



Teachers in Residence

The Musculoskeletal System

Secondary Level Lesson Plan



Centre for Research in Medical Devices

“Breaking Barriers”

THE PHILOSOPHY BEHIND OUR LESSON PLANS

Teachers participating in CÚRAM’s Teachers in Residence programme have developed a ‘learning module’ on MedTech in Ireland that links with multiple streams and themes in the primary and junior cycle curricula. The primary and secondary lesson plans were created **by teachers for teachers** and are accessible online to use in classrooms all over the world.

During their residencies, teachers developed the contents of the lesson plans by working directly with CÚRAM researchers, while learning about the medical device research being carried out at CÚRAM. Primary teachers were paired with secondary teachers to create plans covering five major themes: biomaterials, heart, brain, musculoskeletal system and stem cells. The partnership between the primary and secondary teachers ensured that the materials created follow a natural progression from one age group to the next.

The lesson plans were further designed and formatted by a Visual Artist who used various teaching methodologies to suit the multiple intelligences and range of learning styles and abilities present in classrooms. By using a range of teaching approaches we hope to engage all children at all levels whatever their natural talents or interests may be.

We hope that you and your students find these resources an enjoyable way to learn about our research centre and the MedTech industry!

Sincerely,

Dr. Sarah Gundy

Programme Manager-Teachers in Residence

Medical Devices & the Musculoskeletal System

Introduction Lesson

Secondary School 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:

Investigating in science

Students should be able to:

3. Design, plan and conduct investigations; explain how reliability, accuracy, precision, fairness, safety, ethics and selection of suitable equipment have been considered.

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

Children should be enabled to:

1. Identify the main parts of the human skeleton and state the main functions of the musculoskeletal system.
2. Describe the general structure and action of muscles (working in opposition).
3. State the function of tendons and the relationship between these and bones.
4. Outline some of the problems arising in the musculoskeletal system and describe possible methods of treatment.
5. Appreciate what a medical device is.
6. Describe what a biomaterial is.
7. Construct a paper model of the human hand.
8. Problem-solve ways of how to fix a tendon that has been cut in the hand.

9. Demonstrate the relationships between bones, tendons and muscles by use of model.
10. Appreciate that the suitability of biomaterials are based on the properties of the biomaterials and their ability to match the original tissue.

Keywords & Definitions

	Keyword	Definition
1.	Bones	Make up the skeleton and provide support and protection to the body.
2.	Long bone	Bones that support the weight of the body and facilitate movement. (Femur, tibia, humerus)
3.	Short bone	Bones that provide stability and some movement. (Carpals and tarsals)
4.	Irregular bone	Bones that have a complex shape, which help to protect internal organs. (Vertebrae, sacrum, coccyx)
5.	Flat bone	Bones that protect internal organs. (Sternum, scapula, ribs)
6.	Osteogenic cells	Bone cells that develop into osteoblasts. The only bone cells that divide.

7.	Osteoblasts	Bone cells that make and secrete a collagen matrix and calcium salts. Responsible for forming new bones.
8.	Osteocytes	Osteoblasts that have become trapped in the matrix they have secreted. The most common and mature type of bone cell.
9.	Osteoclasts	Bone cells that break down and reabsorb bone.
10.	Muscle	Tissues that contract and lengthen to make the body move.
11.	Flexion	The movement that decreases the angle between two bones. Opposite of extension.
12.	Extension	The movement that increases the angle between two bones. Opposite of flexion.
13.	Antagonistic pairs	Pairs of muscles that contract (agonist) and relax/lengthen (antagonist) together to start or stop movement.
14.	Agonist	The contracting muscle of an antagonistic pair.
15.	Antagonist	The muscles that oppose the force of movement of the agonist muscles.
16.	Joint	Where bone connects with bone. Joints allow for different types of movement.

17.	Pivot joint	Allows rotational movement. Found between the C1 (atlas) and C2 (axis) vertebrae.
18.	Hinge joint	Allows swinging movement. Found in the elbow, ankle, and knee.
19.	Saddle joint	Similar to hinge joint, but allows more range of motion. Found in the thumb.
20.	Plane joint	Allows sliding movement. Found between the small bones of the wrists (carpals) and ankles (tarsals).
21.	Ball-and-socket joint	Allows movement in three planes and is the most mobile type of joint. Found in the hip and shoulder.
22.	Condylloid joint	Allows movement similar to ball-and-socket joint without rotation. Found in the wrist.
23.	Ligament	Connective tissue that connects bones with bones.
24.	Cartilage	Connective tissue that covers and protects the ends of bones at joints.
25.	Tendon	Connective tissue that connects muscles to bones.
26.	Strain	An overstretched or torn muscle.
27.	Sprain	An overstretched or torn ligament.

28.	Arthroscope	Flexible tube with a camera that can be inserted into the body.
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Learning Activities

Children will:

- Complete The K and W parts of the KWL Chart.
- Engage in talk and discussion on the musculoskeletal system.
- Participate in group activities to construct their own model hand (see PowerPoint and hand out).
- Present their work to the class.
- Engage in talk and discussion on biomaterials and medical devices.
- Evaluate their work.
- Fill in the L Part of the KWL Chart.

Extra Info / Files

	Web Address	Brief Description
1.	www.youtube.com/watch?v=94Q-fvCAJzQ	Muscle Basics: What Athletes Need to Know About the Muscular System
2.	www.youtube.com/watch?v=0vLiPT_Otw	Bone Basics: How They Heal and How to Keep them Healthy

3.	www.youtube.com/watch?v=hdes6W76OOw	The Basic Science of Tendons and Tendinitis
4.	www.sheppardsoftware.com/health/anatomy/skeleton/Skeleton_game_2.htm	Game about the bones and their positions in the body
5.	theinteractivehand.worldsecuresystems.com/	Website exploring the hand including tendons and bones.
6.	www.innerbody.com/image/skel13.html	2D and 3D views of the hand

Resources

- Teacher Lesson Plan
- PowerPoint to guide lesson
- Interactive KWL
- Evaluation sheet
- One set of materials for each group constructing a medical device:
 - Hand template printed out on thick card paper
 - String
 - Straws (large)
 - Tape
 - Glue
 - Ribbon
 - Lollipop stick
 - Elastic band

Methodologies

- Talk and discussion
- Active learning
- Guided and discovery learning
- Collaborative learning
- Free exploration of materials
- Investigative approach

Assessment

- Self-assessment – evaluation sheet
- Teacher observation – construction of medical devices
- Teacher questioning – KWL, talk and discussion

Linkage and Integration

- **Maths** – problem solving
- **STEM** – I.T. / Engineering
- **Art** – construction
- **S.P.H.E.** – working together co-operatively
- **English** – oral language through talk and discussion and presenting their work

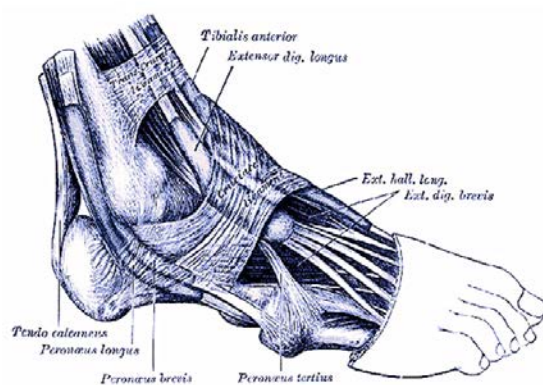
Differentiation by:

- Teaching style
- Support
- Task

Power Point Presentation – The Musculoskeletal System

Introducing the MUSCULOSKELETAL system

Slide 1



cúrom
Centre for Research in Medical Devices

Teachers in Residence Programme
Andrew Fogarty and Clive Monahan

Slide 2

Class discussion around the Musculoskeletal System

Why do you require a skeleton?

What is it made from?

Is it living tissue?

Can you name bones?

How does the skeleton allow for movement?

Explain the functions of muscles?

What are tendons?

What can go wrong with the musculoskeletal system?

K-W-L Chart

Topic:

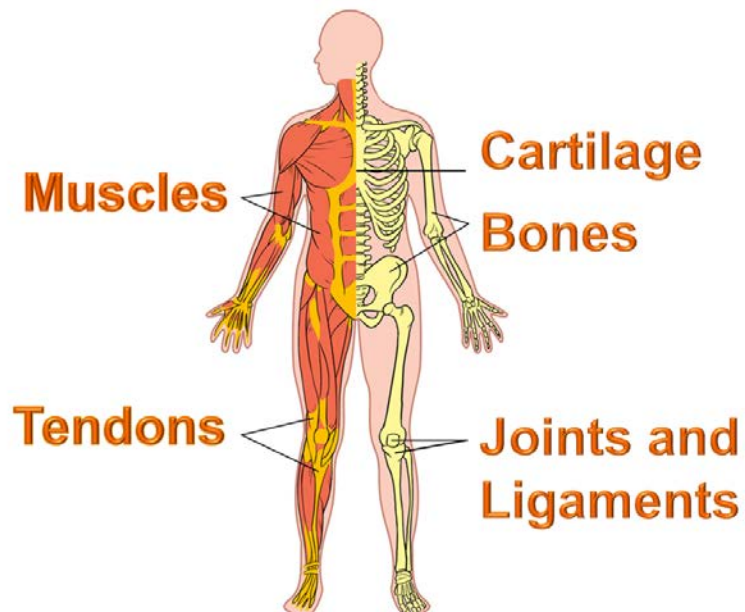
What I Know

What I Want to Know

What I Learned

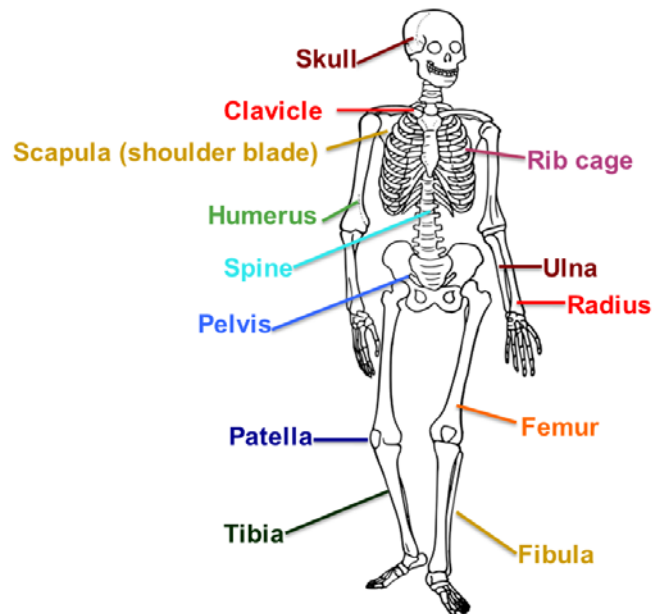
Slide 3

Musculoskeletal System



Slide 4

Bones-Human Skeleton



Slide 5

How many bones do you have?

You have:

300 bones at birth

206 bones by adulthood

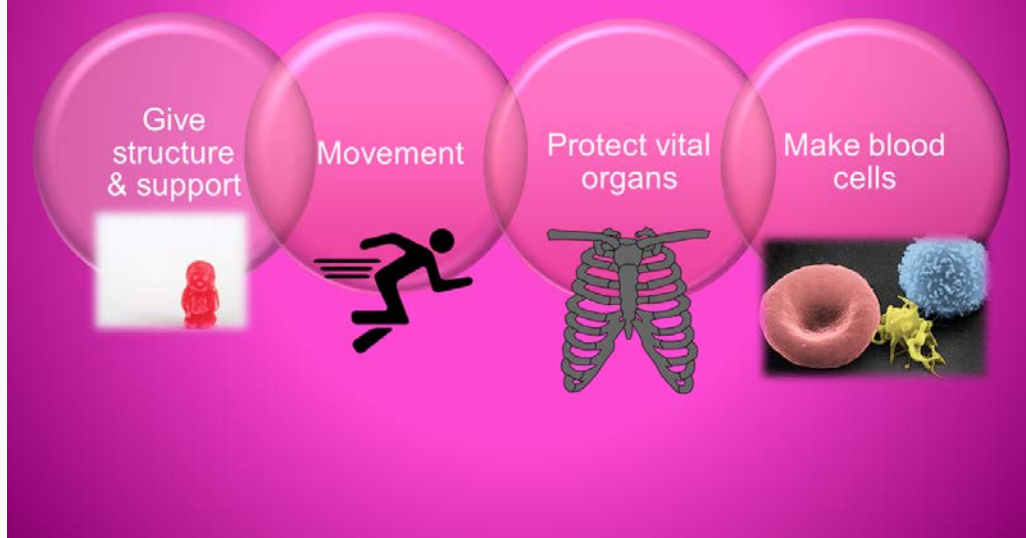


Where do they go?



Slide 6

Bones-Functions



Slide 7

Bones-Types



Long bone



Short bone



Irregular bone

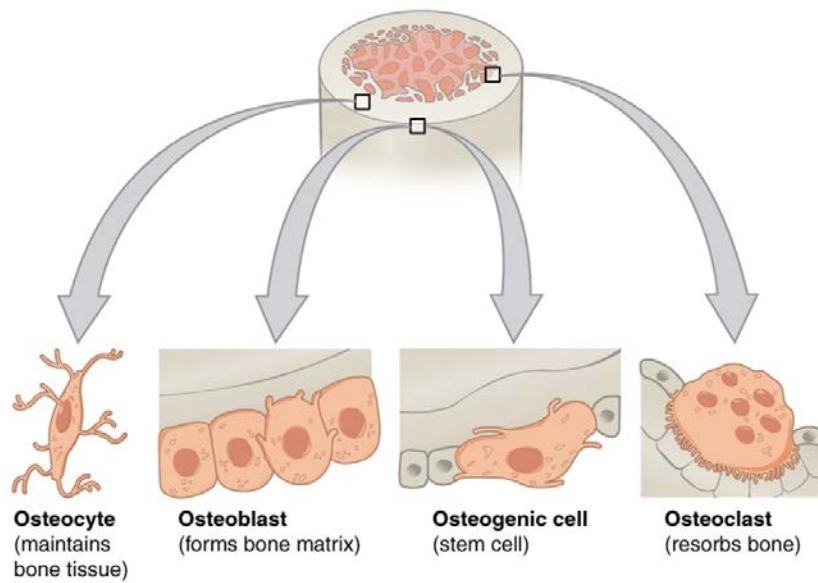


Flat bone

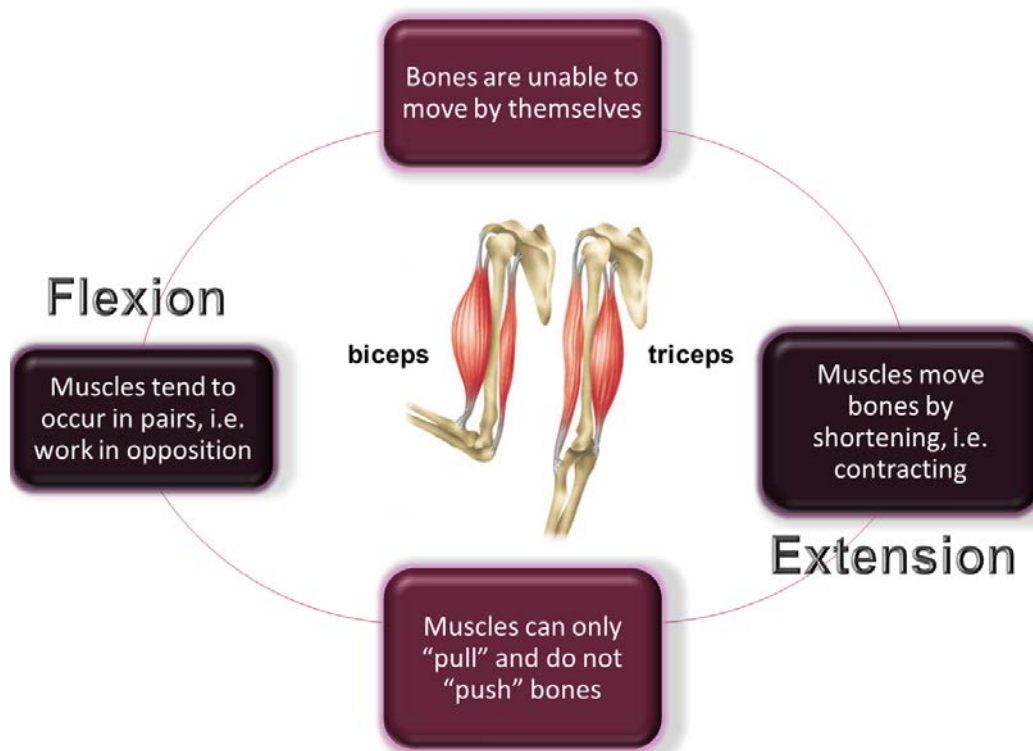
Can you give examples?

Slide 8

Bone Cells



Slide 9



Slide 10

Muscles-Antagonistic Pairs

Biceps (Agonist)

As you bend your elbow and raise your forearm which muscle is contracting?

As you straighten your elbow and lower your forearm which muscle is contracting?

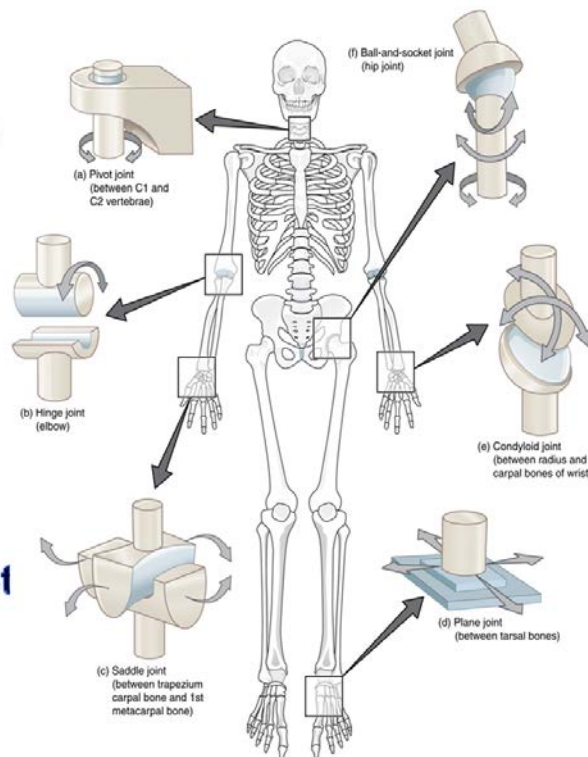
Triceps (Agonist)

What are the antagonist muscles and what are they doing?

Slide 11

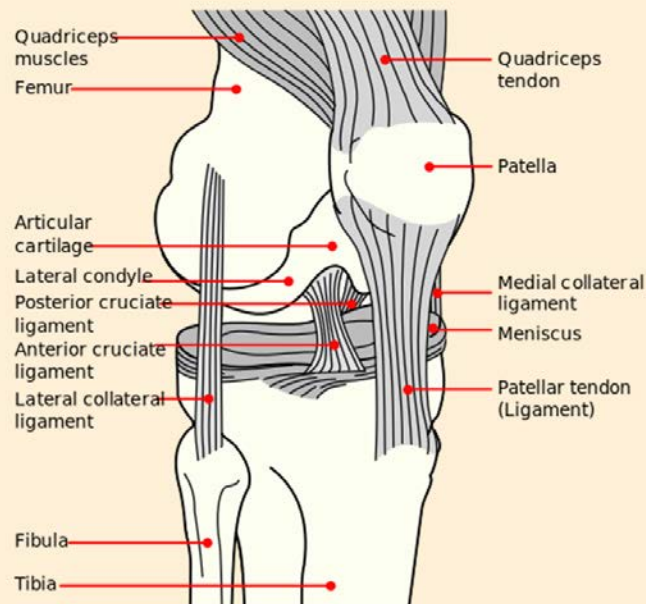
Joints

- **Connect bones to bones**
- **Six types:**
 - **Pivot**
 - **Hinge**
 - **Saddle**
 - **Plane**
 - **Condyloid**
 - **Ball-and-Socket**



Slide 12

Joints-Cartilage and Ligaments



Slide 13

Tendons-Connect Muscles to Bones



Slide 14

Do you have this tendon in your wrist?

Most people have it

14% of people do not have it.

Was used by humans years ago to flex the wrist.

Not needed anymore and can be removed

Can be used to replace damaged tendons



Palmaris Longus

Slide 15

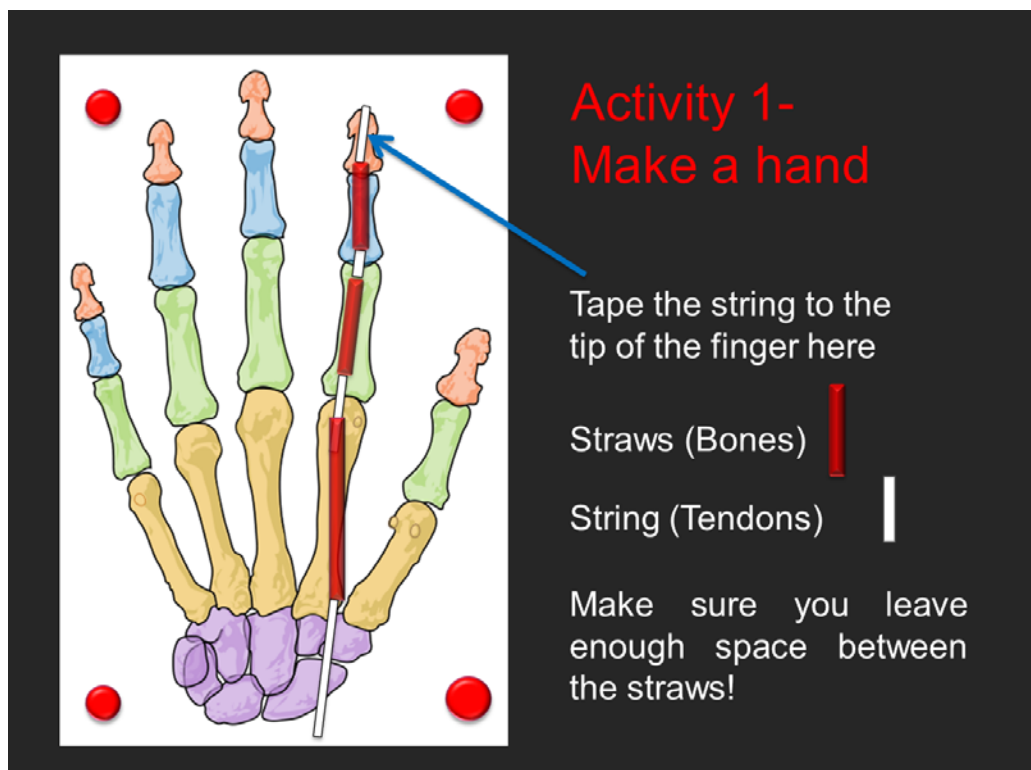
Damage to MS System

What	Damage	Medical Treatment
Bones	<ul style="list-style-type: none">• Simple fracture• Compound fracture	<ul style="list-style-type: none">• Cast• Plates• Pins
Muscles	<ul style="list-style-type: none">• Strain• Tears	<ul style="list-style-type: none">• RICE• Brace
Cartilage	<ul style="list-style-type: none">• Break down• Tears• Loose pieces	<ul style="list-style-type: none">• Assess damage with arthroscope• Clean with saline solution
Ligaments	<ul style="list-style-type: none">• Sprain• Tears	<ul style="list-style-type: none">• Brace• Surgery
Tendons	<ul style="list-style-type: none">• Tears• "Snapped"	<ul style="list-style-type: none">• RICE• Splint• Brace

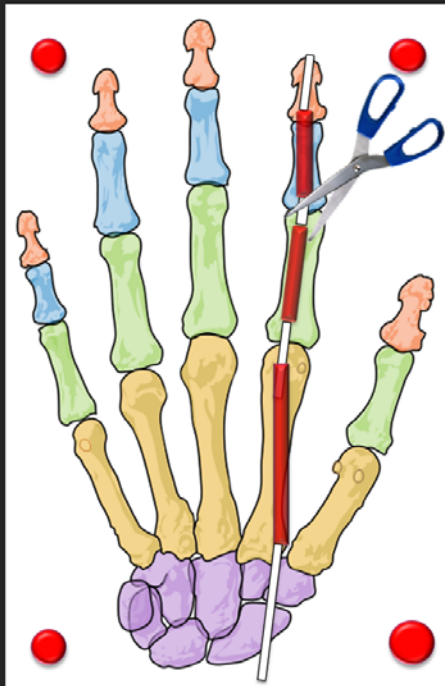
Slide 16



Slide 17



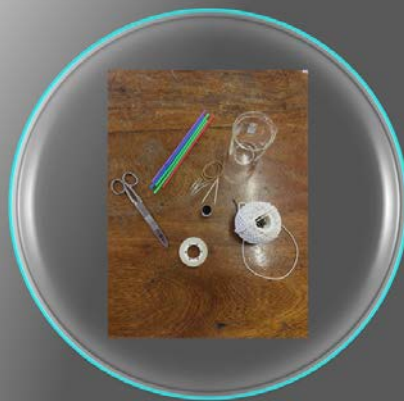
Slide 18



Activity 2- Damage and repair a tendon

1. Use your scissors to cut one of your tendons
2. Repair your "tendon" using the biomaterials available in your Biomedical Engineering Kit

Slide 19



Paper hand cut-out

Straws

String

Paperclips

Rubber bands

Toothpicks

Thread

Scissors

Tape

Slide 20



Slide 21

References:

1. Gray's Anatomy
2. commons.wikimedia.org
3. www.flickr.com
4. www.pixabay.com

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Slide 22

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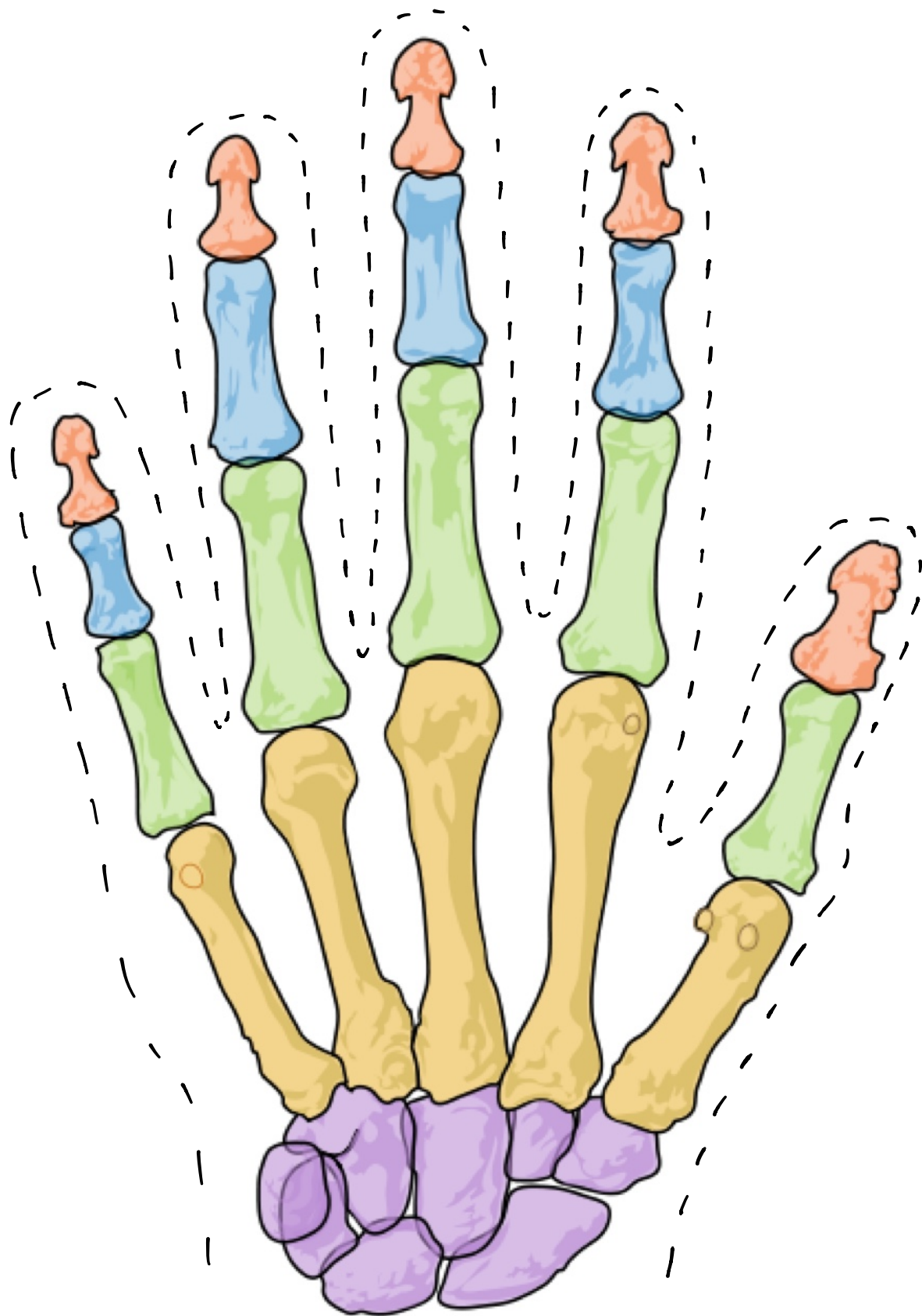
This project has been funded by the European Union Seventh Framework Programme under Marie Curie Initial Training Networks (FP7-PEOPLE-2012-ITN) and Grant Agreement Number 317304 (AngioMatTrain). This project has also been funded by the European Union Horizon 2020 Programme (H2020-MSCA-ITN-2015) under the Marie Skłodowska-Curie Innovative Training Networks and Grant Agreement Numbers 676408 (BrainMatTrain) and 676338 (Tendon Therapy Train).



K-W-L Chart

Topic: Musculoskeletal System

What I K now	What I W ant to Know	What I L earned



Musculoskeletal System

Secondary Level Evaluation Sheet

Please answer the following questions into your exercise copy:

1. Explain why bones may be described as living tissue.
2. Outline the main functions of the skeleton.
3. Name organs that are protected by the skull.
4. List the three main bones in the (i) arm and (ii) leg.
5. State another name for the collar bone.
6. What is the purpose of a joint in the skeleton?
7. Describe three types of joints giving examples of each.
8. Explain the impact of diet on healthy bones.
9. Outline the difference between ligaments and tendons.

Reflection using 3-2-1 method:

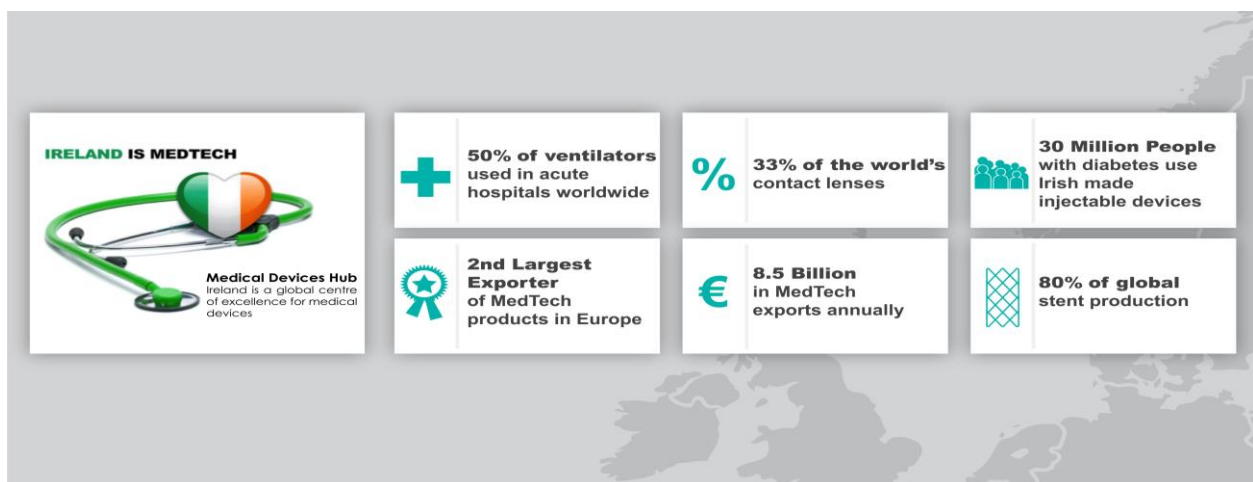
Please reflect on the activities you have completed and include the following into your exercise copy:

- 3 new pieces of information
- 2 interesting facts
- 1 question

FACTS ABOUT 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.
- 18 of the world's top 25 MedTech companies have a base in Ireland.
- Galway employs one third of the country's MedTech employees.

A wide range of products relevant to treating damaged 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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