enjoyed, and one habit to keep.

3.1 MACRONUTRIENTS BY THE GRAM: WILBUR ATWATER'S CHAMBER

OBJECTIVES

- Tell how Wilbur Atwater and his team measured the energy in food and in the human body in the 1890s.
- Explain what carbohydrates, proteins and fats do in the body, and name good food sources of each.
- Use 4, 4 and 9 calories per gram to calculate where the energy in a food comes from.
- Plan and prepare a balanced plate or snack that fuels an active day.

Warm-up. Jog in place for 1 minute, do 15 squats, 10 push-ups at your level and 1 minute of jumping jacks. Put your hand on your chest and feel your heart working, then feel the warmth of your face. Think about it: the heat your body is making right now came from somewhere. Where?

WATCH

Nutrition 1 - Carbohydrates, Proteins and Fats

Health Literacy • 9:08

<https://www.youtube.com/watch?v=jqrVl4V5ttQ>

WHEN TO WATCH

After the “How your body works” paragraph. Listen for the definition of a calorie and the numbers 4, 4 and 9.

Note: A simple hand-drawn lesson from a small health-education channel with no description, chosen because it explains the calorie and the 4-4-9 rule clearly. It shows chemical diagrams of sugars and fats; students do not need to memorize them.

KEY TERMS

macronutrients

The three nutrients the body needs in large amounts: carbohydrates, proteins and fats. All three supply energy.

protein

The building material for muscles, organs, skin and blood, made of amino acids. Found in meat, fish, eggs, beans, nuts, milk and cheese. About 4 calories per gram.

calorie (food Calorie)

A unit of energy. The food calorie on a label is the energy needed to warm 1 kilogram (about 1 quart) of water by 1 °C. It measures energy, the way an inch measures length.

carbohydrate

The body's main fuel, especially for the brain and hard-working muscles. Found in grains, fruits, vegetables, beans and milk. About 4 calories per gram.

fat

A concentrated energy store that also helps build cells and carry vitamins A, D, E and K. Found in nuts, seeds, oils, butter, fish and meat. About 9 calories per gram.

calorimeter

An instrument or chamber that measures heat. Atwater's respiration calorimeter measured the heat a person gave off while living inside it.

CORE IDEAS

The story. Wilbur Olin Atwater, the son of a Methodist minister, was born in New York in 1844 and became a chemistry professor at Wesleyan University in Middletown, Connecticut. He wanted to know something very practical: how much real nourishment did families get for the money they spent on food? To answer it he first had to measure the energy in food, and then find out whether the human body used that energy the way a steam engine uses coal. In the 1890s, with a physicist named Edward Rosa, he built one of the most remarkable machines in the history of nutrition: a sealed room, only about 7 feet long, 4 feet wide and 6 feet high, with a bed, a chair, a table and a stationary bicycle. A volunteer lived inside it for several days at a time, eating carefully weighed meals passed in through a small opening, while the scientists outside measured the air he breathed and the heat his body gave off.

How they figured it out. First Atwater's team burned small samples of thousands of foods in a sealed metal container surrounded by water and measured how much the water warmed: that showed the energy stored in each food. They also measured what the body could not digest and passed out as waste. Then, inside the big chamber, they measured everything going in (food, oxygen) and everything coming out (heat, carbon dioxide, wastes). The numbers matched: the energy a person got from food equaled the energy his body gave off as heat and work, whether he rested or pedaled hard. The body obeys the same law of energy as the rest of God's creation. From these measurements Atwater worked out simple averages still used on every Nutrition Facts label: about **4 calories per gram of carbohydrate, 4 per gram of protein, and 9 per gram of fat.**

How your body works. Digestion breaks food into small pieces your blood can carry. **Carbohydrates** become glucose, the main fuel for your brain and your working muscles; your muscles and liver store some as glycogen, ready for hard play.

Proteins are broken into amino acids, the building blocks your body uses to grow and repair muscle, bone, skin and blood; you are growing fast at your age, so protein at each meal matters. **Fats** are a concentrated energy store, help build every cell, and carry vitamins A, D, E and K. A calorie is simply a unit of energy, like an inch for length or a degree for temperature. Growing, active young people need plenty of energy, and the right amount differs from person to person; your hunger and fullness, your growth and your doctor are better guides than any number. That is why in this course we use calories to *understand* food, never to count or cut it.

Build a fuel plate. A balanced plate has whole grains or starchy vegetables for carbohydrate, a protein food, plenty of fruits and vegetables for vitamins, minerals and fiber, a calcium food such as milk, yogurt or cheese, and a little healthy fat from foods such as nuts, olive oil or fish. Before activity, choose mostly carbohydrate that is easy to digest (a banana, toast, oatmeal); after activity, pair carbohydrate with protein (yogurt and fruit, a turkey sandwich, eggs and toast) to refuel and repair. Daniel and his friends ate vegetables and drank water, and were healthier than the young men who ate the king's rich food (Daniel 1:15); God has given us good food in great variety.

Try it. This week you will use labels to calculate how much energy comes from carbohydrate, protein and fat in several foods, then plan and prepare a balanced snack or lunch for an active day and figure out where its energy comes from.

PICTURE STUDY



Still Life with Figs and Bread, Luis Meléndez, About 1770 · Oil on canvas · National Gallery of Art, Washington, D.C.

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

Luis Meléndez was a Spanish painter of the 1700s who painted ordinary foods with great care: bread, fruit, cheese, fish and kitchen pots. He wanted to show the beauty of everyday food, and his paintings are so exact that historians use them to learn what Spanish families ate.

Look closely

- Find the bread. Which macronutrient does bread supply most of?
- Find the figs. What does fruit give the body besides carbohydrate?
- Is there a protein food on this table? What could you add to make it a balanced meal?
- Look at the light. How does Meléndez make each food look solid and real?

Talk about it

1. If this were a workman's lunch, would it give him quick energy, lasting energy, or both? Explain.
2. Atwater measured the energy in foods like these. Which food here do you think stores the most energy per gram, and why?

3. Meléndez treated ordinary bread and fruit as worth painting carefully. How could we show thankfulness for ordinary food?

Safety first. Wash your hands before handling food. A parent supervises any knife or stove use. Check with a parent about food allergies (especially nuts, milk, eggs and wheat) before preparing or tasting anything, and choose a substitute if needed.

ACTIVITY

Energy by the Gram and a Fuel Plate

Atwater turned grams into energy. You will do the same with real labels, and then put what you learn on a plate.

You will need

- Labels from 5 foods: for example whole-grain bread, peanut butter, plain yogurt or milk, a granola bar and canned beans
- A calculator (or pencil and paper), colored pencils and your fitness journal
- Foods for a balanced snack or lunch (see step 6), a plate, measuring cups and a kitchen scale if you have one

Steps

1. **Make an energy table.** For each label, copy the serving size and the grams of total carbohydrate, protein and total fat.
2. **Multiply:** carbohydrate grams $\times$ 4, protein grams $\times$ 4, fat grams $\times$ 9. Add the three to get the total. Compare your total with the calories on the label. (Labels round their numbers, and some carbohydrate is fiber, so yours may be a few calories off.)
3. For each food, find what fraction of its energy comes from each macronutrient (for example, fat calories $\div$ total calories). Draw a small pie or bar for each food in three colors.
4. Example to check your method: 2 tablespoons of peanut butter with 7 g carbohydrate, 8 g protein and 16 g fat: $28 + 32 + 144 = 204$ calories, and $144 \div 204 \approx 71\%$ from fat. Peanut butter is a nutrient-dense food rich in healthy fat and protein.
5. **Plan a fuel plate.** Draw a plate divided into sections: about a quarter grains, a quarter protein, half fruits and vegetables, with a cup of milk or a calcium food on the side. Choose real foods from your kitchen for each section for an active day's lunch.
6. **Session 2: prepare it.** With a parent, wash your hands and prepare your plate. Ideas: a turkey or bean wrap on a whole-wheat tortilla with carrots and

an apple; scrambled eggs, whole-grain toast and berries; a peanut-butter and banana sandwich with milk and cucumber slices. Before you eat, give thanks.

7. Use the labels of the main foods to estimate the grams of carbohydrate, protein and fat on your plate and where most of its energy comes from. Write whether it has quick fuel, building material and lasting energy.
8. **Session 3: fuel and move.** Plan a pre-activity snack (mostly carbohydrate, eaten 30–60 minutes before) and a post-activity snack (carbohydrate plus protein). Eat the first, do 30 minutes of active play or the Ringer circuit from Lesson 2.1, then eat the second. Rate your energy (1–10) before, during and after.

Tips

- Use the serving size on the label. If you eat two servings, double every number.
- Fiber is a carbohydrate your body cannot fully digest; it feeds healthy gut bacteria and helps digestion, which is one reason labels and your math may differ.
- Do not use these numbers to count what you eat each day. They are for understanding food, the way a map helps you understand a country.

Check your work

- ☐ I can tell the story of Atwater's chamber and what it proved.
- ☐ I can calculate the energy from carbohydrate, protein and fat in a food.
- ☐ I planned and prepared a balanced plate and explained where its energy comes from.

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1. Copy your energy table for all 5 foods and draw the three-color bar or pie for each.
2. Draw your fuel plate, label each section with the foods you chose and the main macronutrient each supplies.
3. Draw Atwater's chamber from the description: the room, the bed, the bicycle, the food opening, and arrows for food and oxygen in, heat and carbon dioxide out.
4. Record your Session 3 energy ratings and write which snacks helped most.

From history. Atwater also became the U.S. Department of Agriculture's first chief of nutrition investigations. His tables of the energy and nutrients in American foods, first published in the 1890s, were the ancestors of the food databases nutrition scientists use today.

COMMON MISTAKES

- Thinking fat is “bad.” Fat is essential; it is simply more concentrated energy, and healthy fats from nuts, oils and fish are nutrient-dense.
- Skipping carbohydrate before hard exercise. Muscles and the brain run best on it.
- Using calories to count or cut what you eat. Growing bodies need plenty of energy; calories are a unit for understanding, not a score.
- Forgetting the serving size when doing label math.

Make it a game • Gram Math Dash. Pick three foods and read their grams of carbohydrate, protein and fat. Multiply by four, four and nine to find calories on paper while your parent times you. Fastest correct answer scores. Tell Wilbur Atwater's chamber story in thirty seconds. Then plan a fuel plate using one food from each nutrient group.

3.2 ADDED SUGAR AND THE NUTRITION FACTS LABEL

OBJECTIVES

- Tell the history of the Nutrition Facts label (1994) and the added-sugars line (2016).
- Explain the difference between natural sugars and added sugars, and why experts recommend limiting added sugars.
- Turn grams of added sugar into teaspoons and %DV, and compare foods using labels.
- Plan and prepare a balanced, lower-sugar breakfast.

Warm-up. Do 1 minute of skipping or jogging in place, 10 lunges on each leg, 10 push-ups at your level and a 30-second plank. Then look at the breakfast foods in your kitchen. Think about it: which of them do you think has the most sugar added by the company that made it? Write your guess down.

WATCH

How to read a nutrition facts label

Osmosis from Elsevier · 3:24

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

WHEN TO WATCH

After the “How they figured it out” paragraph. Pause on the label and find the serving size, total sugars and added sugars lines.

Note: A clear animated walk-through of the current label from a medical-education channel. It says the label has been required since 1990; the law was passed in 1990, and the label appeared on packages in 1994.

KEY TERMS

Nutrition Facts label

The standard panel on packaged foods, required in the United States since 1994, showing the serving size, calories and nutrients in one serving.

total sugars

All the sugar in one serving, both the sugar found naturally in foods such as fruit and milk and any sugar added.

added sugars

Sugars and syrups put into foods and drinks when they are made or prepared, such as table sugar, honey, corn syrup and syrups in drinks. Listed on the label since the 2016 update.

nutrient-dense food

A food that gives a lot of vitamins, minerals, fiber or protein for its energy, such as fruits, vegetables, whole grains, beans, eggs, milk and nuts.

treat food

A food enjoyed mainly for its taste, often high in added sugar, that has a good place at celebrations and now and then, but not as an everyday staple.

CORE IDEAS

The story. Before the 1990s, food packages in America could show nutrition information in many different ways, or not at all. In 1990 Congress passed the Nutrition Labeling and Education Act, and the Food and Drug Administration set out to design one clear label for nearly every packaged food. The designer Burkey Belser and his team tried many layouts and settled on the plain black-and-white box with bold lines that you know today; in 1994 it began appearing on packages, and the design won a Presidential Award for Design Excellence in 1997. In 2016 the FDA announced the label's biggest update: larger type for calories and servings, potassium and vitamin D added, and a brand-new line, "Includes __ g Added Sugars," with a %Daily Value. Large food companies had to use the new label by 2020.

How they figured it out. Why add a line for added sugars? Scientists who write the *Dietary Guidelines for Americans* had looked at many studies. They found that most Americans eat far more added sugar than is good for them, mostly from sweetened drinks, desserts, candy and sweetened cereals, and that a diet of many sugary foods crowds out the nutrient-dense foods growing bodies need and contributes to tooth decay and other health problems. They recommended that people age 2 and older get **less than 10 percent** of their food energy from added sugars. The American Heart Association recommends that children and teens have less than about **25 grams (6 teaspoons)** of added sugar a day. The old label lumped all sugars together, so the sugar in plain milk or raisins looked the same as sugar poured in at a factory. The new line lets you tell them apart.

How your body works. All sugars are carbohydrates, and your body turns them into glucose for fuel. The difference is what comes with them. The sugar in an orange or a glass of milk comes packaged with water, fiber, vitamins, minerals or protein, so it fills you up and nourishes you. A soda with about 39 grams of added sugar (almost 10 teaspoons) gives quick energy and nothing else, and drinks like that are the largest single source of added sugar for most young people. Sugar that sits on your teeth also feeds the bacteria that cause cavities. To read a label: 4 grams of sugar is about 1 teaspoon, and the Daily Value for added sugars is 50 grams, so 10 grams of added sugar is 20% DV.

Think it through. Sweet things are not wicked; honey was one of the good gifts of the Promised Land, and Nehemiah told the people to eat the fat and drink the sweet on a feast day (Nehemiah 8:10). The proverb's advice is about measure: "Hast thou found honey? eat so much as is sufficient for thee." Self-control at the table, like self-control in training, is a kind of freedom.

Try it. This week you will hunt for added sugars in your pantry, measure them out in teaspoons for a display, compare a few breakfast foods, and plan and make a balanced, lower-sugar breakfast for yourself or your family.

PICTURE STUDY



Still Life with Sweets and Pottery, Juan van der Hamen y León, 1627 · Oil on canvas · National Gallery of Art, Washington, D.C.

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

Juan van der Hamen y León painted in Madrid in the 1600s, when sugar was costly and sweets were a sign of celebration and hospitality. Here he arranged boxes of candied fruit, sugared pastries and fine glass and pottery on stone shelves as carefully as jewels.

Look closely

- Count the different kinds of sweets. Which ones look like they were made with fruit?
- Find the boxes and jars. Why might sweets have been stored in containers like these?
- Look at how the shelves step up and down. How does the painter lead your eye from one sweet to the next?
- Is there anything in this painting that looks like an everyday meal?

Talk about it

1. In 1627 sweets like these were rare and costly, saved for guests and feasts. How is that different from today?
2. Would these foods count as nutrient-dense foods or treat foods? What would make a feast both joyful and balanced?

3. How could you keep treats special, the way they were in van der Hamen's day?

Safety first. Wash your hands and have a parent supervise the stove and any knives. Check for food allergies before tasting anything. The sugar spoons in the display are for looking only; do not eat them.

ACTIVITY

The Pantry Sugar Lab and a Better Breakfast

You cannot see added sugar in most foods, but the label can show it to you. You will measure it, display it and then put what you learn to work in a breakfast that fuels a morning of school and play.

You will need

- Labels from 6–8 foods and drinks: for example a sweetened cereal, plain oats, flavored yogurt, plain yogurt, a granola bar, 100% juice, a soda or sweet tea (label or picture), ketchup or a pasta sauce
- A bowl of sugar, measuring spoons and small clear cups or plates (for the display only)
- Breakfast foods: plain yogurt or oatmeal, fruit, eggs, whole-grain bread, milk, nuts or seeds (as allergies allow)
- Fitness journal with a table: food, serving size, total sugars (g), added sugars (g), teaspoons, %DV

Steps

1. **Guess first.** Line up your foods and rank them from most to least added sugar by guessing. Write your ranking down.
2. **Read the labels.** For each food, record the serving size, total sugars and added sugars in grams.
3. **Do the math.** Teaspoons = added sugars $\div$ 4. %DV = added sugars $\div$ 50 $\times$ 100. Check your %DV against the label. Example: a cereal with 12 g added sugars per serving has 3 teaspoons, 24% DV.
4. **Build the display.** Measure level teaspoons of sugar onto a small plate or cup for each food, and set each label beside its pile. Compare with your guesses. Which surprised you most?
5. **Natural or added?** Compare plain yogurt with flavored yogurt, or plain milk with chocolate milk: how much of the total sugar is added? Explain why plain milk has sugar even though none was added (it is lactose, milk's natural sugar).

6. **Session 2: plan a better breakfast.** Choose a breakfast with a protein food, a whole grain, a fruit and a calcium food, with little or no added sugar. Ideas: oatmeal cooked in milk with sliced banana and cinnamon; plain yogurt with berries and a sprinkle of oats or nuts; scrambled eggs, whole-grain toast and an orange. Write the grams of added sugar it has, compared with a sweetened-cereal breakfast.
7. **Prepare it.** With a parent, wash your hands and make your breakfast. Serve it to someone in your family if you can. Ask them to rate taste and fullness from 1 to 5.
8. **Session 3: the taste test and the morning test.** Sweeten a cup of plain yogurt only with fruit (mashed berries or banana) and compare it with a flavored yogurt. Which do you prefer? Then, on a morning when you eat your better breakfast, rate your energy and hunger at 9, 10 and 11 o'clock (1–10) and compare with a morning of your usual breakfast.

Tips

- Check the serving size: many bottles and packages hold more than one serving.
- Ingredients are listed from most to least by weight. Sugar has many names: corn syrup, cane sugar, honey, dextrose, fruit juice concentrate and more.
- Taste buds adjust. If you cut back slowly on very sweet foods, fruit begins to taste sweeter within a few weeks.

Check your work

- ☐ I can explain the difference between total sugars and added sugars.
- ☐ I can turn grams of added sugar into teaspoons and %DV.
- ☐ I planned and prepared a balanced, lower-sugar breakfast.

FITNESS JOURNAL

1. Copy your sugar table and draw a bar graph of teaspoons of added sugar for each food.
2. Sketch a Nutrition Facts label and label the serving size, calories, total sugars, added sugars and %DV.
3. Write your better-breakfast recipe, its added sugar in grams and teaspoons, and your family's ratings.

4. Record your morning energy and hunger ratings for both breakfasts and write two sentences about the difference.

From history. The Nutrition Facts label has been copied around the world, and its plain black-and-white design has been used as a model for other labels that explain complicated information simply.

COMMON MISTAKES

- Confusing total sugars with added sugars. Fruit and plain milk have natural sugar but no added sugar.
- Forgetting that drinks count. A sweetened drink can hold a whole day's recommended added sugar.
- Calling foods “bad” or feeling guilty about treats. Treats are good gifts in their place; the goal is wise everyday choices.
- Reading only the front of the package. Words like “natural” or “made with fruit” do not tell you the added sugar; the label does.

Make it a game • Sugar Pile Showdown. Choose two snacks. Read total sugars and added sugars from each label, convert grams to teaspoons by dividing by four, and spoon the sugar onto plates. Guess first, then check. Closest guess wins a point. Tell the history of the Nutrition Facts label and name one nutrient-dense swap.

Scripture. “Hast thou found honey? eat so much as is sufficient for thee” (Proverbs 25:16, KJV)

Honey is a good gift, and the proverb does not forbid it. It teaches measure: enjoy what is sufficient. That is the heart of wise eating.

UNIT 3

NUTRITION

Food is a gift from God and the fuel for everything your body does: growing, thinking, running, healing. But how do we know how much energy is in a slice of bread or a spoonful of peanut butter? In the 1890s a chemistry professor named Wilbur Atwater built a sealed room at Wesleyan University in Connecticut where a man could live for days while scientists measured every bit of food he ate and every bit of heat his body gave off. From that work came the numbers printed on every food label today: carbohydrate and protein supply about 4 calories of energy per gram, and fat about 9. In this unit you will learn what each macronutrient does, use the gram numbers to see where the energy in a meal comes from, and build a plate that fuels a growing, active body.

Then you will become a label detective. The Nutrition Facts label has been on American food packages since 1994, and since 2016 it has had a line for **added sugars**: sugars put into food when it is made, as opposed to the sugar naturally found in fruit and milk. You will learn why health experts recommend keeping added sugars low, turn grams into teaspoons, compare foods in your own pantry, and plan and prepare a lower-sugar breakfast. Treats and feasts are good gifts in their place; the goal is wisdom, not fear.

PREREQUISITES

- Can multiply and divide whole numbers and decimals, and find a percentage
- Knows how to read a serving size and %DV on a label (Lesson 2.1)
- Knows kitchen safety: wash hands, a parent supervises knives and the stove

MASTERY CHECKLIST

- ☐ I can tell how Wilbur Atwater measured the energy in food and the body.
- ☐ I can name the three macronutrients, what each does, and how many calories of energy per gram each supplies.
- ☐ I can calculate the energy from carbohydrate, protein and fat in a food from its label, and explain why we use calories as a unit of energy, not something to count.
- ☐ I can find added sugars on a label, turn grams into teaspoons and %DV, and explain the difference between added and natural sugars.
- ☐ I can plan and prepare a balanced, lower-sugar breakfast.

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 on the label. A good reference for both lessons.
- **“Added Sugars on the Nutrition Facts Label” (U.S. Food and Drug Administration)**: Free. Explains the added-sugars line and its Daily Value. Read it with Lesson 3.2.
- **“Food Labels” (Nemours TeensHealth)**: Free. A short article on reading labels, written for young people.

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 Macronutrients by the Gram: Wilbur Atwater’s Chamber

3.2 Added Sugar and the Nutrition Facts Label

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**

What did Wilbur Atwater build at Wesleyan University, and what did his measurements prove?

2. **5 pts**

Name the three macronutrients, one job of each, and the calories of energy each supplies per gram.

3. **5 pts**

A granola bar has 20 g carbohydrate, 3 g protein and 6 g fat. Calculate the energy from each macronutrient and the total. What percent comes from carbohydrate?

4. **5 pts**

What is a calorie, and why does this course use calories only to understand food and never to count it?

5. **5 pts**

What should a pre-activity snack be mostly made of, and what should a post-activity snack include? Give an example of each.

6. **5 pts**

When did the Nutrition Facts label first appear on packages, and what new line was added in the 2016 update?

7. **5 pts**

A flavored yogurt has 18 g total sugars and 10 g added sugars. How many teaspoons of added sugar is that, and what %DV? Where did the other 8 grams come from?

8. (5 pts)

What do the Dietary Guidelines and the American Heart Association recommend about added sugars for young people?

9. (5 pts)

What would happen if a student drank two sodas a day, each with about 39 g of added sugar? Use the AHA recommendation in your answer.

10. (5 pts)

Short answer: In three or four sentences, explain how a Christian can enjoy treats and feasts and still practice self-control at the table. Use Proverbs 25:16 or Nehemiah 8:10.

ANSWER KEY

1. A sealed respiration calorimeter, a small room where a volunteer lived for days while the team measured food, oxygen, heat, carbon dioxide and wastes. It proved that the energy a person gets from food equals the energy the body gives off as heat and work; the body follows the same law of energy as the rest of creation.
2. Carbohydrate: main fuel for brain and muscles, 4 per gram. Protein: building and repairing muscle, bone, skin and blood, 4 per gram. Fat: concentrated energy store, building cells, carrying vitamins A, D, E and K, 9 per gram.
3. $20 \times 4 = 80$; $3 \times 4 = 12$; $6 \times 9 = 54$. Total = 146 calories. $80 \div 146 \approx 0.55$, about 55% from carbohydrate.
4. A unit of energy: the food calorie is the energy needed to warm 1 kg of water by 1 °C. Growing, active young people need plenty of energy and the right amount differs from person to person; hunger, fullness, growth and the doctor are better guides, so calories are a tool for understanding, not a score.
5. Before: mostly easy-to-digest carbohydrate, e.g., a banana, toast or oatmeal. After: carbohydrate plus protein, e.g., yogurt and fruit, a turkey sandwich, or eggs and toast.
6. 1994 (after the 1990 Nutrition Labeling and Education Act). The 2016 update added “Includes __ g Added Sugars” with a %Daily Value.
7. $10 \div 4 = 2\frac{1}{2}$ teaspoons; $10 \div 50 = 20\%$ DV. The other 8 g are natural sugar (lactose) from the milk.
8. The Dietary Guidelines: less than 10 percent of food energy from added sugars for ages 2 and up. The American Heart Association: less than about 25 grams (6 teaspoons) of added sugar a day for children and teens.
9. That is about 78 g of added sugar, more than three times the 25 g limit and about 156% DV. Drinks like that give energy without nutrients, can crowd out nutrient-dense foods and milk, and feed the bacteria that cause tooth decay. Water or milk would be better everyday drinks, with a soda as an occasional treat.
10. Answers will vary. A good answer says that sweet foods and feasts are good gifts from God (Nehemiah 8:10), that the proverb teaches eating what is sufficient rather than forbidding honey, and that self-control means making nutrient-dense foods the everyday habit and keeping treats in their place, with thankfulness.

UNIT CHALLENGE: MY LOWER-SUGAR BREAKFAST MENU

Plan three different balanced, lower-sugar breakfasts, each with a protein food, a whole grain, a fruit or vegetable and a calcium food. For each, write the recipe, a shopping list, the grams of carbohydrate, protein and fat for the main foods with the energy from each (4, 4 and 9), and the grams and teaspoons of added sugar. With a parent's help, prepare each breakfast at least once over two weeks and serve it to your family. Record their ratings and your own morning energy, and write a short reflection on which breakfast worked best and why.

LOOK FOR	WHAT IT MEANS
Balanced plans	Each breakfast includes a protein food, a whole grain, a fruit or vegetable and a calcium food, with little or no added sugar.
Accurate label math	Energy from each macronutrient and added sugar in grams, teaspoons and %DV are calculated correctly with work shown.
Preparation	All three breakfasts were prepared safely with a parent, with clean hands and careful knife and stove use.
Records	Family ratings and morning energy ratings are recorded for each breakfast.
Reflection	A thoughtful paragraph on what worked best, what the family enjoyed, and one habit to keep.

UNIT 4

STRENGTH

Every movement you make is a muscle pulling on a bone. More than three hundred years ago an Italian scientist named Giovanni Alfonso Borelli looked at the arm and saw a machine: bones as levers, joints as pivots, muscles as the force that moves them. His great book *On the Motion of Animals*, published in 1680 and 1681, showed something surprising: most of your muscles work at a mechanical disadvantage, pulling many times harder than the weight in your hand. In this unit you will learn how muscles, tendons and bones work together, build a model of the biceps as a third-class lever, and feel the lever principle in your own arm and leg.

Then you will learn how strength is trained. During the First World War, Walter Camp, the famous Yale football coach, made up a short daily routine of twelve exercises for servicemen, the “Daily Dozen,” and millions of people later did it at home. Today coaches organize strength training into sets, repetitions and rest, adding a little at a time. You will write and follow a two-week plan using your body weight, a backpack with books, water jugs or a light resistance band, and measure your improvement.

PREREQUISITES

- Knows the dynamic warm-up and static cool-down (Unit 1)
- Knows good form for the squat, push-up and plank
- Can multiply and divide, and use a ruler

MASTERY CHECKLIST

- ☐ I can tell how Giovanni Borelli explained muscles and bones as levers.
- ☐ I can name the parts of a lever and the three classes of levers, with an example of each in the body.
- ☐ I can explain how a tendon connects muscle to bone and why the biceps must pull much harder than the load in the hand.
- ☐ I can explain sets, repetitions, rest and progressive overload, and the safe guidelines for strength training at my age.
- ☐ I can follow a two-week strength plan with good form and record my improvement.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“Strength Training” (Nemours TeensHealth):** Free. A sensible article for young people on safe strength training, form and rest. Read it with Lesson 4.2.
- **“Your Muscles” (Nemours KidsHealth):** Free. A clear review of how muscles, tendons and bones work together. Fits Lesson 4.1.
- **A light resistance band:** Optional. A light, looped exercise band adds resistance to rows, presses and squats in Lesson 4.2. Choose a light one and check it for nicks before every use.

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 Muscles, Tendons and Levers: Borelli’s Machine

3 sessions of 40–45 minutes

4.2 Sets, Reps and Rest: Walter Camp’s Daily Dozen

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)

Who was Giovanni Alfonso Borelli, and what did his book *On the Motion of Animals* explain?

2. (5 pts)

Name the three parts of a lever and tell what each one is in the human arm.

3. (5 pts)

Give one example from the body of a first-class, a second-class and a third-class lever.

4. (5 pts)

A biceps attaches 2 inches from the elbow. A student holds a 6-pound water jug 13 inches from the elbow. About how hard must the biceps pull?

5. (5 pts)

What is the difference between a tendon and a ligament? Why should load be added slowly?

6. (5 pts)

Define a repetition, a set and a rest interval, and explain progressive overload.

7. (5 pts)

Jada did 3 sets of squats: 12, 11 and 10 reps on Monday, and 14, 13 and 12 on Friday. What were her total reps each day, and by what percent did her total increase?

8. (5 pts)

List four safe guidelines for strength training at your age.

9. (5 pts)

What was Walter Camp's Daily Dozen, and what would happen if someone did it exactly the same way every day for years?

10. (5 pts)

Short answer: In three or four sentences, explain why rest, sleep and food are part of strength training, and connect it to 1 Corinthians 9:25.

ANSWER KEY

1. An Italian mathematician and scientist (1608–1679), a follower of Galileo. His book, published in 1680–1681, explained the movements of animals and people with mathematics, showing bones as levers, joints as fulcrums and muscles as the effort; he is called the father of biomechanics.
2. Fulcrum: the elbow joint. Effort: the biceps pulling through its tendon. Load: the forearm and hand plus anything held.
3. First-class: nodding the head (neck joint between face and neck muscles). Second-class: rising onto the toes (ball of foot as fulcrum, body weight in the middle, calf pulling the heel). Third-class: biceps bending the elbow.
4. $\text{Effort} \times 2 = 6 \times 13 = 78$, so $\text{effort} = 78 \div 2 = 39$ pounds.
5. A tendon connects muscle to bone; a ligament connects bone to bone. Tendons and ligaments strengthen more slowly than muscles, so adding load gradually protects them.
6. A rep is one complete movement; a set is a group of reps done without stopping; a rest interval is the pause between sets. Progressive overload means making training a little harder over time (more reps, another set, a harder version or a little more load) so the body keeps adapting.
7. Monday: $12 + 11 + 10 = 33$. Friday: $14 + 13 + 12 = 39$. Increase = 6; $6 \div 33 \approx 0.18$, about an 18% increase.
8. Any four: supervised, with form first; 2–3 days a week on non-consecutive days; 1–3 sets of 8–15 reps; 1–2 minutes of rest between sets; progress slowly (reps, then sets, then load); never test a one-rep maximum; stop at joint or sharp pain.
9. A routine of twelve simple exercises taking about eight minutes, created during World War I for servicemen and later done at home. Done the same way forever, it would keep a person active and maintain fitness, but strength would stop increasing because there is no progressive overload.
10. Answers will vary. A good answer explains that muscles are challenged during training but rebuilt during rest and sleep with protein and energy from food, so skipping rest slows progress and invites injury; and that Paul says those who strive for mastery are temperate (self-controlled) in all things, including training, rest and eating.

UNIT CHALLENGE: MY TWO-WEEK STRENGTH CHALLENGE

Follow your two-week strength plan from Lesson 4.2: three sessions a week, with the dynamic warm-up and the cool-down every time. Record every set in your training table, use the progress rule, and on the last day retest one set of each exercise at your Day 1 level. Make a before-and-after bar graph of reps (and plank seconds) for all six exercises, and write a one-page reflection on what improved, what you changed and how you felt about training a little more each week.

LOOK FOR	WHAT IT MEANS
Plan	The plan follows the safe guidelines: 2–3 non-consecutive days, 1–3 sets of 8–15 reps, rest between sets, and slow progression.
Complete records	Every session recorded with level or load, reps for each set, rest and effort rating.
Good form	A parent confirms that form cues were followed and loads stayed light and safe.
Retest and graph	A neat before-and-after graph for all six exercises using the same level as Day 1.
Reflection	A thoughtful page about improvement, changes made using the progress rule, and the role of rest and self-control.

4.1 MUSCLES, TENDONS AND LEVERS: BORELLI'S MACHINE

OBJECTIVES

- Tell how Giovanni Alfonso Borelli explained the body's movements as levers in *On the Motion of Animals* (1680–1681).
- Name the parts of a lever and the three classes of levers, with an example of each in the body.
- Explain how tendons connect muscles to bones and calculate how hard the biceps pulls to hold a load.
- Build a lever model and do a lever-based strength circuit.

Warm-up. Do the Ling Ten dynamic warm-up. Then hold one arm out with the elbow bent at a right angle and lay your other hand on the front of your upper arm. Slowly bend and straighten the elbow 5 times. Now feel the cord just inside your elbow crease when you bend it hard. Think about it: what is that cord, and where is it pulling?

WATCH

The 3 Classes of Levers || How we use levers in the world and our bodies || By: Kinesiology Kris

KinesiologyKris · 6:17

https://www.youtube.com/watch?v=A0y_2b8SSbs

WHEN TO WATCH

After the “How your body works” paragraph. Pause after each class of lever and find the fulcrum, the load and the effort.

Note: A cartoon explanation by a kinesiology teacher, using a seesaw, a wheelbarrow, tweezers and the body. It uses the word “resistance” for the load.

KEY TERMS

lever

A rigid bar that turns around a fixed point. In your body, bones are the levers.

fulcrum

The fixed point a lever turns around. In the body, the fulcrum is a joint.

effort and load

The effort is the force that moves the lever (in the body, a muscle pulling through its tendon). The load is what is being moved (your body part plus anything you hold).

third-class lever

A lever with the effort between the fulcrum and the load, like the biceps lifting the forearm. It gives speed and range of motion but needs a large effort.

tendon

A tough cord of tissue that connects a muscle to a bone. The Achilles tendon at your heel is the largest and strongest in the body.

ligament

A tough band of tissue that connects one bone to another at a joint and holds the joint together.

CORE IDEAS

The story. Giovanni Alfonso Borelli was born in Naples in 1608 and became a professor of mathematics in Messina and Pisa. He was a follower of Galileo, who had shown that nature can be described with mathematics. Borelli asked a bold question: could the same mathematics explain how animals move? He studied the arms and legs of people, the wings of birds and the fins of fish, measured where muscles attach to bones, and drew them as levers and pulleys. In his last years he lived in Rome under the patronage of Queen Christina of Sweden, and he finished his great book, *De Motu Animalium* (*On the Motion of Animals*), just before he died in 1679. It was published in two parts in 1680 and 1681, and he is often called the father of biomechanics, the science of how living bodies move.

How they figured it out. Borelli noticed that a muscle usually attaches to a bone very close to the joint. The biceps, for example, attaches to the forearm only about 2 inches from the elbow, while your hand is about 14 inches away. Using the law of the lever, which Archimedes had described long before, he calculated that a muscle attached so close to the joint must pull far harder than the weight in the hand: the effort times its distance from the fulcrum must equal the load times its distance. With the biceps 2 inches from the elbow and a 10-pound load 14 inches away, the biceps must pull about $10 \times 14 \div 2 = 70$ pounds. Why would the Creator design muscles to work at such a disadvantage? Borelli saw the answer: a small shortening of the muscle swings the hand through a large, fast arc. Your arm trades force for speed and reach, which is exactly what you need to throw, write or swing a hammer.

How your body works. A lever has a **fulcrum** (the pivot), an **effort** (the push or pull) and a **load** (what is moved). In a **first-class lever** the fulcrum is in the middle, like a seesaw; nodding your head is one, with the neck joint as the fulcrum, the weight of your face in front and the neck muscles pulling behind. In a **second-class lever** the load is in the middle, like a wheelbarrow; rising onto your toes is one, with the ball of the foot as fulcrum, your body weight over the ankle and the calf muscles pulling up on the heel through the Achilles tendon. In a **third-class lever** the effort is in the middle, like tweezers or a broom; the biceps bending the elbow is the classic example, and most of your limbs work this way. Muscles can only pull, never push, so they work in pairs: the biceps bends the elbow and the triceps on the back of the arm straightens it. Each muscle is fixed to the bone by a **tendon**, a cord of tough fibers that carries the muscle's pull to the bone, and bones are held together at joints by **ligaments**.

Good form. Because your muscles already work at a disadvantage, a load held far from a joint is much harder (and harder on the joint) than the same load held close. Carry heavy things close to your body, lift with your legs by bending your knees and hips while keeping your back flat, and move slowly and in control. Tendons and ligaments grow stronger more slowly than muscles, which is one reason to add load a little at a time.

Try it. This week you will build a ruler model of the arm to see how the attachment point changes the effort, test the lever principle in your own arm with a backpack, and do a strength circuit with one exercise for each class of lever.

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 painted the famous professional rowers of his day. John and Bernard Biglin of New York were champion oarsmen. Eakins studied anatomy and the mechanics of motion, and he painted the brothers at the exact moment their oars grip the water.

Look closely

- Find the oars. Where is the fulcrum of each oar? Where is the effort, and where is the load?
- Look at the rowers' arms. Which joints are bending or straightening? Which muscles are working?
- Look at their backs and legs. How do the brothers use their whole bodies, not only their arms?
- Find the boat at the bottom edge and the steamboat full of people. How does Eakins show that this is a race?

Talk about it

1. An oar is a lever, and so is the rower's forearm. How many levers can you find in this painting?
2. Why must the two brothers move at exactly the same moment?

3. Eakins studied anatomy to paint the body truthfully. Why does knowing how muscles and bones work help an artist, a coach or a doctor?

Safety first. Use only a light load: a backpack with two or three books (about 5–8 pounds) or a half-gallon water jug. Keep your back straight, move slowly, and stop if a joint hurts; muscle tiredness is normal, joint pain is not. Use the rubber band gently and away from faces.

ACTIVITY

Borelli's Arm and the Lever Circuit

Borelli measured where muscles attach and calculated the forces. You will build a simple model to see the same thing, then feel it in your own body.

You will need

- A 12-inch ruler with holes or a paint stirrer, a pencil, string, tape and a large rubber band
- A small bag of coins or a full water bottle as a load, and a second ruler to measure the rubber band's stretch
- A backpack with 2–3 books, or a half-gallon water jug
- A sturdy step, a mat, a timer and your fitness journal

Steps

1. **Build the arm.** Tape one end of the ruler to the edge of a table so it can swing up and down like a hinge: that end is the elbow (fulcrum). Hang the load from the far end (12 inches) with string: that is the hand.
2. **Add the muscle.** Tie the rubber band to the ruler 2 inches from the fulcrum and hold its other end straight above, as the biceps attaches to the forearm. Lift until the ruler is level, and measure how far the band stretches. Repeat with the band attached at 4, 6 and 8 inches.
3. Make a table and a line graph: attachment distance versus stretch. More stretch means more force. Write one sentence explaining what you found, and why the muscle attached close to the joint has the hardest job but moves the hand fastest.
4. **Do Borelli's math.** If the band were attached 2 inches from the fulcrum and the load were 1 pound at 12 inches, how hard must it pull? ($1 \times 12 \div 2 = 6$ pounds.) Now do your own arm: measure from your elbow crease to the middle of your palm, and use 2 inches for the biceps.
5. **Feel it.** Hold the backpack by its top strap with your arm bent at a right angle, elbow at your side, for 20 seconds. Then hold it with your hand close to your shoulder for 20 seconds. Then (carefully, light pack only) with your arm

reaching forward, for 10 seconds. Rate each from 1 to 10. Which was hardest, and why?

6. **Session 2: the lever circuit.** Warm up with the Ling Ten. Do 3 rounds of: (1) slow neck nods, 10 (first-class lever; gentle, no weight); (2) calf raises on the edge of a step, holding a rail, 15, rising high and lowering slowly (second-class); (3) biceps curls with the backpack or jug, 12 each arm, elbow pinned to your side (third-class); (4) triceps dips from a sturdy chair, 8–10, elbows pointing back, shoulders down; (5) a 30-second plank. Rest 30 seconds between exercises and 2 minutes between rounds.
7. Record the reps and an effort rating for each exercise in each round. Name the class of lever beside each one.
8. **Session 3: repeat and improve.** Do the circuit again and try to add 1 or 2 reps to the calf raises, curls or dips with the same good form, or 5 seconds to the plank. Cool down with your five static stretches, adding a triceps stretch (hand behind your head, gently press the elbow).

Tips

- On curls, do not swing your back or let the elbow drift forward. Let the biceps do the work.
- On calf raises, go all the way up and lower slowly for 3 seconds; the lowering builds strength too.
- Breathe out as you lift and in as you lower.

Check your work

- ☐ I can tell how Borelli explained the body as a set of levers.
- ☐ I can name the three classes of levers with an example of each in my body.
- ☐ I can explain why the biceps pulls much harder than the load in my hand, and I completed the lever circuit with good form.

FITNESS JOURNAL

1. Draw the bones of the arm (upper arm, two forearm bones) with the biceps and triceps, their tendons, the elbow joint as fulcrum and the load in the hand. Label effort, fulcrum and load.
2. Copy your rubber-band table and line graph.
3. Draw the three classes of levers side by side with a body example of each.

4. Record both lever circuits and circle every number that improved.

From history. Borelli's book included careful engraved plates showing muscles as cords pulling on bony levers. Scientists still study animal and human movement with his method, now using cameras, computers and force plates.

COMMON MISTAKES

- Thinking muscles can push. Muscles only pull; they work in pairs to move a joint back and forth.
- Confusing tendons and ligaments. Tendons join muscle to bone; ligaments join bone to bone.
- Holding loads far from the body. The farther from the joint, the harder the muscle and joint must work.
- Swinging the body to lift a weight. Slow, controlled movement trains the muscle and protects the joint.

Make it a game • Lever Class Charades. Act out the three lever classes with your body: calf raise, elbow curl, head tilt. Your parent guesses which class and where the fulcrum, effort and load are. Switch. Then draw Borelli's arm and label tendon and ligament. First to score five correct explanations wins. Tell Borelli's story to finish.

4.2 SETS, REPS AND REST: WALTER CAMP'S DAILY DOZEN

OBJECTIVES

- Tell how Walter Camp created the Daily Dozen and how strength training came to be organized into sets and repetitions.
- Define repetition, set, rest interval and progressive overload, and state safe guidelines for strength training at your age.
- Write a two-week strength plan using body weight and light household loads.
- Follow the plan with good form, record every set, and retest.

Warm-up. Do the Ling Ten dynamic warm-up, then 10 bodyweight squats, 10 wall push-ups and 10 slow lunges (5 each leg). Think about it: if you did 30 push-ups in a row, then 30 more tomorrow, and 30 more every day forever, would you keep getting stronger? Why or why not?

WATCH

Strength Training For Young Athletes | Cincinnati Children's

Cincinnati Children's • 9:26

<https://www.youtube.com/watch?v=LN39MfLto20>

WHEN TO WATCH

After the “How your body works” paragraph. Watch the section for ages 10–11 and the one for 12 and up, and note the form cues the trainer gives.

Note: From Cincinnati Children’s Hospital’s sports-medicine team. A trainer shows age-appropriate exercises with young athletes and explains why mental readiness and good coaching matter more than age.

KEY TERMS

repetition (rep)

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

set

A group of repetitions done in a row without stopping, such as 12 squats. A workout may have 2 or 3 sets of each exercise.

rest interval

The pause between sets that lets your muscles recover enough to do the next set with good form, usually 1–2 minutes.

progressive overload

Making training a little harder over time (more reps, another set, a slightly heavier load or a harder version) so the body keeps adapting and growing stronger.

muscular endurance

The ability of a muscle to keep working for many repetitions or a long time without tiring.

CORE IDEAS

The story. Walter Camp is often called the father of American football: as a player and coach at Yale in the late 1800s he helped invent its rules, from the line of scrimmage to the system of downs. He also believed that ordinary people, not only athletes, should exercise every day. During the First World War, while advising the U.S. military on fitness, he devised a short routine of twelve simple exercises that servicemen could do in about eight minutes with no equipment at all. He gave them plain names: hands, grind, crawl, wave, hips, grate, curl, weave, head, grasp, crouch and wing. The Navy and the Army used his methods, and after the war Camp wrote a book about the routine and recorded it on phonograph records with music, so families could do it at home. By the 1920s “the Daily Dozen” had become a common phrase for any morning exercise.

How they figured it out. Camp’s routine was meant to keep people fit, but later trainers asked how to make people *stronger*. In the 1940s an army doctor named Thomas DeLorme, helping injured soldiers rebuild weak legs, organized exercise into **sets** of about 10 **repetitions** and added a little resistance as each patient grew stronger. His patients recovered faster than with endless light exercise. Since then, studies have shown the same pattern again and again: muscles grow stronger when they are asked to do a little more than they are used to, given time to recover, and asked again. That is **progressive overload**. The Daily Dozen done the same way forever keeps you moving; adding a little more each week makes you stronger.

How your body works. When you work a muscle hard, its fibers are challenged and tired. During rest, especially sleep, and with protein from your meals, your body

repairs them and your nervous system learns to use more fibers at once, so next time the same work is easier. In young people, much of the early strength gain comes from that nervous-system learning: better coordination and better form. Experts in youth strength training, such as the National Strength and Conditioning Association, say that strength training is safe and good for young people when it is supervised and form comes first. Sensible guidelines for your age: 2 or 3 days a week, not on back-to-back days; 1 to 3 sets of each exercise; 8 to 15 repetitions per set, ending each set when 2 or 3 more good reps would be hard; 1 to 2 minutes of rest between sets; and progress slowly, first adding reps, then a set, and only then a little load. Never test the most you can lift once.

Good form. Squat: feet shoulder-width, chest up, sit back, knees over toes. Push-up: straight body from head to heels or knees, elbows angled back about 45 degrees. Row: back flat, pull elbows back and squeeze shoulder blades together. Lunge: long step, back knee drops straight down, front knee over the ankle. Glute bridge: feet flat, push through heels, lift hips until knees, hips and shoulders line up. Plank: straight line, eyes down. Move slowly (about 2 seconds down, 1 second up), breathe out on the effort, and stop any exercise that hurts a joint.

Try it. This week you will learn a six-exercise plan with a backpack or water jugs, find the right starting level for each exercise, write a two-week plan with sets, reps and rest, and record every set.

PICTURE STUDY



The Wood Sawyers, Jean-François Millet, About 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 painted country people at their daily labor. Here two sawyers cut a felled tree into planks with a long saw, pulling it back and forth stroke after stroke, while a woodcutter works behind them. Work like this built great strength and endurance long before anyone wrote a training plan.

Look closely

- Look at the sawyer on the right. How are his legs placed, and how is he using his back, hips and arms together?
- Find the second sawyer. How must the two men work together for the saw to cut?
- Find the man with the axe in the background. Which muscles does chopping use?
- Look at the size of the log. How many strokes do you think it takes to cut through it?

Talk about it

1. Sawing is done in strokes, with short rests to straighten up and breathe. How is that like doing sets, reps and rest?

2. These men grew strong by doing a little more work day after day. What does that teach about progressive overload?
3. Why is good form, like the sawyer's braced stance, just as important in hard work as in exercise?

Safety first. Strength work at this age uses body weight, a backpack with a few books, water jugs or a light band, never maximum lifts. Keep your back flat, move slowly, rest between sets, and stop at joint pain, sharp pain, dizziness or trouble breathing. Check that chairs and steps are sturdy and will not slide, and train with a parent nearby.

ACTIVITY

My Two-Week Strength Plan

Walter Camp gave people a routine; DeLorme showed how to make a routine grow. You will write a plan with sets, reps and rest, find the right starting level for each exercise, and add a little each session.

You will need

- A backpack and 2–5 books, or two half-gallon or gallon water jugs with handles
- A sturdy chair against a wall, a step, a towel or mat, and a timer
- A light resistance band (optional)
- Fitness journal with a training table: date, exercise, level or load, set 1, set 2, set 3, rest, effort (1–10)

Steps

1. **Choose your six exercises.** (1) Squat (body weight, or hugging the backpack to your chest). (2) Push-up (wall, chair or knee level, or full). (3) Bent-over row (backpack or jug in one hand, other hand and knee on a chair, back flat; or a band looped around a sturdy post). (4) Reverse lunge (step back, alternate legs). (5) Glute bridge (body weight, or the backpack resting on your hips). (6) Plank (forearms; hold in seconds).
2. **Find your level.** After the Ling Ten warm-up, try one set of each. Choose the level or load at which you can do 8 to 15 good reps and the last 2 or 3 feel hard. If you can do more than 15 easily, choose a harder version; if fewer than 8, an easier one. For the plank, find the time you can hold with good form.
3. **Write the plan.** Two weeks, 3 strength days a week with at least one day between (for example Monday, Wednesday, Friday). Each day: 2 sets of each exercise in Week 1 and 3 sets in Week 2, with 60–90 seconds of rest between sets. On the other days, do your aerobic activity and active play.
4. **Progress rule.** When you can do 15 good reps on every set of an exercise, make it a little harder next time: add a book, move to the next push-up level,

or slow the lowering to 3 seconds. For the plank, add 5 seconds when you can hold every set for your target time.

5. **Session 2: Day 1.** Warm up, then do your plan in order with a timer for rest. Record the reps for every set and an effort rating. A partner watches one form cue for each exercise.
6. **Camp's cool-down.** End every session with a short version of the Daily Dozen spirit: 2 minutes of easy walking, then your five static stretches and 10 slow arm circles.
7. **Session 3: Day 2.** Repeat, using your progress rule. Compare every set with Day 1 and circle each improvement.
8. **Keep going.** Follow the plan for the full two weeks as your unit challenge, recording every session.

Tips

- Rest really matters. If your form breaks down in a set, stop the set; rest longer before the next one.
- Sleep and meals are part of training. Muscles rebuild overnight with protein from real food.
- Soreness a day or two after a new exercise is normal and fades. Sharp pain or joint pain is not; stop and tell an adult.

Check your work

- ☐ I can tell how Walter Camp's Daily Dozen and DeLorme's sets and reps shaped strength training.
- ☐ I can explain sets, reps, rest and progressive overload, and the safe guidelines for my age.
- ☐ I wrote a two-week plan and recorded every set honestly with good form.

FITNESS JOURNAL

1. Copy your two-week plan as a calendar showing strength days, rest and aerobic days.
2. Keep the training table for each session: exercise, level or load, reps for each set, rest and effort.
3. Draw a stick figure doing each of your six exercises with one form cue written beside it.

4. After the first week, write which exercise improved most and what you changed using the progress rule.

From history. Walter Camp's Daily Dozen reached the new medium of radio in 1922, when morning exercise broadcasts began inviting listeners to exercise along at home. Camp died in 1925, but morning exercise programs on radio and later television continued for decades.

COMMON MISTAKES

- Adding load before mastering form. Reps and good form come first; load comes last and in small steps.
- Training the same muscles hard every day. Muscles grow stronger during rest.
- Rushing through reps or holding your breath. Move slowly and breathe out on the effort.
- Trying to find the most you can lift once. Young athletes build strength safely with sets of 8–15 reps.

Make it a game · Set Rep Rest Plan. Design a two-week plan on paper using one bodyweight move, with reps, sets and rest interval. Your parent plays a coach and asks why each number. Defend your plan with progressive overload and safe guidelines for your age. Then do one set and report how it felt. She scores your reasons.

Scripture. “And every man that striveth for the mastery is temperate in all things.” (1 Corinthians 9:25, KJV)

Paul knew athletes trained with self-control in everything: training, rest, food and sleep. Steady, patient training, a little more each week, is a picture of the self-control God works in us.

UNIT 4

STRENGTH

Every movement you make is a muscle pulling on a bone. More than three hundred years ago an Italian scientist named Giovanni Alfonso Borelli looked at the arm and saw a machine: bones as levers, joints as pivots, muscles as the force that moves them. His great book *On the Motion of Animals*, published in 1680 and 1681, showed something surprising: most of your muscles work at a mechanical disadvantage, pulling many times harder than the weight in your hand. In this unit you will learn how muscles, tendons and bones work together, build a model of the biceps as a third-class lever, and feel the lever principle in your own arm and leg.

Then you will learn how strength is trained. During the First World War, Walter Camp, the famous Yale football coach, made up a short daily routine of twelve exercises for servicemen, the “Daily Dozen,” and millions of people later did it at home. Today coaches organize strength training into sets, repetitions and rest, adding a little at a time. You will write and follow a two-week plan using your body weight, a backpack with books, water jugs or a light resistance band, and measure your improvement.

PREREQUISITES

- Knows the dynamic warm-up and static cool-down (Unit 1)
- Knows good form for the squat, push-up and plank
- Can multiply and divide, and use a ruler

MASTERY CHECKLIST

- ☐ I can tell how Giovanni Borelli explained muscles and bones as levers.
- ☐ I can name the parts of a lever and the three classes of levers, with an example of each in the body.
- ☐ I can explain how a tendon connects muscle to bone and why the biceps must pull much harder than the load in the hand.
- ☐ I can explain sets, repetitions, rest and progressive overload, and the safe guidelines for strength training at my age.
- ☐ I can follow a two-week strength plan with good form and record my improvement.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“Strength Training” (Nemours TeensHealth):** Free. A sensible article for young people on safe strength training, form and rest. Read it with Lesson 4.2.
- **“Your Muscles” (Nemours KidsHealth):** Free. A clear review of how muscles, tendons and bones work together. Fits Lesson 4.1.
- **A light resistance band:** Optional. A light, looped exercise band adds resistance to rows, presses and squats in Lesson 4.2. Choose a light one and check it for nicks before every use.

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 Muscles, Tendons and Levers: Borelli’s Machine

3 sessions of 40–45 minutes

4.2 Sets, Reps and Rest: Walter Camp’s Daily Dozen

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

Who was Giovanni Alfonso Borelli, and what did his book *On the Motion of Animals* explain?

2. 5 pts

Name the three parts of a lever and tell what each one is in the human arm.

3. 5 pts

Give one example from the body of a first-class, a second-class and a third-class lever.

4. 5 pts

A biceps attaches 2 inches from the elbow. A student holds a 6-pound water jug 13 inches from the elbow. About how hard must the biceps pull?

5. 5 pts

What is the difference between a tendon and a ligament? Why should load be added slowly?

6. 5 pts

Define a repetition, a set and a rest interval, and explain progressive overload.

7. 5 pts

Jada did 3 sets of squats: 12, 11 and 10 reps on Monday, and 14, 13 and 12 on Friday. What were her total reps each day, and by what percent did her total increase?

8. 5 pts

List four safe guidelines for strength training at your age.

9. (5 pts)

What was Walter Camp's Daily Dozen, and what would happen if someone did it exactly the same way every day for years?

10. (5 pts)

Short answer: In three or four sentences, explain why rest, sleep and food are part of strength training, and connect it to 1 Corinthians 9:25.

ANSWER KEY

1. An Italian mathematician and scientist (1608–1679), a follower of Galileo. His book, published in 1680–1681, explained the movements of animals and people with mathematics, showing bones as levers, joints as fulcrums and muscles as the effort; he is called the father of biomechanics.
2. Fulcrum: the elbow joint. Effort: the biceps pulling through its tendon. Load: the forearm and hand plus anything held.
3. First-class: nodding the head (neck joint between face and neck muscles). Second-class: rising onto the toes (ball of foot as fulcrum, body weight in the middle, calf pulling the heel). Third-class: biceps bending the elbow.
4. $\text{Effort} \times 2 = 6 \times 13 = 78$, so $\text{effort} = 78 \div 2 = 39$ pounds.
5. A tendon connects muscle to bone; a ligament connects bone to bone. Tendons and ligaments strengthen more slowly than muscles, so adding load gradually protects them.
6. A rep is one complete movement; a set is a group of reps done without stopping; a rest interval is the pause between sets. Progressive overload means making training a little harder over time (more reps, another set, a harder version or a little more load) so the body keeps adapting.
7. Monday: $12 + 11 + 10 = 33$. Friday: $14 + 13 + 12 = 39$. Increase = 6; $6 \div 33 \approx 0.18$, about an 18% increase.
8. Any four: supervised, with form first; 2–3 days a week on non-consecutive days; 1–3 sets of 8–15 reps; 1–2 minutes of rest between sets; progress slowly (reps, then sets, then load); never test a one-rep maximum; stop at joint or sharp pain.
9. A routine of twelve simple exercises taking about eight minutes, created during World War I for servicemen and later done at home. Done the same way forever, it would keep a person active and maintain fitness, but strength would stop increasing because there is no progressive overload.
10. Answers will vary. A good answer explains that muscles are challenged during training but rebuilt during rest and sleep with protein and energy from food, so skipping rest slows progress and invites injury; and that Paul says those who strive for mastery are temperate (self-controlled) in all things, including training, rest and eating.

UNIT CHALLENGE: MY TWO-WEEK STRENGTH CHALLENGE

Follow your two-week strength plan from Lesson 4.2: three sessions a week, with the dynamic warm-up and the cool-down every time. Record every set in your training table, use the progress rule, and on the last day retest one set of each exercise at your Day 1 level. Make a before-and-after bar graph of reps (and plank seconds) for all six exercises, and write a one-page reflection on what improved, what you changed and how you felt about training a little more each week.

LOOK FOR	WHAT IT MEANS
Plan	The plan follows the safe guidelines: 2–3 non-consecutive days, 1–3 sets of 8–15 reps, rest between sets, and slow progression.
Complete records	Every session recorded with level or load, reps for each set, rest and effort rating.
Good form	A parent confirms that form cues were followed and loads stayed light and safe.
Retest and graph	A neat before-and-after graph for all six exercises using the same level as Day 1.
Reflection	A thoughtful page about improvement, changes made using the progress rule, and the role of rest and self-control.

UNIT 5

AEROBIC TRAINING

In the 1960s an Air Force doctor named Kenneth Cooper wanted a simple way to measure how fit a person's heart and lungs were, without a laboratory full of machines. His answer was beautifully plain: see how far you can run, or run and walk, in 12 minutes. In 1968 he published his book *Aerobics*, giving a new word to the world and starting a running and walking movement that spread across America. In this unit you will learn how the heart, lungs and blood deliver oxygen to working muscles, what “aerobic” means, and why steady training makes the heart stronger and the resting heart rate lower. You will run your own 12-minute test, chart your laps, and retest a week later.

Then you will learn to train by heart rate. Around 1970 two heart researchers, Dr. Samuel Fox and Dr. William Haskell, drew a simple line through other scientists' data that gave the famous estimate “220 minus your age” for the highest heart rate a person can reach. You will learn what that estimate means and its limits, find your own moderate and vigorous heart-rate zones, check your pulse during exercise, and plan a week of aerobic training. The quarter ends with a family fitness day that you plan and lead.

PREREQUISITES

- Can find a pulse at the wrist or neck and count it accurately
- Can multiply and divide, find a percentage and convert yards to miles
- Knows the talk test, the FITT principle and the dynamic warm-up (Unit 1)

MASTERY CHECKLIST

- ☐ I can tell how Kenneth Cooper created the 12-minute test and the idea of aerobics.
- ☐ I can explain how the heart, lungs and blood deliver oxygen to muscles, and why training lowers the resting heart rate.
- ☐ I can run a 12-minute test, calculate my distance and lap pace, and retest.
- ☐ I can estimate my maximum heart rate, explain its limits, and calculate my moderate and vigorous zones.
- ☐ I can plan a week of aerobic training and lead a family fitness day.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“Your Heart and Circulatory System” (Nemours TeensHealth)**: Free. A clear article on how the heart, blood vessels and pulse work. Read it with Lesson 5.1.
- **A jump rope**: Optional. A great aerobic workout for rest-day activity and the family fitness day. Size it so the handles reach your armpits when you stand on the middle.
- **A stopwatch with a lap button**: Optional. Makes lap times in the 12-minute test easy. A phone stopwatch works the same way.

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 Kenneth Cooper and the 12-Minute Run

3 sessions of 40–45 minutes

5.2 Target Heart Rate, Simply

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)

What problem was Kenneth Cooper trying to solve with the 12-minute test, and how did he show that it worked?

2. (5 pts)

What does “aerobic” mean? Give three examples of aerobic exercise.

3. (5 pts)

Trace the path of oxygen from the air to a working leg muscle.

4. (5 pts)

Why does aerobic training lower the resting heart rate?

5. (5 pts)

Eli ran $7\frac{1}{2}$ laps of a 437-yard track in 12 minutes. How many yards did he cover? About how many miles? What was his average time per lap?

6. (5 pts)

Where did the formula “220 minus age” come from, and what are its limits?

7. (5 pts)

Calculate the estimated maximum heart rate and the moderate zone (64–76%) for a 12-year-old. What 10-second counts match that zone?

8. (5 pts)

During a run, Grace counted 29 beats in 10 seconds. What is her heart rate? Is she in the moderate or vigorous zone for an 11-year-old (moderate 134–159, vigorous 161–194)?

9. (5 pts)

What would happen if a runner started a 12-minute test with a lap far faster than his usual pace? Explain using what you know about oxygen and pacing.

10. **5 pts**

Short answer: In three or four sentences, explain what Hebrews 12:1 means by running “with patience,” and how that idea fits aerobic training.

ANSWER KEY

1. He wanted a simple way to measure heart-and-lung fitness without an expensive laboratory treadmill test. He had 115 Air Force men take both the lab test and the 12-minute run; those who went farther in 12 minutes were almost always the ones who could use the most oxygen, so the distance could stand in for the lab test.
2. “With oxygen”: steady exercise that can be kept up a long time because the heart and lungs supply enough oxygen. Examples: jogging, brisk walking, cycling, swimming, jumping rope, skating.
3. Air is breathed into the lungs; oxygen passes into the blood in tiny vessels; blood goes to the heart, which pumps it through the arteries to the leg muscle, where oxygen is delivered; the veins carry blood back to the heart and lungs.
4. Training makes the heart muscle stronger so it pumps more blood with each beat (larger stroke volume). Since each beat delivers more blood, the heart does not need to beat as often at rest.
5. $7.5 \times 437 = 3,277.5$ yards. $3,277.5 \div 1,760 \approx 1.86$ miles. $720 \text{ seconds} \div 7.5 \text{ laps} = 96$ seconds per lap (1 minute 36 seconds).
6. Drs. Samuel Fox and William Haskell drew a line through data from about a dozen earlier studies around 1970. It was a quick estimate, not a new experiment. Real maximum heart rates vary widely between people of the same age, and in young people the maximum stays high (often about 200 or more) instead of falling each year.
7. $220 - 12 = 208$. $208 \times 0.64 \approx 133$; $208 \times 0.76 \approx 158$. Moderate zone $\approx 133\text{--}158$ bpm. 10-second counts: $133 \div 6 \approx 22$ and $158 \div 6 \approx 26$, so about 22–26 beats.
8. $29 \times 6 = 174$ beats per minute, which is in the vigorous zone.
9. He would quickly use more energy than his heart and lungs could supply with oxygen, become very out of breath, and have to slow down a lot or walk, usually covering less distance than with an even pace.
10. Answers will vary. A good answer says that patience means steady endurance over a long course rather than a burst of speed; that aerobic training is built the same way, through steady, faithful work and wise pacing over weeks; and that the Christian life is a long race run with our eyes on Christ.

UNIT CHALLENGE: MY ZONE TRAINING WEEK AND FAMILY FITNESS DAY

Complete the five-day training week you planned in Lesson 5.2, recording minutes, two heart-rate checks per session and an effort rating, and finish with your 12-minute retest. Then plan, lead and report on the family fitness day with stations from all five units. Put together a final page for your fitness journal with your zone card, a graph of heart rates from your training week, your two 12-minute results, and your three biggest improvements of the quarter.

LOOK FOR	WHAT IT MEANS
Training week	Five sessions recorded honestly with minutes, heart-rate checks in the right zones and effort ratings, plus two rest or light days.
Accurate zones	The zone card is calculated correctly with work shown, including 10-second counts.
Family fitness day plan	A clear schedule with a warm-up, stations from all five units, water and shade, a lower-sugar snack and a cool-down.
Leadership	The student explained each station, showed good form, kept everyone safe and encouraged each person at his or her own pace.
Quarter summary	A final page with graphs, 12-minute results and three improvements, measured against the student's own earlier numbers.

5.1 KENNETH COOPER AND THE 12-MINUTE RUN

OBJECTIVES

- Tell how Kenneth Cooper developed the 12-minute test and published *Aerobics* in 1968.
- Explain how the heart, lungs and blood deliver oxygen to working muscles, and what aerobic means.
- Explain why aerobic training strengthens the heart and lowers the resting heart rate.
- Run a 12-minute test, calculate distance and lap pace, and retest with a more even pace.

Warm-up. Before you get up, take your resting pulse for 30 seconds and multiply by 2. Then do the Ling Ten dynamic warm-up and 2 minutes of easy jogging. Take your pulse again for 10 seconds and multiply by 6. Think about it: why does your heart beat faster when your legs work harder? What are your muscles asking for?

WATCH

Kenneth H. Cooper and The Institute For Aerobics Research - September 1971

SMU Jones Film · 4:51

<https://www.youtube.com/watch?v=oeS80LqlluU>

WHEN TO WATCH

After the story paragraph. Listen for why Dr. Cooper started his institute and what he hoped aerobic exercise would do.

Note: A 1971 Dallas television news film from Southern Methodist University's film archive, showing Dr. Cooper the year after he left the Air Force, with runners on his new track. The picture and sound are old.

BACKUP VIDEO

Dr. Kenneth Cooper on 50th anniversary of "Aerobics"

The Dallas Morning News · 1:37

https://www.youtube.com/watch?v=T0_gt4mE5wg

After the lesson, to see Dr. Cooper, still exercising in his eighties, talking about the book fifty years later.

KEY TERMS

aerobic

“With oxygen.” Aerobic exercise is steady activity, such as brisk walking, jogging, biking or swimming, that the body can keep up for a long time because the heart and lungs supply enough oxygen.

resting heart rate

How many times your heart beats in a minute when you are calm and still. It usually falls as aerobic fitness improves.

cardiorespiratory endurance

The ability of the heart, lungs and blood vessels to supply oxygen to working muscles for a long time.

stroke volume

The amount of blood the heart pumps with each beat. Training makes the heart muscle stronger, so it pumps more per beat.

pace

How long it takes to cover a set distance, such as minutes per lap or per mile. An even pace spreads your effort wisely.

CORE IDEAS

The story. Kenneth Cooper was born in Oklahoma City in 1931. He became a doctor and served in the U.S. Army and then the Air Force, where in the 1960s he worked in San Antonio, Texas, studying the fitness of pilots and airmen. Many men who looked healthy were out of shape, and heart disease was a leading cause of death in America. The best measure of heart-and-lung fitness was a laboratory treadmill test that measured how much oxygen a person could use, but it needed expensive machines and trained staff. Cooper wanted a test anyone could take on a track with a stopwatch.

How they figured it out. Cooper had 115 Air Force men take the laboratory treadmill test, and also had each of them run, or run and walk, as far as he could in 12 minutes. When he compared the two, the men who covered more distance in 12 minutes were, almost every time, the ones who could use the most oxygen in the laboratory. So the simple distance could stand in for the expensive test. He published his results in a medical journal in 1968, the same year his book *Aerobics* came out. Cooper had coined the word “aerobics” to mean any steady exercise that trains the heart and lungs: running, walking, swimming, cycling. He gave points for each kind of exercise so people could plan a week of training, and the book sold millions of copies. In 1970 he left the Air Force and opened a research institute in Dallas, which later created the FitnessGram tests used in many schools.

How your body works. Your muscles release energy from food fastest and longest when they have oxygen. You breathe air into your **lungs**, where oxygen passes into tiny blood vessels. Your **heart**, a muscular pump about the size of your fist, pushes that oxygen-rich blood out through the arteries to your muscles, and the veins bring blood back for more. When you run, your muscles need many times more oxygen than at rest, so you breathe faster and deeper and your heart beats faster and harder. Aerobic training slowly changes the body: the heart muscle grows stronger and pumps more blood with each beat (a larger **stroke volume**), so at rest it does not need to beat as often; the muscles grow more tiny blood vessels and more of the cell

parts that use oxygen. That is why a well-trained endurance athlete may have a resting heart rate in the 50s or lower, while an average resting rate at your age is about 70 to 100 beats per minute.

Pace it. In a timed run, most beginners start too fast, run out of breath and slow to a shuffle. An even pace covers more ground. Start at an effort that feels steady (you can say a few words), use the first lap to settle in, and save any extra speed for the last two minutes. Walking breaks are allowed; walk briskly and start jogging again at a landmark.

Try it. This week you will run or run-walk your own 12-minute test on a measured loop, record your laps, calculate your distance and pace, train with steady runs and intervals, and retest a week later with a more even pace.

PICTURE STUDY



The Skating Minister (Rev. Robert Walker Skating on Duddingston Loch), Attributed to Sir Henry Raeburn, About 1790s · Oil on canvas · Scottish National Gallery, Edinburgh

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

The Reverend Robert Walker was a minister of the Church of Scotland and a member of the Edinburgh Skating Club, one of the first skating clubs in the world. In this famous painting he glides over the frozen Duddingston Loch near Edinburgh, calm and balanced, arms folded, as if skating were the easiest thing in the world.

Look closely

- Look at his position: his body leans forward, one leg stretches back. How does he keep his balance?
- His arms are folded. What does that tell you about how steady and smooth his skating is?
- Look at the faint marks in the ice. What do they show about his path?
- What is he wearing? How does it compare with what you wear to exercise?

Talk about it

1. Is long-distance skating an aerobic exercise? What would his heart and lungs be doing?
2. A skilled skater glides at an even pace. How is that like pacing a 12-minute run?

3. A minister enjoying healthy exercise on a winter afternoon: why might that have pleased the painter and the people who saw it?

Safety first. Run in daylight on a safe track, path or yard away from traffic, with an adult or buddy, in good running shoes. Warm up first and walk for at least 3 minutes after you finish; walking during the test is always allowed. On hot days run early or late and carry water. Stop and tell an adult right away at chest pain, dizziness, faintness, trouble breathing or sharp pain.

ACTIVITY

My 12-Minute Test and Retest

Cooper found that the distance you can cover in 12 minutes is a good window into how well your heart and lungs deliver oxygen. You will run your own test, chart every lap and see how training and better pacing change your result. Your only competitor is yourself.

You will need

- A measured loop: a school track (400 meters, or about 437 yards, per lap) or a route around a block, park or yard measured with a map app or a car odometer and marked with chalk or cones
- A stopwatch with a lap button, a helper to count laps and call time, and a whistle or loud voice for the end
- Water bottle, good running shoes and fitness journal with a lap chart

Steps

1. **Measure your loop.** Write the length of one lap in yards or meters. Put a cone every quarter lap so you can measure a partial lap at the end.
2. **Session 2: the test.** Warm up for 8–10 minutes: walking, the Ling Ten and two easy laps. Then start the stopwatch and run or run-walk as far as you can at a steady effort for exactly 12 minutes. Your helper presses the lap button each time you pass the start and calls out the time every 3 minutes.
3. When the helper calls “stop,” stand still while the helper marks your spot to the nearest quarter lap. Walk for 3–5 minutes to cool down, drink water and stretch your calves, thighs and hamstrings.
4. **Calculate.** Distance = full laps $\times$ lap length + the partial lap. Change to miles (1 mile = 1,760 yards). Example: $6\frac{3}{4}$ laps of a 437-yard track = $6.75 \times 437 \approx 2,950$ yards ≈ 1.68 miles. Find your average lap time (720 seconds $\div$ laps), and compare your fastest and slowest laps.
5. Take your pulse for 10 seconds right after you stop ($\times 6$) and again after 2 minutes of walking. Record both.
6. **Train between tests (3 sessions over the week).** Day A: 20 minutes of steady jogging or run-walking at a talk-test effort. Day B: intervals, 6 rounds of 1

minute of faster running and 2 minutes of walking. Day C: 30 minutes of any aerobic activity you enjoy (biking, swimming, jumping rope, brisk hiking).

7. **Session 3: the retest.** At least a week after the first test, warm up the same way and run the 12 minutes again on the same loop. Plan an even pace: aim for each lap to be within a few seconds of your planned lap time, which is your first test's average lap or a little faster.
8. Make a bar graph of your lap times for both tests side by side, and write your distance for each. Were your laps more even? Did your distance or your recovery heart rate improve?

Tips

- Hold back on the first lap. It should feel easier than you think it ought to.
- Relax your shoulders and hands, swing your arms forward and back, and breathe in a steady rhythm.
- If you walk, walk briskly with long steps and start jogging again at the next cone.

Check your work

- ☐ I can tell how Kenneth Cooper created the 12-minute test and what aerobic means.
- ☐ I can explain how training makes the heart stronger and lowers the resting heart rate.
- ☐ I ran the test, calculated my distance and pace, trained during the week and retested.

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1. Draw the path of blood: lungs → heart → arteries → muscles → veins → heart → lungs, with arrows and a label where oxygen is picked up and where it is delivered.
2. Copy your lap chart for both tests, with your distance in yards and miles and your average lap time.
3. Record your training week: day, activity, minutes, effort rating and pulse after exercise.
4. Write a short paragraph: How did pacing change your result? What will you do differently next time?

From history. Cooper's point system let people choose their exercise: running, swimming, cycling, walking and other sports each earned points by distance and time, with a goal of about 30 points a week. Dr. Cooper continued to exercise and to teach about prevention well into his nineties.

COMMON MISTAKES

- Sprinting the first lap. An even pace covers more distance.
- Skipping the cool-down. Walk until your breathing settles so blood does not pool in your legs.
- Comparing your distance with a brother, sister or friend. Your test measures your own heart and lungs against your own earlier test.
- Running only fast. Steady, easier runs build the base of aerobic fitness.

Make it a game · Twelve Minute Test. Run or walk laps for twelve minutes, counting each lap as Kenneth Cooper's test would. Your parent counts laps and records resting heart rate before and after. Explain what aerobic means and how oxygen travels. Retest in a week and aim to beat your laps. Record the numbers in a small table.

Scripture. “let us run with patience the race that is set before us” (Hebrews 12:1, KJV)

The Christian life is pictured as a long race, not a sprint. It is run with patience, a steady pace and our eyes on Christ, as the next verse says.

5.2 TARGET HEART RATE, SIMPLY

OBJECTIVES

- Tell how the estimate “220 minus age” for maximum heart rate came about, and explain its limits.
- Calculate estimated maximum heart rate and moderate and vigorous heart-rate zones.
- Check heart rate during exercise with a 10-second count, and compare it with the talk test and an effort rating.
- Plan a week of aerobic training using heart-rate zones, and plan and lead a family fitness day.

Warm-up. Take your resting pulse for 30 seconds ($\times 2$). Do the Ling Ten and then 2 minutes of jogging or jumping jacks. Take a 10-second pulse ($\times 6$). Now jog in place as fast as you comfortably can for 30 seconds and take a 10-second pulse again. Think about it: how high can a heart rate go? Is there a limit?

WATCH

Do You Have a Maximum Heart Rate?

SciShow • 2:44

<https://www.youtube.com/watch?v=0on5LV3k26o>

WHEN TO WATCH

After the story paragraph. Listen for why the heart cannot beat faster than a certain rate and where the “subtract your age” estimate comes from.

Note: A short science explainer for older students and adults.

BACKUP VIDEO

FINDING YOUR TARGET HEART RATE ZONE

MS LOLA TEACHER • 5:24

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

Before the activity, to see the zone calculation worked step by step.

KEY TERMS

maximum heart rate

The highest number of times your heart can beat in a minute during all-out effort. It is often estimated as 220 minus your age, but real values vary from person to person.

target heart-rate zone

A range of heart rates to aim for during exercise. The CDC describes moderate exercise as about 64–76% of maximum heart rate and vigorous exercise as about 77–93%.

rating of perceived exertion (RPE)

A number you give to how hard exercise feels, for example 1 (very easy) to 10 (as hard as possible). Moderate is about 5–6; vigorous is about 7–8.

recovery heart rate

How quickly your heart rate falls after exercise stops. A faster drop is a sign of better aerobic fitness.

CORE IDEAS

The story. In the late 1960s, doctors in America were beginning to prescribe exercise for people with heart trouble and for healthy people who wanted to stay well. They needed a rule of thumb: how fast should a person's heart beat during exercise? Dr. Samuel Fox, a heart specialist, and Dr. William Haskell, an exercise scientist, were studying how physical activity helps prevent heart disease. Around 1970 they gathered the results of about a dozen earlier studies that had measured the highest heart rates of people of different ages.

How they figured it out. When Fox and Haskell plotted the numbers, they saw that maximum heart rate tended to fall with age, and they drew a line through the points that could be written very simply: **maximum heart rate $\approx 220 - \text{age}$** . They did not run a new experiment; it was a quick estimate from other people's data, and Haskell later said it was never supposed to be an absolute guide. Yet it was so easy to remember that it spread to textbooks, gyms and heart-rate monitors around the world. Later studies found that real maximum heart rates vary a great deal: two healthy people of the same age can differ by 20 beats per minute or more, and in children and teens the maximum heart rate stays high, often around 200 or more, rather than falling each year. So the formula is a useful starting point, not a law, and your own breathing and effort are good guides too.

How your body works. Your heartbeat starts in a small cluster of special cells in the heart called its natural pacemaker. When you exercise, nerves and hormones signal it to fire faster, and the heart muscle contracts harder. The heart cannot beat infinitely fast, though: after every beat it needs a fraction of a second for its chambers to refill with blood. Training does not raise your maximum heart rate much, but it raises how much blood you pump at every heart rate, so you can do more work at the same heart rate. To find your zones, first estimate your maximum: for a 12-year-old, $220 - 12 = 208$ beats per minute. **Moderate** exercise is about 64–76% of that ($208 \times 0.64 \approx 133$ to $208 \times 0.76 \approx 158$), and **vigorous** exercise is about 77–93% (about 160 to 193). During exercise, count your pulse for 10 seconds and multiply by 6, or use the talk test or an effort rating from 1 to 10.

Think it through. A number is a tool, not a master. On a hot day, after poor sleep or when you are getting sick, your heart rate runs higher at the same speed, so slow down. If your count seems far off from how you feel, trust how you feel and tell an adult if anything feels wrong. The goal is not to chase a number but to train faithfully and wisely.

Try it. This week you will calculate your zones, test them during walking, jogging and running, compare your heart rate with your effort rating and the talk test, plan a training week, and plan and lead a family fitness day.

PICTURE STUDY



Max Schmitt in a Single Scull, Thomas Eakins, 1871 · Oil on canvas · The Metropolitan Museum of Art, New York

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

Thomas Eakins painted his friend Max Schmitt, a champion rower, on the Schuylkill River in Philadelphia in the autumn of 1871, not long after Schmitt had won a race there. Eakins himself appears in the painting, rowing a second scull farther off.

Look closely

- Find Max Schmitt. Is he racing or resting at this moment? How can you tell?
- Find the second rower in the distance, the painter himself. What is he doing?
- Look at the water. How calm is it, and what does that tell you about the weather?
- Find the bridges and the trees. What season is it?

Talk about it

1. Rowing a long distance is aerobic exercise. What would Max's heart rate be doing during a race, and now as he rests?
2. How could a rower use a target heart-rate zone to train for a race?
3. Eakins and Schmitt rowed together as friends. How can training with family or friends help you keep going?

Safety first. Count your pulse gently with two fingers, never with your thumb, and never press hard on both sides of the neck. Work up to vigorous effort gradually; you do not need to reach your maximum heart rate, and you should never try. Stop and tell an adult at chest pain, dizziness, faintness, a racing or fluttering heartbeat that does not settle, or trouble breathing.

ACTIVITY

Zone Training Week and the Family Fitness Day

You will turn the zone numbers into a real week of training, checking your heart rate, effort and breathing together, and then gather your family for a fitness day that brings together everything you have learned this quarter.

You will need

- A stopwatch or phone timer, a measured loop or safe walking route, and a jump rope if you have one
- Fitness journal with a zone card: estimated maximum, moderate zone and vigorous zone in beats per minute and in 10-second counts
- For the family fitness day: cones or chalk, water and cups, a lower-sugar snack you prepare, and a written plan

Steps

1. **Make your zone card.** Estimated maximum = $220 - \text{your age}$. Moderate = 64% to 76% of that; vigorous = 77% to 93%. Divide each number by 6 to get the 10-second count. Example for age 11: maximum 209; moderate about 134–159 (22–26 beats in 10 seconds); vigorous about 161–194 (27–32 beats).
2. **Session 2: the zone test.** After the Ling Ten, do 4 stages of 3 minutes each with 1 minute of easy walking between: (1) easy walk, (2) brisk walk, (3) steady jog, (4) faster running or jumping rope. At the end of each stage, stop and take a 10-second pulse at once, rate your effort (1–10) and do the talk test (could you sing, talk or only say a few words?).
3. Record each stage in a table and draw a bar graph of heart rate with lines across for your moderate and vigorous zones. Which stage put you in each zone? Did your effort ratings and talk test agree with the numbers?
4. **Plan a training week.** Using FITT, write 5 days of aerobic training: at least 3 days with 20–30 minutes in the moderate zone (steady jog, bike, brisk hike), 2 days with intervals that reach the vigorous zone (for example 6×1 minute fast, 2 minutes easy), and 2 days of rest or light play. Add your strength days from Unit 4.

5. Follow the week, checking your pulse twice in each session and recording heart rate, effort and minutes.
6. **Plan the family fitness day.** Write a schedule for about an hour: (1) you lead the Ling Ten warm-up (Unit 1); (2) a water and shade station with your hot-day plan (Unit 2); (3) a snack station with a lower-sugar snack you prepare (Unit 3); (4) a strength station with squats, push-ups at every level and a plank (Unit 4); (5) a family 12-minute walk-run where each person counts laps and checks a pulse (Unit 5); (6) a cool-down walk and stretches, and a prayer of thanks.
7. **Session 3: lead it.** Hold the family fitness day. Explain each station, show good form, and encourage everyone to work at his or her own pace and zone. Take your pulse at each station.
8. Afterward, write what went well, what you would change, and one thing each family member enjoyed. Look back over your whole fitness journal and circle your three biggest improvements this quarter.

Tips

- Count the pulse within 15 seconds of stopping; it starts to fall quickly.
- If you cannot find your pulse at the wrist, try the side of the neck, just beside the windpipe, pressing gently on one side only.
- Keep the family day joyful. Everyone moves at his or her own pace; the point is to enjoy being active together.

Check your work

- ☐ I can explain where “220 minus age” came from and why it is only an estimate.
- ☐ I can calculate my moderate and vigorous zones and check my heart rate during exercise.
- ☐ I planned and followed a training week and led a family fitness day.

FITNESS JOURNAL

1. Copy your zone card and your zone-test table, and draw the bar graph with the zone lines.
2. Record your training week: day, activity, minutes, two heart-rate checks and an effort rating.

3. Write your family fitness day schedule and, afterward, a short report of how it went.
4. Write a letter to yourself to read next year: your three biggest improvements this quarter and the habits you want to keep.

From history. Fox and Haskell's line was published in 1971 in a paper on physical activity and the prevention of heart disease. Later researchers proposed other formulas, such as $208 - 0.7 \times \text{age}$, but the simple "220 minus age" remains the best known.

COMMON MISTAKES

- Treating 220 minus age as exact. It is an estimate, and young people's real maximums vary widely.
- Trying to reach your maximum heart rate. Training happens well below it.
- Pressing hard on the neck or using the thumb to count. Use two fingers gently on one side.
- Ignoring how you feel because the number looks fine. The talk test and your effort rating matter too.

Make it a game • Zone Calculation Race. Calculate 220 minus your age, then find the moderate zone at fifty to seventy percent and vigorous at seventy to eighty-five percent. Race your parent to finish the math. Then explain the limits of the formula. Jog two minutes, count your pulse and say which zone you hit. Beat your accuracy next time.

UNIT 5

AEROBIC TRAINING

In the 1960s an Air Force doctor named Kenneth Cooper wanted a simple way to measure how fit a person's heart and lungs were, without a laboratory full of machines. His answer was beautifully plain: see how far you can run, or run and walk, in 12 minutes. In 1968 he published his book *Aerobics*, giving a new word to the world and starting a running and walking movement that spread across America. In this unit you will learn how the heart, lungs and blood deliver oxygen to working muscles, what “aerobic” means, and why steady training makes the heart stronger and the resting heart rate lower. You will run your own 12-minute test, chart your laps, and retest a week later.

Then you will learn to train by heart rate. Around 1970 two heart researchers, Dr. Samuel Fox and Dr. William Haskell, drew a simple line through other scientists' data that gave the famous estimate “220 minus your age” for the highest heart rate a person can reach. You will learn what that estimate means and its limits, find your own moderate and vigorous heart-rate zones, check your pulse during exercise, and plan a week of aerobic training. The quarter ends with a family fitness day that you plan and lead.

PREREQUISITES

- Can find a pulse at the wrist or neck and count it accurately
- Can multiply and divide, find a percentage and convert yards to miles
- Knows the talk test, the FITT principle and the dynamic warm-up (Unit 1)

MASTERY CHECKLIST

- ☐ I can tell how Kenneth Cooper created the 12-minute test and the idea of aerobics.
- ☐ I can explain how the heart, lungs and blood deliver oxygen to muscles, and why training lowers the resting heart rate.
- ☐ I can run a 12-minute test, calculate my distance and lap pace, and retest.
- ☐ I can estimate my maximum heart rate, explain its limits, and calculate my moderate and vigorous zones.
- ☐ I can plan a week of aerobic training and lead a family fitness day.

OPTIONAL BOOKS AND GEAR FOR THIS UNIT

- **“Your Heart and Circulatory System” (Nemours TeensHealth)**: Free. A clear article on how the heart, blood vessels and pulse work. Read it with Lesson 5.1.
- **A jump rope**: Optional. A great aerobic workout for rest-day activity and the family fitness day. Size it so the handles reach your armpits when you stand on the middle.
- **A stopwatch with a lap button**: Optional. Makes lap times in the 12-minute test easy. A phone stopwatch works the same way.

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 Kenneth Cooper and the 12-Minute Run

3 sessions of 40–45 minutes

5.2 Target Heart Rate, Simply

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

What problem was Kenneth Cooper trying to solve with the 12-minute test, and how did he show that it worked?

2. 5 pts

What does “aerobic” mean? Give three examples of aerobic exercise.

3. 5 pts

Trace the path of oxygen from the air to a working leg muscle.

4. 5 pts

Why does aerobic training lower the resting heart rate?

5. 5 pts

Eli ran $7\frac{1}{2}$ laps of a 437-yard track in 12 minutes. How many yards did he cover? About how many miles? What was his average time per lap?

6. 5 pts

Where did the formula “220 minus age” come from, and what are its limits?

7. 5 pts

Calculate the estimated maximum heart rate and the moderate zone (64–76%) for a 12-year-old. What 10-second counts match that zone?

8. 5 pts

During a run, Grace counted 29 beats in 10 seconds. What is her heart rate? Is she in the moderate or vigorous zone for an 11-year-old (moderate 134–159, vigorous 161–194)?

9. 5 pts

What would happen if a runner started a 12-minute test with a lap far faster than his usual pace? Explain using what you know about oxygen and pacing.

10. **5 pts**

Short answer: In three or four sentences, explain what Hebrews 12:1 means by running “with patience,” and how that idea fits aerobic training.

ANSWER KEY

1. He wanted a simple way to measure heart-and-lung fitness without an expensive laboratory treadmill test. He had 115 Air Force men take both the lab test and the 12-minute run; those who went farther in 12 minutes were almost always the ones who could use the most oxygen, so the distance could stand in for the lab test.
2. “With oxygen”: steady exercise that can be kept up a long time because the heart and lungs supply enough oxygen. Examples: jogging, brisk walking, cycling, swimming, jumping rope, skating.
3. Air is breathed into the lungs; oxygen passes into the blood in tiny vessels; blood goes to the heart, which pumps it through the arteries to the leg muscle, where oxygen is delivered; the veins carry blood back to the heart and lungs.
4. Training makes the heart muscle stronger so it pumps more blood with each beat (larger stroke volume). Since each beat delivers more blood, the heart does not need to beat as often at rest.
5. $7.5 \times 437 = 3,277.5$ yards. $3,277.5 \div 1,760 \approx 1.86$ miles. $720 \text{ seconds} \div 7.5 \text{ laps} = 96$ seconds per lap (1 minute 36 seconds).
6. Drs. Samuel Fox and William Haskell drew a line through data from about a dozen earlier studies around 1970. It was a quick estimate, not a new experiment. Real maximum heart rates vary widely between people of the same age, and in young people the maximum stays high (often about 200 or more) instead of falling each year.
7. $220 - 12 = 208$. $208 \times 0.64 \approx 133$; $208 \times 0.76 \approx 158$. Moderate zone $\approx 133\text{--}158$ bpm. 10-second counts: $133 \div 6 \approx 22$ and $158 \div 6 \approx 26$, so about 22–26 beats.
8. $29 \times 6 = 174$ beats per minute, which is in the vigorous zone.
9. He would quickly use more energy than his heart and lungs could supply with oxygen, become very out of breath, and have to slow down a lot or walk, usually covering less distance than with an even pace.
10. Answers will vary. A good answer says that patience means steady endurance over a long course rather than a burst of speed; that aerobic training is built the same way, through steady, faithful work and wise pacing over weeks; and that the Christian life is a long race run with our eyes on Christ.

UNIT CHALLENGE: MY ZONE TRAINING WEEK AND FAMILY FITNESS DAY

Complete the five-day training week you planned in Lesson 5.2, recording minutes, two heart-rate checks per session and an effort rating, and finish with your 12-minute retest. Then plan, lead and report on the family fitness day with stations from all five units. Put together a final page for your fitness journal with your zone card, a graph of heart rates from your training week, your two 12-minute results, and your three biggest improvements of the quarter.

LOOK FOR	WHAT IT MEANS
Training week	Five sessions recorded honestly with minutes, heart-rate checks in the right zones and effort ratings, plus two rest or light days.
Accurate zones	The zone card is calculated correctly with work shown, including 10-second counts.
Family fitness day plan	A clear schedule with a warm-up, stations from all five units, water and shade, a lower-sugar snack and a cool-down.
Leadership	The student explained each station, showed good form, kept everyone safe and encouraged each person at his or her own pace.
Quarter summary	A final page with graphs, 12-minute results and three improvements, measured against the student's own earlier numbers.