



Strength in Science

The Effects of Exercise on the Bones

Secondary Level Lesson Plan



SFI Research Centre for Medical Devices

‘Strength in Science’

Physical inactivity is one of the leading risk factors for poor health and is now identified by the World Health Organization (WHO) as the fourth leading risk factor for global mortality. In Ireland, physical inactivity is thought to be responsible for 8.8% of the burden of disease from coronary artery disease, and 10.9% of type 2 diabetes.

Currently, only 8% of female secondary students in Ireland receive the Department of Education and Skills (DES) recommended 60 minutes of Physical Education (PE) per week. The goal of the ‘Strength in Science’ project is to develop cross-curricular resources for science and PE teachers that are linked with the Junior Cycle Science and PE curricula that will **increase girls’ interest in both learning science and participating in exercise**. We hope to make science more personal and relevant to teenage girls by linking how the biology and physics involved in exercise affects their health.

The lesson plan kits present fun and unique ways to participate in exercise and the scientific effects that different exercises have on the body. The suggested activities can be used to teach the Health-Related Activity area of study in the Junior Cycle PE Curriculum. Alternatively, the videos and flyers can be used to complement activities in other PE areas of study such as Athletics, Gymnastics, and Dance. All lesson plan booklets, films, and optional resources are free to download at: <http://www.curamdevices.ie/curam/public-engagement/teachers-in-residence/>.

The kits were developed through collaboration between researchers, science teachers, PE teachers, fitness instructors, and Junior Cycle students. This is a pilot scheme and we are keen to receive your feedback so that we can improve the resources and make them as useful for teachers as possible. We are excited to hear how these kits “play out” in the sports hall setting!

Sincerely,

A handwritten signature in blue ink, appearing to read 'S. Gundy'.

Dr. Sarah Gundy

CÚRAM Teachers in Residence

Programme Manager

The Effects of Exercise on the Bones

Junior Cycle Physical Education Curriculum Links

Junior Cycle Syllabus in Physical Education (2003)

Area of study 3: Athletics

Topics:

Jumping

Throwing

Area of study 5: Invasion games

Topics:

Attacking play

Defending play

Area of study 8: Health-related activity

Topics:

Health benefits of physical activity

Health-related fitness

Warm-up and cool-down

NCCA Junior Cycle Short Course in Physical Education (2016)

Strand 1: Physical activity for health and wellbeing

Strand 3: Individual and team challenges

Junior Cycle Science Curriculum Links

Strand One: The Nature of Science

Element:

Understanding About Science

Students should be able to:

1. *Appreciate* how scientists work and how scientific ideas are modified over time.

Element:

Science in Society

Students should be able to:

10. *Appreciate* the role of science in society; and its personal, social and global importance; and how society influences scientific research.

Strand Five: Biological World**Element:**

Systems and Interactions

Students should be able to:

6. *Evaluate* how human health is affected by: inherited factors and environmental factors including nutrition; lifestyle choices.

Element:

Sustainability

Students should be able to:

9. *Discuss* medical, ethical, and societal issues.

Learning Outcomes

Students should be able to:

1. Jump for distance and/or height.
2. Throw for distance using modified as well as standard equipment.
3. Make appropriate responses (relative to her/his own ability) to the particular problems posed by a game.
4. Gain experience of various degrees of competitive play.
5. Display an understanding of the dynamics of team efficiency.
6. Demonstrate an understanding of the effects of exercise on the body.
7. Show an understanding of the role of physical activity in establishing and maintaining health.
8. Plan for and participate in regular physical activity.
9. Know the general functions of differing bone cells.
10. Understand how bone cells remodel bone tissue.

11. Know the cause of osteoporosis.
12. Understand how to build peak bone mass with impact exercises.

Keywords and Definitions

	Keyword	Definition
1.	Osteoclasts	Specialised bone cells that remove old or damaged bone.
2.	Osteoblasts	Specialised bone cells that make new bone.
3.	Osteocytes	Specialised bone cells that act as "sensors" to monitor the mechanical forces on bones.
4.	Peak Bone Mass	The maximum amount of bone a person has during their life usually obtained between the ages of 16-25 years.

Learning Activities

Students will:

- Watch a video discussing:
 - How bones cells react to forces and how they remodel bone.
 - Current Irish research in treating diseases in bones.
 - How impact exercises build peak bone mass.
- Perform exercises to keep their bones healthy.

Resources Provided

- Teacher lesson plan
- Short film "The Effects of Exercise on the Bones"
- Flyers for students "The Effects of Exercise on Your Bones"

Note: These resources will also complement any impact or jumping activities (long, triple, high) or lessons taught in P.E. classes.

Warm-Up

Warm-Up Your Bones

Equipment/Space Needed:

- Large hall
- Poly spots (3 per group) for Part A
- Hula hoops (1 per group) for Part B
- Pool noodles (1 per group) for Part C
- **Note:** If pool noodles are not available, jump ropes or any equipment that can be used in a jump rope motion can be used instead.

Instructions:

- Divide the students into groups of three.
- Part A:
 - All of the groups start at one end of the hall.
 - One student from each group is the "Jumper," the other two students are the "Path Builders".
 - The Path Builders are given three poly spots.
 - The Path Builders put one of the poly spots on the ground in front of the Jumper.
 - The Jumper jumps onto the poly spot.
 - The Path Builders continue to work together to put poly spots on the ground in a path one at a time in front of the Jumper.
 - The Jumper continues to jump onto the poly spot path that the Path Builders create.
 - **Note:** If the poly spots are placed too close in front of the Jumper, the Jumper will move across the hall slower. If the poly spots are placed too far in front of the Jumper, the Jumper won't be able to jump onto the poly spot.
 - The first team to make it to the other side of the hall and back are the winners.
- Part B:
 - All of the groups start at one end of the hall.

- Assign a new student from each group as the "Jumper," the other two students as the "Path Builders".
- The Path Builders are given a hula hoop.
- The Path Builders put the hula hoop on the ground in front of the jumper.
- The Jumper jumps into the hula hoop.
- The Path Builders pick the hula hoop up off of the floor, lift it over the Jumper's head and place it on the ground in front of the Jumper.
- The Jumper jumps into the hula hoop again.
- The Path Builders continue to work together to pick the hula hoop up off of the floor, lift it over the Jumper's head and place it on the ground in front of the Jumper.
- The Jumper continues to jump into the hula hoop path that the Path Builders create.
- **Note:** If the hula hoop is placed too close in front of the Jumper, the Jumper will move across the hall slower. If the hula hoop is placed too far in front of the Jumper, the Jumper won't be able to jump into the hula hoop.
- The first team to make it to the other side of the hall and back are the winners.
- Part C:
 - All of the groups start at one end of the hall.
 - Assign a new student from each group as the "Jumper," the other two students as the "Path Builders".
 - The Path Builders are given a pool noodle.
 - The Path Builders put the pool noodle in front of the Jumper. The pool noodle can be slightly above the floor to act like a low hurdle.
 - The Jumper jumps over the pool noodle.
 - The Path Builders lift the pool noodle (from behind the Jumper) over the Jumper's head and in front of the Jumper. (In a jump rope-like movement)
 - The Jumper jumps over the pool noodle again.

- The Path Builders continue to work together to lift the pool noodle over the Jumper's head and in front of the Jumper like a jump rope.
- The Jumper continues to jump over the pool noodle path that the Path Builders create.
- **Note:** If the pool noodle is placed too close in front of the Jumper, the Jumper will move across the hall slower. If the pool noodle is placed too far in front of the Jumper, the Jumper won't be able to jump over the pool noodle.
- The first team to make it to the other side of the hall and back are the winners.

Stretches

After the warm-up, get the students to perform dynamic stretches targeting the following muscle groups in preparation for the activities:

- Hamstrings
- Quadriceps
- Gastrocnemius and soleus (calves)
- Deltoids (shoulders)
- Biceps and triceps (upper arms)
- Trapezius (upper back)
- Pectoralis major and minor (chest)

Activity 1

Osteo Obstacle Course

Equipment/Space Needed:

- Large hall
- Any equipment that can be used as an obstacle to jump over. For example, cones, ladders, steps, training hurdles, pylon spots, hula hoops, pool noodles, etc.
- **Note:** The same equipment should be given to each team.

Instructions:

- Divide the students into a suitable number of teams depending on equipment available and size of the hall. Try not to have too many students on one team as it will prevent them from being as active because they will have to wait longer for a turn.
- Each team builds a jumping obstacle course using the equipment that is given to them. The obstacle course should be set up from one side of the hall and back.
- Each team lines up behind the start of a jumping obstacle course that another team created.
- The teacher says "Ready, steady, go!"
- The first person from each team goes from one side of the hall and back trying to complete the jumping obstacle course as fast as possible.
- When the first person makes it back to the start, he/she tags the second person.
- The second person goes from one side of the hall and back trying to complete the jumping obstacle course as fast as possible.
- The teams continue to perform a jumping relay-style race over another team's obstacle course.
- There are two team winners:
 - Jumping team winners: The first team to have all of its members make it to the other side of the hall and back are the jumping winners.
 - Obstacle course team winners: The team that builds the obstacle course that takes the longest time to finish are the obstacle course winners.
- Variation: The students can complete the course in one direction, and then sprint back on the flat surface along the side of the course to the start.

Activity 2

Build-a-Bone Bases

Equipment/Space Needed:

- Large hall
- 16 Large (1m x 1m) jigsaw mats (8 per team)
- 10-15 Dodgeballs
- 8 Hula hoops (4 per team)
- 4 Cones
- **Note:** You can see how the game is set up from 2:02 to 2:31 of the following video: <https://www.youtube.com/watch?v=qCQ7BcTG4yQ&t=51s>

Instructions:

- The students are divided into two teams and move to separate ends with the length of the hall between them.
- Put half of the hula hoops on each side of the hall, with the width of the hall between them. (Four hula hoops on one side, and four hula hoops on the other)
- Each side with hula hoops is assigned to a team.
- Place two cones on each side of the hall, with the width of the hall between them. Position the cones $\frac{1}{4}$ ways into the length of the hall. (These cones act as a foul line for one of the teams)
- Repeat this for the other two cones, but on the other end of the hall. Again, position the cones $\frac{1}{4}$ ways into the length of the hall. (These cones act as a foul line for the other team)
- Each team makes a base at separate ends of the hall by balancing two jigsaw mats against one another to make an upside down V-shape. The mats should act as a barrier that the team can hide behind from the other team.
- Each team makes three more bases with the remaining six jigsaw mats.
- Each team should have four bases each.
- Each team assigns four people to hide behind each base. These team members are "Bases".
- The remaining team members are "Throwers".
- The dodgeballs are released in the centre of the hall and the teacher says "Ready, steady, go!"

- The Throwers throw the balls at the opposing team's bases and try to knock them down.
- The Bases throw the balls at the opposing team's Throwers and try to knock them out.
- The Throwers cannot cross the foul line (marked by the cones) that is closest to their bases.
- If Throwers cross their foul line, they have to go to one of their team's hula hoops and do 15 squat jumps.
- If Throwers get hit by a ball thrown by the other team, they have to go to one of their team's hula hoops and jump forwards and backwards, in and out of the hoop 15 times.
- If one of the bases gets knocked down, the person behind the base has to go to one of their team's hula hoops and jump side to side, in and out of the hoop 15 times.
- After completing the required hula hoop jumps, the students return to their positions.
- The first team to knock down all of their opponent's bases at the same time are the winners.
- Variation: You can vary the amount of jumps or type of jumps the students have to do in the hula hoops.

Cool-Down

Stretches

Get the students to perform static stretches targeting the following muscle groups that were worked during the activities:

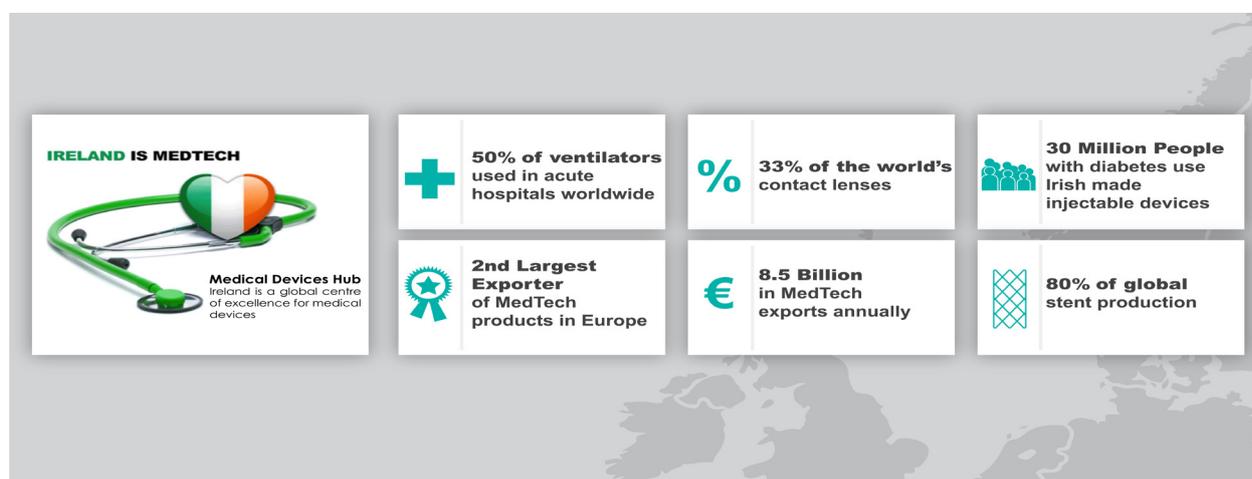
- Hamstrings
- Quadriceps
- Gastrocnemius and soleus (calves)
- Deltoids (shoulders)
- Biceps and triceps (upper arms)
- Trapezius (upper back)
- Pectoralis major and minor (chest)

FACTS ABOUT OSTEOPOROSIS AND MEDTECH IN IRELAND

- Ireland is the second largest exporter of MedTech products in Europe.
- Ireland's MedTech sector employs 29,000 people across 450 companies.
- Ireland has the highest number of people working in the MedTech industry than in any other European country, per head of population.
- 13 of the top 15 MedTech companies have operations in Ireland.
- Galway employs one third of the country's MedTech employees.

At present it is estimated that 300,000 people in Ireland have osteoporosis. One in four men and one in two women over 50 will develop a fracture due to osteoporosis in their lifetime. The disease can also affect children.

A wide range of products relevant to treating damaged bones and other musculoskeletal tissues are manufactured in Ireland. These include hip and knee implants, bone cement, and surgical blades used for cutting and shaping bones. In fact, 75% of global orthopaedic knee production comes from Ireland. Stryker is one of the world's leading MedTech companies producing medical devices to treat the musculoskeletal system. Stryker has four manufacturing sites and a Research and Development Innovation Centre based in Cork and Limerick. Zimmer Biomet, with facilities in Galway and Shannon, supplies hospitals and orthopaedic surgeons with implants for hips, knees, extremities, spine and trauma.



Source: IDA Ireland, 2017

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