Teachers in Residence

Biomaterials

Secondary Level Lesson Plan

curam

SFI Research Centre for Medical Devices

Science Foundation Ireland sfi For what's next

SFI Research Centre for Medical Devices

TEACHERS IN RESIDENCE

"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 devices 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.

All presentations, lesson plan booklets and optional resources are free to download at: http://www.curamdevices.ie/curam/public-engagement/teachers-in-residence/. 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

Biomaterials Lesson Plan

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:

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:

Sustainability

Students should be able to:

9. *Discuss* medical, ethical, and societal issues.
10. *Appreciate* the benefits that people obtain from ecosystems.

Learning Outcomes

Children should be enabled to:

1. Appreciate what a medical device is.
2. Give examples of medical devices.
3. Identify medical device developments in perspective to historical events.
4. Appreciate what a biomaterial is.
5. Give examples of biomaterials.
6. Recognise that the design of a biomaterial is important for its function.
7. Understand the uses of biomaterials in biomedical procedures.
8. Analyse different materials.
9. Demonstrate where various materials would suit different areas of the body based on their physical properties.

Keywords and Definitions

	Keyword	Definition
1.	**Medical Device**	Any material, apparatus, software or other article that is used to: Diagnose, prevent, monitor or treat a disease or injury; Investigate, replace or modify a part or process of the body.
2.	**Biomaterial**	A material that can be engineered to help the body heal itself.
3.	**Diagnose**	Identify the nature of an illness or other problem by examining the symptoms.
4.	**Monitor**	Observation of an area in the body over time.
5.	**Treat**	Give medical care or attention to.
6.	**Investigate**	Discover the cause of an illness or disease.
7.	**Replace**	When an area of the body is removed and a new one is put in its place.
8.	**Modify**	To change an area of the body.
9.	**Implant**	A medical device that is made to replace an area of the body, or support a damaged area of the body.
10.	**Prosthesis**	An artificial body part to help replace damaged areas of the body (tissues, organs, or limbs)

11.	**Stent**	A tiny tube made with a biomaterial that keeps blood vessels open.
12.	**Natural**	Existing in or coming from a biological source; not made or caused by humankind. Ex. Alginate, collagen, or agarose.
13.	**Synthetic**	A material made by chemical synthesis, especially to imitate a natural product. Ex. Polymer, ceramic or metal.
14.	**Biocompatible**	Not harmful or toxic to living tissues.
15.	**Proliferate**	When cells make more cells.
16.	**Differentiate**	A cell behaving in a specific way.
17.	**Migrate**	Movement of a cell in a particular direction.

Learning Activities

Children will:

- Learn about synthetic and natural sources of biomaterials.
- Learn about how biomaterials can be made into different shapes to support new tissue growth.
- Learn how cells and medicine can be added to biomaterials.
- Participate in a group activity to arrange a timeline of medical device developments in perspective to historical events.
- Participate in a group activity to analyse different properties of materials, and suggest what area of the body would be suitable for them to treat.
- Evaluate their work by filling in the Exit Ticket.

Extra Info / Files

	Web Address	Brief Description
1.	www.youtube.com/watch?v=ptE8dEdSbeY	Video on biomaterials
2.	www.youtube.com/watch?v=T_uMkdKS6wQ&t=213s	Video on biomaterials
3.	edge.rit.edu/edge/P10022/public/team_docs/technical_literature/Overview%20of%20Biomaterials%20and%20Their%20Use%20in%20Midical%20Devices.pdf	"Overview of Biomaterials and Their Use in Medical Devices" Article with helpful background information for teachers

Resources Provided

- Teacher Lesson Plan
- PowerPoint to guide lesson
- History and Medical Devices cards for photocopying
- Exit Ticket
- Optional: Biomaterials PowerPoint quiz
- Optional: "Bittersweet"-A 26 minute documentary produced by CÚRAM capturing the health system's fight to treat the rising number of diabetic patients, and personal stories of young people who are living with diabetes and their daily struggle to manage it using medical devices. A trailer to the film can be viewed using the following link: https://vimeo.com/242714712. The film is available on request by contacting Sarah at sarah.gundy@nuigalway.ie.

Materials Needed

- One set of History and Medical Devices cards per group of students. **Note:** Please ensure that you print out the cards on double sided paper and that the correct information matches what is on the back of each card.
- First aid gauze
- Cling film
- Aluminium foil
- White or blue tack
- Sponges
- Feel free to use other materials that are readily available that the students can analyse!

Instructions

- For Activity 1 (History of Devices):
    - Divide the class into groups of two, three or four depending on class size and amount of materials.
    - Each group is given a set of the supplied history cards.
    - Each group puts the invention dates of the medical devices in chronological order in perspective to the historical events. **Note:** The order of most of the historical events can be figured out logically even if the students haven't covered them in history.
    - Tell the students that the invention dates of the medical devices and historical events alternate (ie. invention-event-invention-event).
    - Tell the students the answers by presenting slides 16-21.

- For Activity 2 (Properties of Biomaterials):
    - Each group is given any assortment of the following: First aid gauze, cling film, aluminium foil, white or blue tack, sponges, and/or any other materials you'd like to use.
    - Each group analyses the properties of each of the materials. Possible properties include:
        - Hard vs. soft
        - Smooth vs. rough
        - Transparent or opaque
        - Stiff or flexible
        - Thin or thick
    - Each group decides where in the body the material could be used as a medical device based on their analysis. **Note:** In the presentation it lists specific areas of the body, but you can instruct the class to think of other areas besides those listed.
    - The materials should have the same consistency as the tissues they are treating. Softer materials (such as blue tack or the sponge) would be used to treat softer areas of the body such as the brain, liver, or heart. Harder materials would be used to treat harder areas of the body such as bone.
    - A thin, transparent material (such as cling film) could be used to treat the eye, in particular as a cornea implant.
    - Flexible materials (such as gauze) could be used to treat the heart in order to accommodate the expanding and contracting due to the pumping of blood.

- Thinner materials (such as tin foil, cling film or gauze) could be used to treat outer layers of the skin.

Teachers' Tips

- For Activity 1, if you would like to make it easier for the students, you can give them the years of the events in advance. Then, the students match the history cards to the years that you give to them.
- For Activity 1, it is easier to handle the cards if they are printed out on thicker, card paper.
- For Activity 2, there are no right or wrong answers. Usually the students will come up with great ideas we never imagined!
- For Activity 2, please make sure the students know that the materials they are analysing are not really used to treat different areas of the body (except for the gauze). They are just using a model!

Methodologies

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

Assessment

- Self-assessment – Exit Ticket
- Teacher observation – identification of medical device developments and analysis of materials
- Teacher questioning – talk and discussion

Linkage and Integration

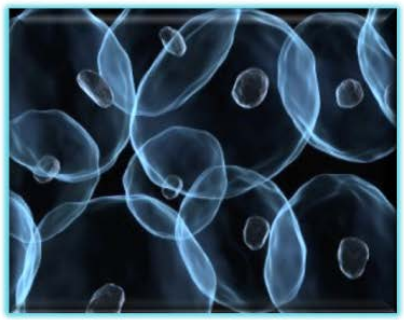
- **Maths** – problem solving
- **STEM** – I.T. / Engineering
- **Art** – construction
- **S.P.H.E** – working together co-operatively
- **English** – oral language through talk and discussion and presenting their work

Differentiation By:

- Teaching style
- Support
- Task

PowerPoint Presentation – Biomaterials

Slide 1



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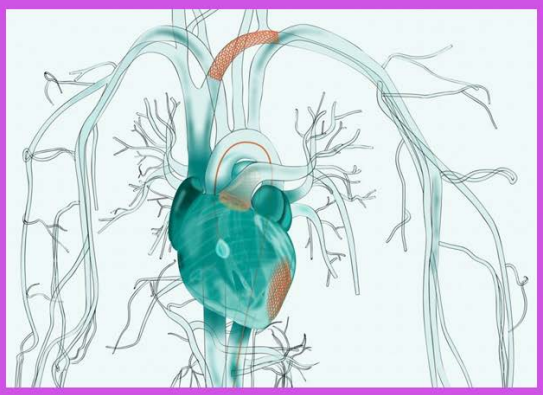
Teachers in Residence Programme
Iseult Mangan and Tom Flanagan

Slide 2

MEDICAL DEVICES

Any material, apparatus, software or other article that is used to:

- *Diagnose*, *prevent*, *monitor* or *treat* a disease or injury
- *Investigate*, *replace* or *modify* a part or process of the body



Slide 3

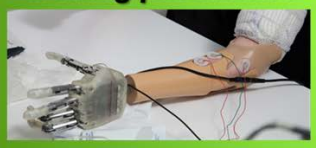
CAN YOU NAME SOME MEDICAL DEVICES?

tongue depressor

hip implant

tooth implant

arm/leg prosthesis



stethoscope

thermometer

stent

disposable gloves

heart valve replacement

Slide 4

Biomaterials are used to make medical devices

What are ***BIOMATERIALS***?

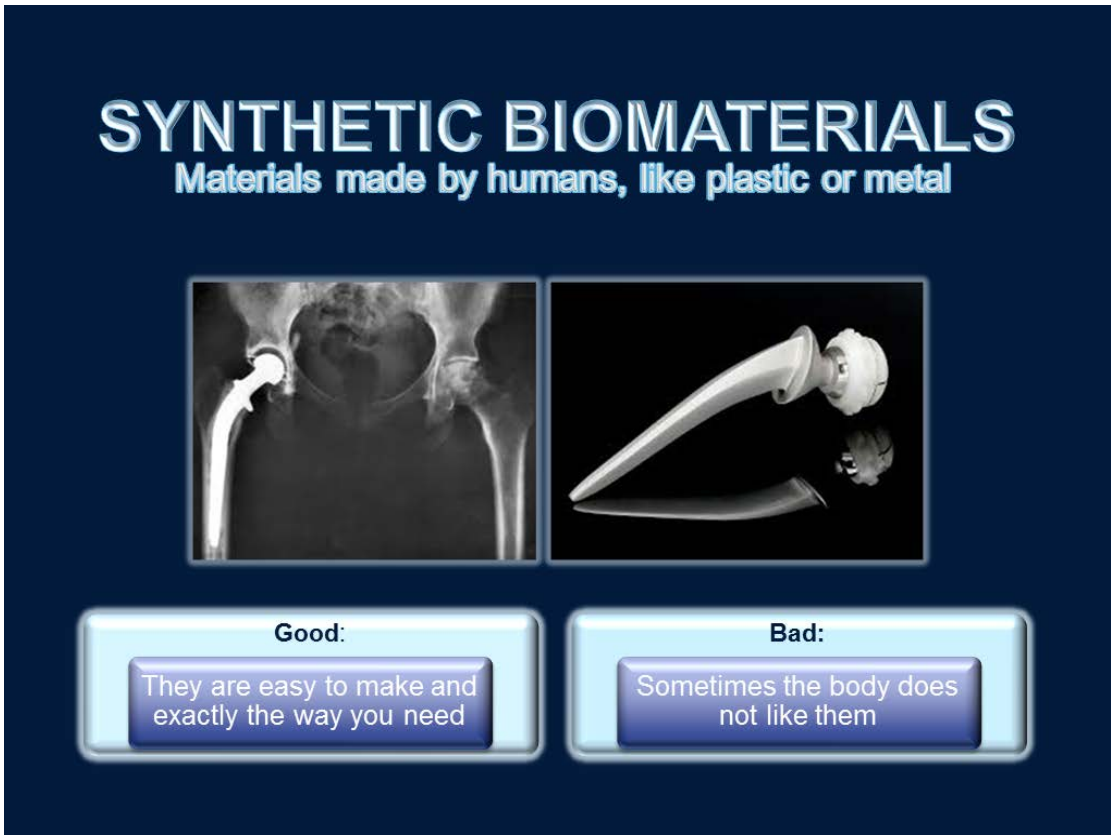
Slide 5

What are Biomaterials?

- A biomaterial is made from a natural or **synthetic** material that can be engineered to help the body heal itself
- A biomaterial can be introduced into the body as part of an implanted medical device or used to replace an organ
- They can be temporary or permanent

Slide 6

Slide 7



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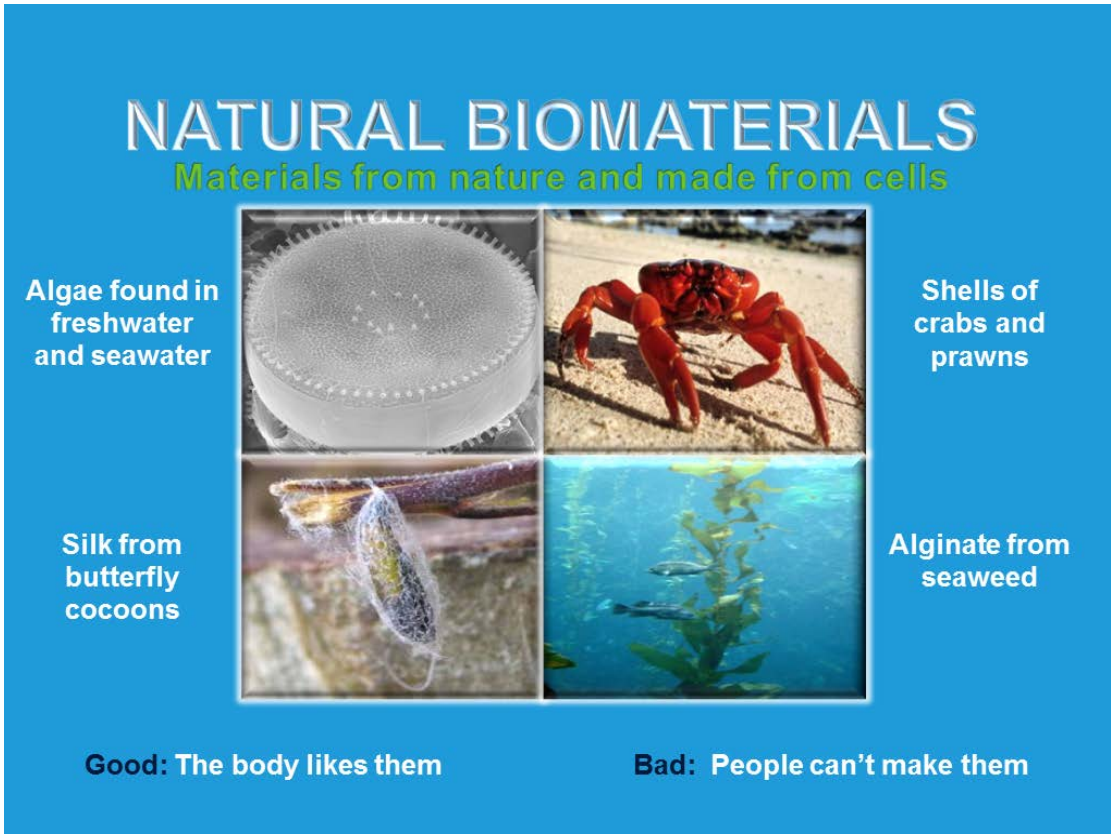

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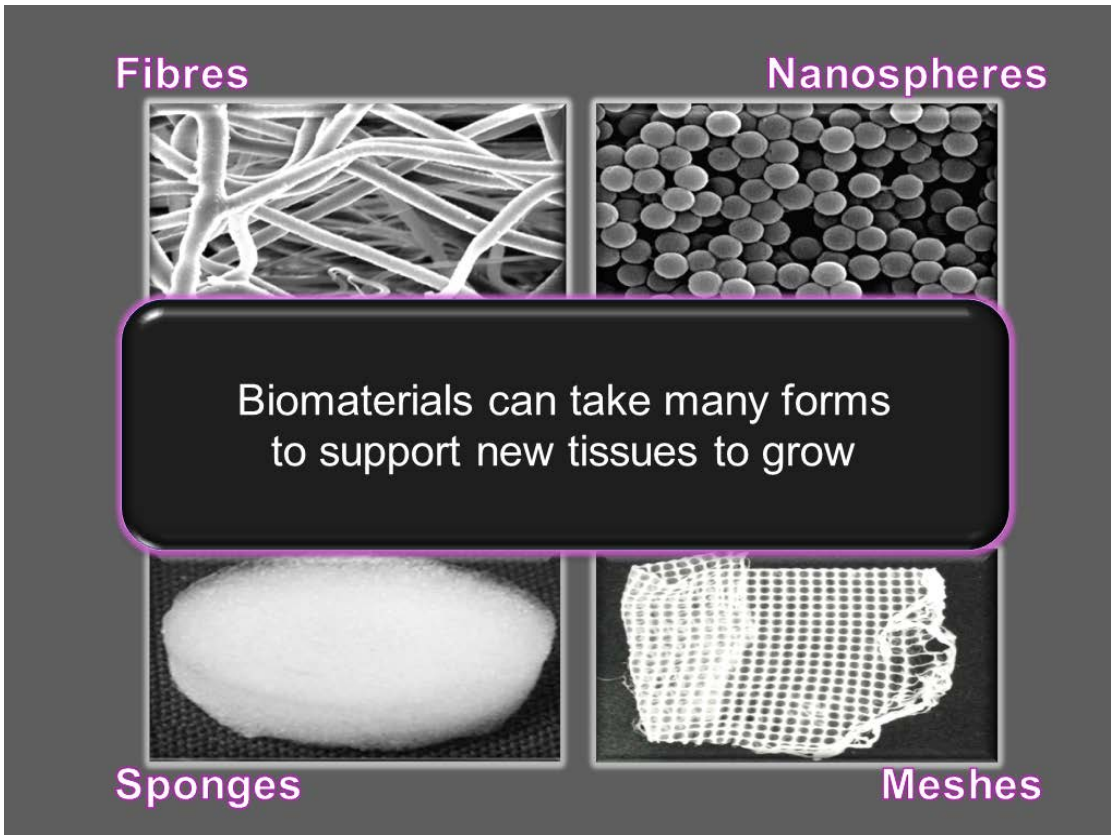

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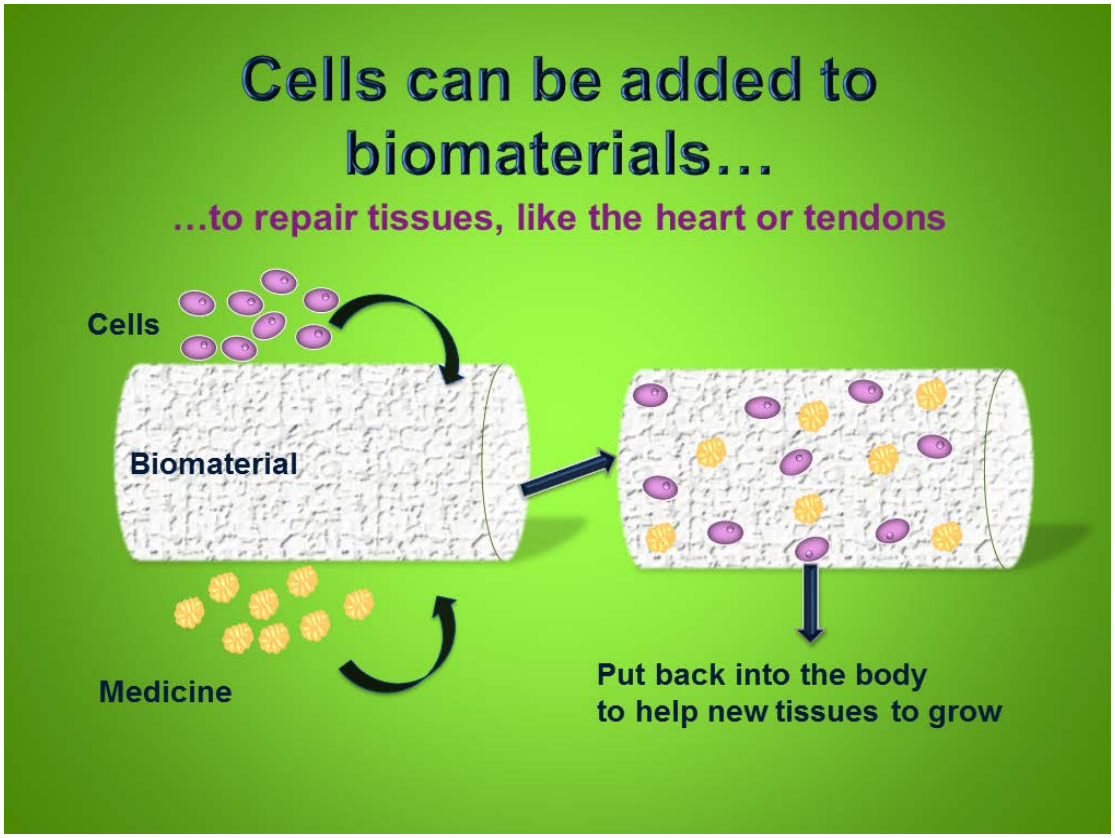

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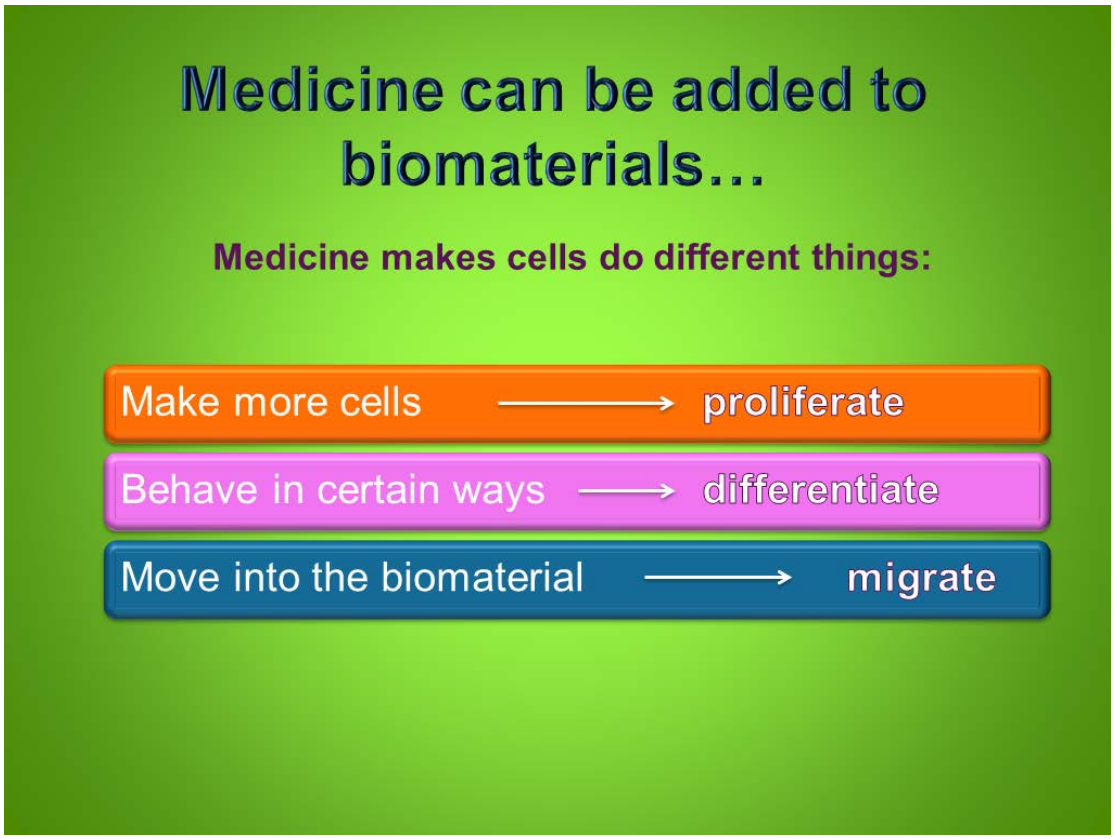

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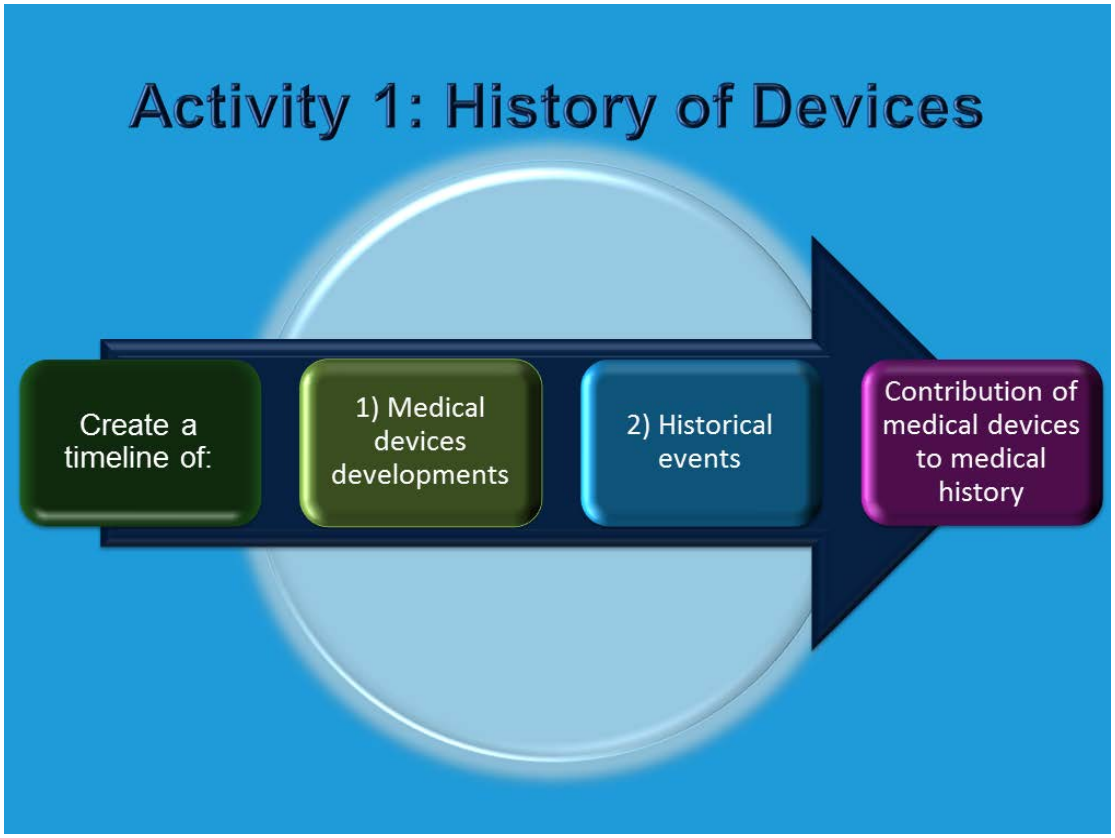

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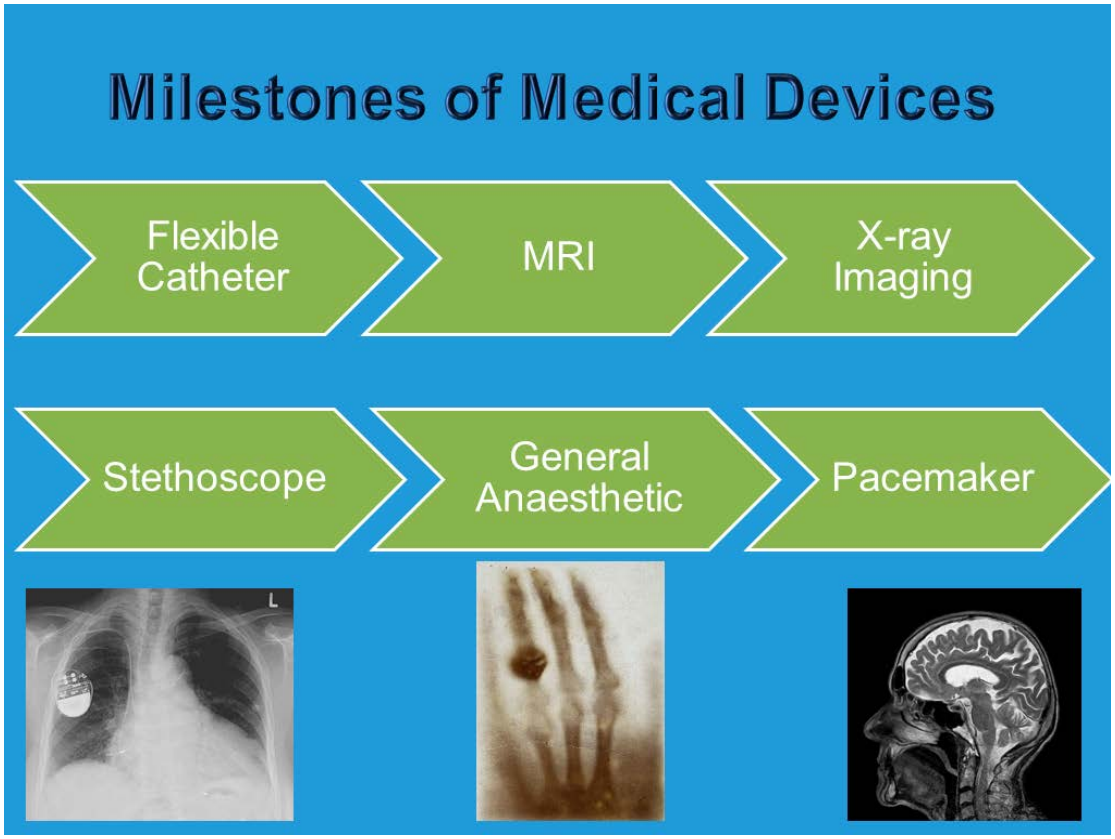

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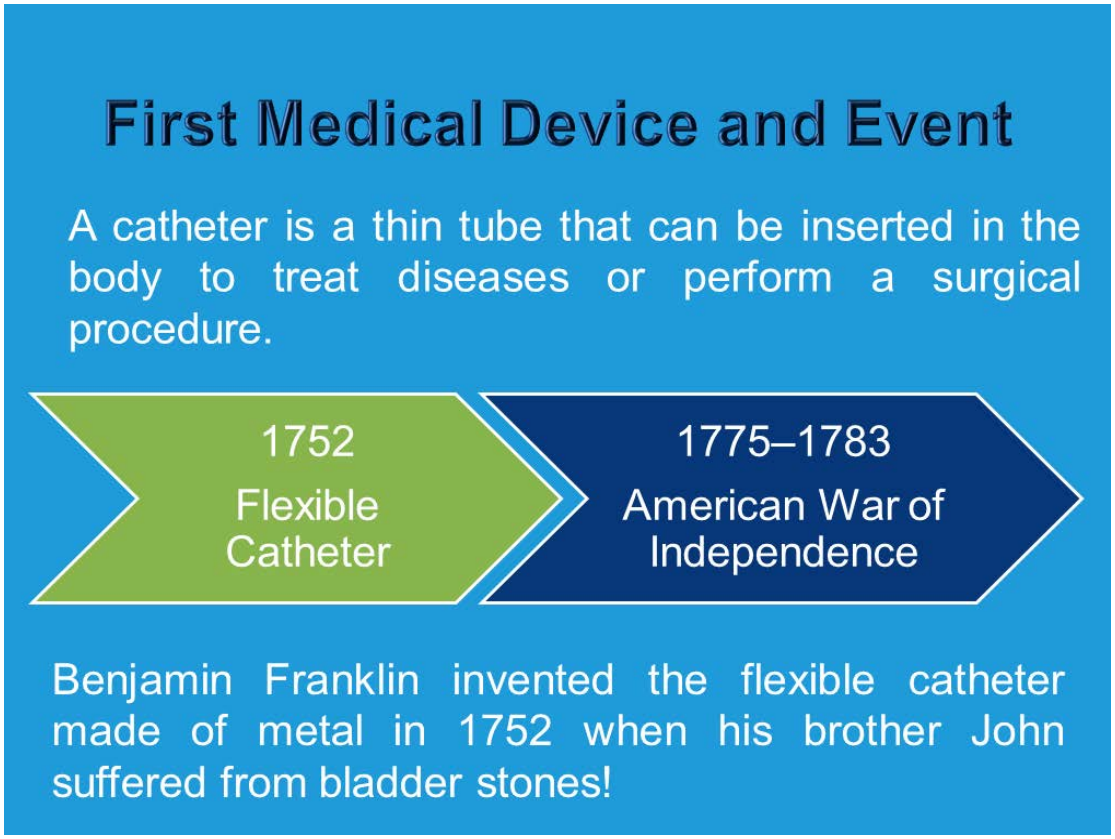
Slide 15



Slide 16

Second Medical Device and Event

A stethoscope is used to listen to the inside of the body, most often the lungs and heart.

René Laennec (France) invented the stethoscope because he was uncomfortable placing his ear on women's chests to hear heart sounds!

Slide 17

Third Medical Device and Event

A general anaesthetic allows medical procedures to be caused without pain.

Dr. Crawford W. Long used ether on a patient who had two tumours removed from the neck. The patient paid two dollars for the procedure.

Slide 18

Fourth Medical Device and Event

X-ray imaging creates pictures of the inside of your body shown in different shades of black and white.

German physics professor Wilhelm Röntgen took the first x-ray image of his wife's hand. When she saw the picture, she said "I have seen my death."

Slide 19

Fifth Medical Device and Event

Pacemakers are devices that use electrical impulses to regulate the beating of the heart if it is too slow, fast or irregular.

In 1932, American physiologist Albert Hyman built the first pacemaker that was powered by a hand-cranked motor.

Slide 20

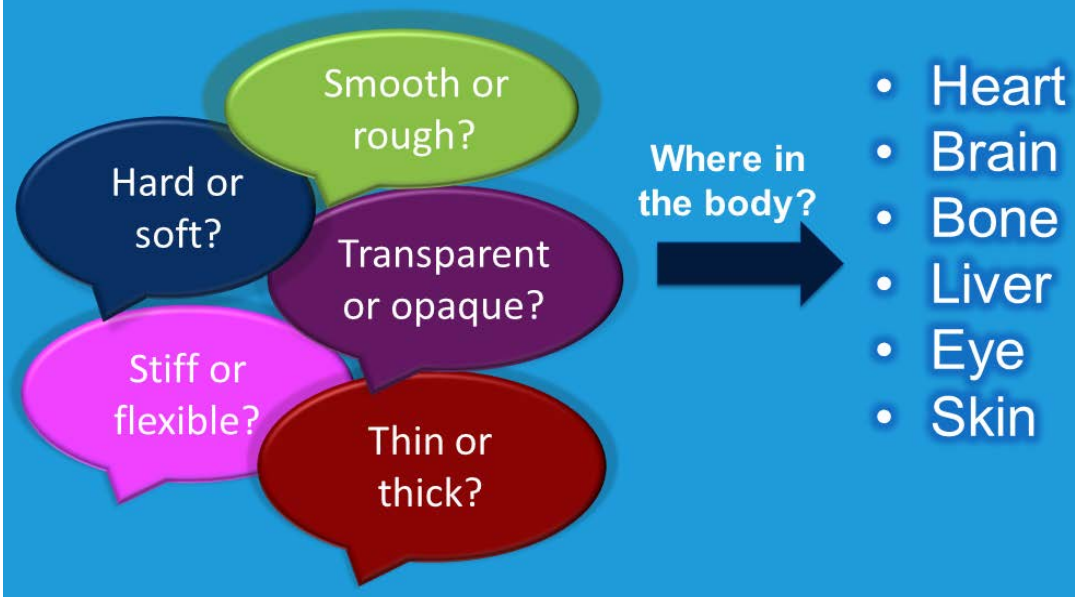
Sixth Medical Device and Event

Magnetic resonance imaging (MRI) is a medical imaging technique used to form pictures of the body using strong magnetic fields.

Raymond Vahan Damadian performed the first full body scan of a human in 1977 to diagnose cancer.

Slide 21

Activity 2: Properties of Biomaterials



Slide 22

Evaluation

3-2-1 Exit Ticket *Name*_____

3 THINGS I LEARNED FROM THIS LESSON:

1._____

2._____

3.

2 QUESTIONS I STILL HAVE:

1._____

2._____

1 IDEA THAT STUCK WITH YOU:

1._____

Slide 23

References:

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Slide 24

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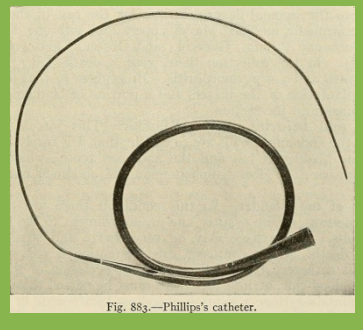
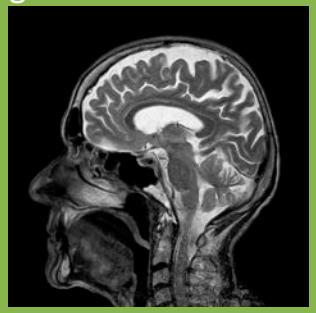
Slide 25

Stethoscope	General Anaesthetic	Pacemaker
Flexible Catheter	MRI	X-ray Imaging

Flexible Catheter: A catheter is a thin tube that can be inserted in the body to treat diseases or perform a surgical procedure.



MRI: Magnetic resonance imaging (MRI) is a medical imaging technique used to form pictures of the body using strong magnetic fields.

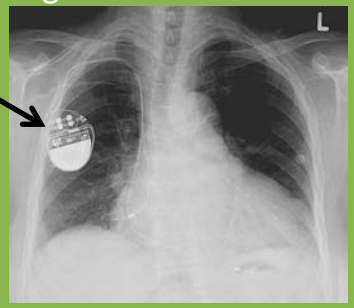


X-ray Imaging: X-ray imaging creates pictures of the inside of your body shown in different shades of black and white.

Stethoscope: A stethoscope is used to listen to the inside of the body, most often the lungs and heart.

General Anaesthetic: A general anaesthetic allows medical procedures to be caused without pain.

Pacemaker: Pacemakers are devices that use electrical impulses to regulate the beating of the heart if it is too slow, fast or irregular.



American Civil War	World War I Begins	Queen Victoria’s Reign Begins
American War of Independence	End of Soviet Union	World War II Begins

American War of Independence: The war was a revolt in which the American colonists in the Thirteen Colonies won independence from Great Britain, becoming the United States of America. The trigger for the war was when Great Britain began to impose new laws and taxes which angered the colonists. This resulted in the motto "No Taxation Without Representation."

End of Soviet Union: The Soviet Union was officially known as the Union of Soviet Socialist Republics (USSR). The country governed by the Communist Party and extended across all of Northern Asia and much of Eastern Europe. The end of the Soviet Union was complete when the country broke up into 15 independent states signalling the end of the Cold War.

World War II Begins: World War II was a global war in which the vast majority of the world's countries formed two opposing military alliances: the Allies and the Axis. Many events throughout the world led to the beginning of World War II. A few reasons are the Japanese wanting to expand, the rise of Hitler and the Nazi's, and the Great Depression.

American Civil War: The American Civil War was largely a result of the long-standing controversy over slavery. A collection of 11 southern states formed their own country, the Confederacy, in order to protect the institution of slavery. The Confederacy were at war with the Union, which was made of 20 states where slavery was prohibited or being legally phased out.

World War I Begins: The main cause for World War I was the assassination of the Archduke Franz Ferdinand of Austria who was heir to the throne of Austria and Hungary. The assassination was planned by a Serbian terrorist group, called The Black Hand. Austria-Hungary threatened war on Serbia. Germany sided with Austria-Hungary, while Russia sided with the Serbians.

Queen Victoria's Reign Begins: Queen Victoria reigned for over 63 years which was longer than anyone had before her. Her reign is known as the Victorian era, and was a period of industrial, cultural, political, scientific, and military change within the United Kingdom, and was marked by a great expansion of the British Empire.

3-2-1 Exit Ticket *Name*_____

3 THINGS I LEARNED FROM THIS LESSON:

1._____

2._____

3.

2 QUESTIONS I STILL HAVE:

1._____

2._____

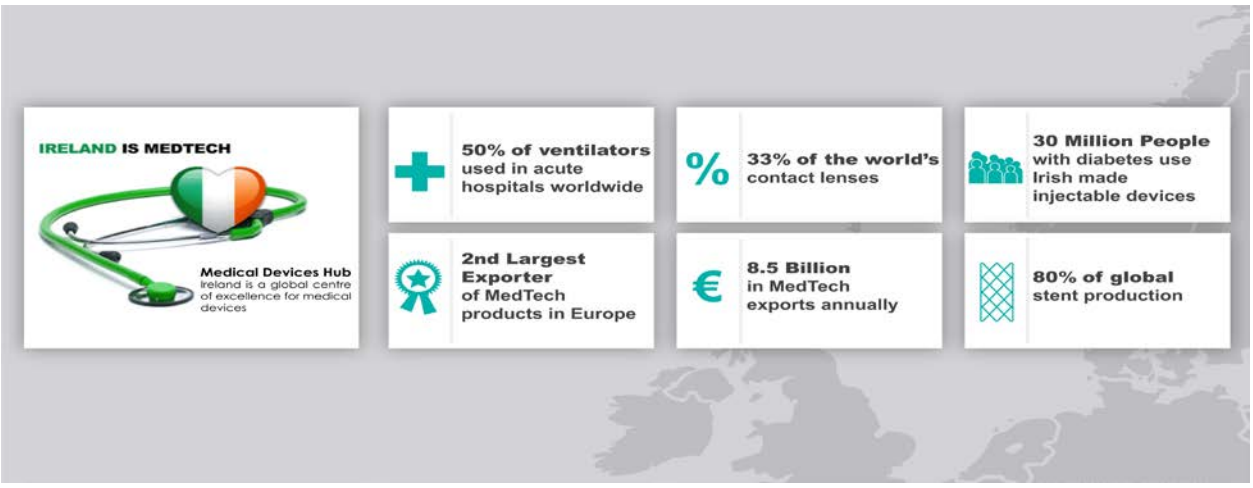
1 IDEA THAT STUCK WITH YOU:

1._____

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.

Companies plan to promote growth in the biomaterials and medical devices sector. Therefore, many opportunities for jobs will exist within this industry in Ireland. This area of work is multidisciplinary and requires people with a range of training including scientists, engineers, IT specialists, and medical graduates. Many types of jobs exist within this industry from inventing new devices, testing devices, maintaining equipment, and working with clinicians and patients. Major employers in Ireland include Johnson and Johnson, Boston Scientific, Medtronic, and Abbot Laboratories.



Source: IDA Ireland, 2017

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AngioMatTrain

brain mattrain

Tendon Therapy Train

Engineering *in vitro* microenvironments for translation of cell-based therapies for tendon repair

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