



Teachers in Residence

Biomaterials

Primary 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

Biomaterials Introduction Lesson

Primary School Curriculum Links

Strand:

Environmental Awareness and Care

Strand Unit:

Science and the Environment

Content Objectives:

Children should be enabled to:

- Appreciate the application of science and technology in familiar contexts.
- Examine some ways that science and technology have contributed positively to the use of the Earth's resources.
- Recognise the contribution of scientists to society.

Strand:

Materials

Strand Unit:

Properties and characteristics of materials

Content Objectives:

Children should be enabled to:

- Recognise that some materials decay naturally while others survive a long time in the environment.
- Identify how materials are used, made or caused by humankind.

Learning Outcomes

Children should be enabled to:

1. Appreciate what a biomaterial is.
2. Give examples of biomaterials.
3. Recognise why the design of biomaterials is important for their function.
4. Understand the uses of scaffolds and spheres in biomedical procedures.
5. Make a sphere using a natural biomaterial.

Keywords and Definitions

	Keyword	Definition
1.	Biomaterial	A material that can be engineered to help the body heal itself.
2.	Natural	Existing in or derived from a biological source; not made or caused by humankind. Ex. Alginate, collagen, or agarose.
3.	Synthetic	A material made by chemical synthesis, especially to imitate a natural product. Ex. Polymer, ceramic or metal.
4.	Biocompatible	Not harmful or toxic to living tissues.
5.	Scaffold	Made from biomaterials to guide the growth of new tissues.
6.	Proliferate	When cells make more cells.

7.	Differentiate	A cell behaving in a specific way.
8.	Migrate	Movement of a cell in a particular direction.
9.	Sphere	A tiny ball that medicine can be put inside and released from slowly.
10.	Alginate	A natural biomaterial that is made from seaweed.
11.	Sodium ion	An ion that holds on to one alginate and does not form a jelly. Given by the symbol Na^+ .
12.	Calcium ion	An ion that holds on to two alginates to form a jelly. Given by the symbol Ca^{2+} .
13.	Hydrogen ion	An ion of which the concentration determines the pH of a solution. Given by the symbol H^+ .
14.	pH	A measure of the number of hydrogen ions. A higher number of hydrogen ions results in a lower pH.
15.	Acidic	Containing a lower pH.

Learning Activities

Children will:

- Complete the K and W parts of the KWL chart.
- Learn about synthetic and natural sources of biomaterials.

- Learn about how biomaterials can be shaped into scaffolds to support new tissue growth.
- Learn how cells and medicine can be added to scaffolds.
- Learn how spheres can be used to slowly release medicine into scaffolds.
- Participate in a group activity to make spheres using a natural biomaterial and juices of differing pH.
- Observe how the pH of the juice affects the formation of the spheres.
- Evaluate their work using a worksheet.
- Fill in the L part of the KWL chart.

Extra Info / Files

	Web Address	Brief Description
1.	www.youtube.com/watch?v=ptE8dEdSbeY	Biomaterials
2.	www.youtube.com/watch?v=T_uMkdKS6wQ&t=213s	Biomaterials
3.	www.youtube.com/watch?v=6kp6qhxchdg	Spherification

Resources

- Teacher Lesson Plan
- PowerPoint to guide lesson
- Interactive KWL worksheet
- Evaluation sheet
- One set of materials for each group making spheres:

- Containers of pre-blended sodium alginate with different juices of varying pH
- Bowl of distilled water mixed with calcium lactate
- 20mL syringes for each juice
- Small sieve/spoon/molecular gastronomy spoon
- Paper towel
- Teacher's Tip:
 - Juices that work best include carrot, apple, blueberry, and cranberry. Lemon juice can be used as an example of a juice that has too high of a pH to form the spheres.
 - Amazon sells a Special Ingredients Molecular Gastronomy Spherification and Reverse Spherification Kit. The kit includes 50g of sodium alginate, 50g of calcium lactate, 5 x 3mL pipettes, 3 x 50mL syringes and instructions.

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 – making of spheres
- 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

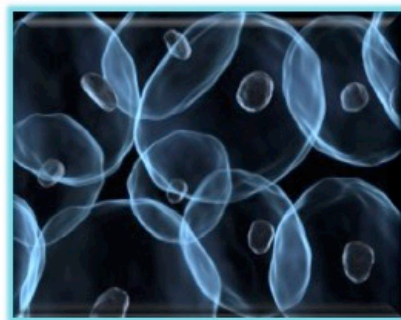
Differentiation By:

- Teaching style
- Support
- Task

Power Point Presentation – Biomaterials



Slide 1



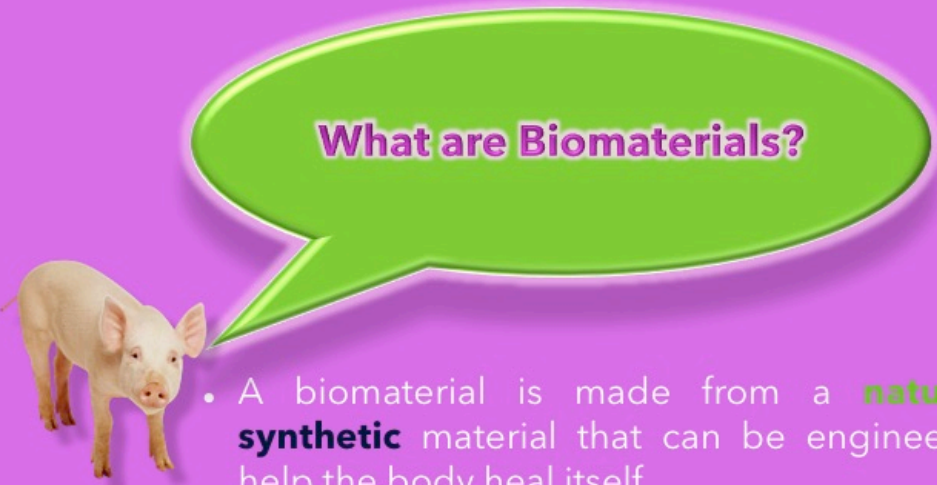
Teachers in Residence Programme
Iseult Mangan and Tom Flanagan

Slide 2

K-W-L Chart		
Topic: <u>Biomaterials</u>		
What I Know	What I Want to Know	What I Learned

whynotajournal.com

Slide 3



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 4



Slide 5

SYNTHETIC BIOMATERIALS

Materials made by humans, like plastic or metal



Good:

They are easy to make and exactly the way you need

Bad:

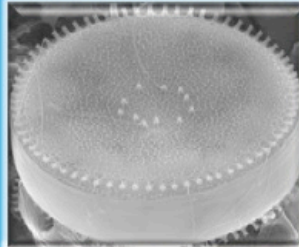
Sometimes the body does not like them

Slide 6

NATURAL BIOMATERIALS

Materials from nature and made from cells

Algae found
in freshwater
and seawater



Shells of crabs
and prawns

Silk from
butterfly
cocoons



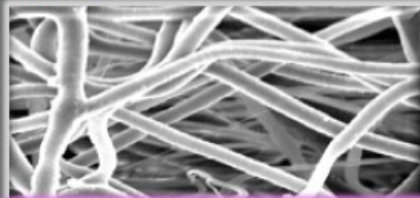
Alginate from
seaweed

Good: The body likes them

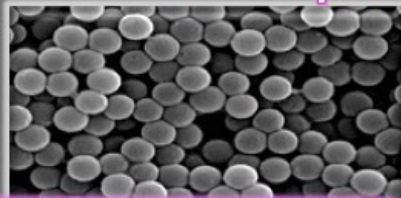
Bad: People can't make them

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Fibres

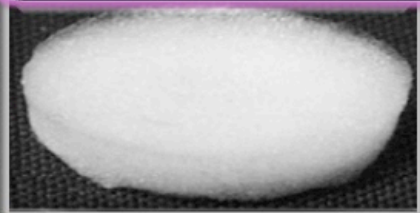


Nanospheres

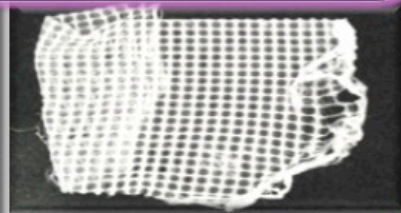


Scaffolds can be made out of biomaterials
to support new tissues to grow

Sponges



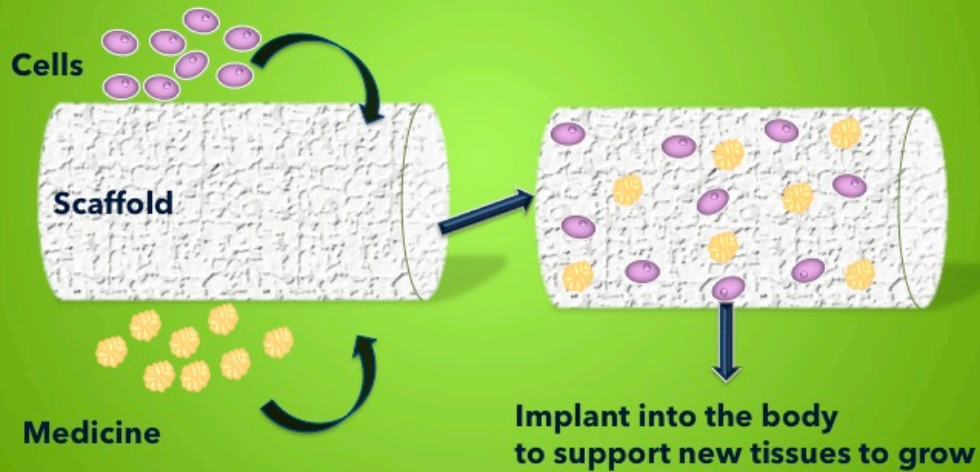
Meshes



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Cells can be added to scaffolds...

...to repair tissues, like the heart or tendons



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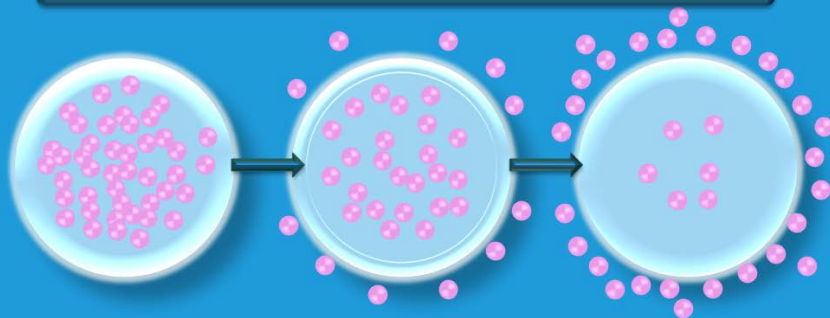
MEDICINE CAN BE ADDED TO SCAFFOLDS

Medicine makes cells do different things:

Make more cells —————> proliferate

Behave in certain ways —————> differentiate

Move into scaffold —————> migrate

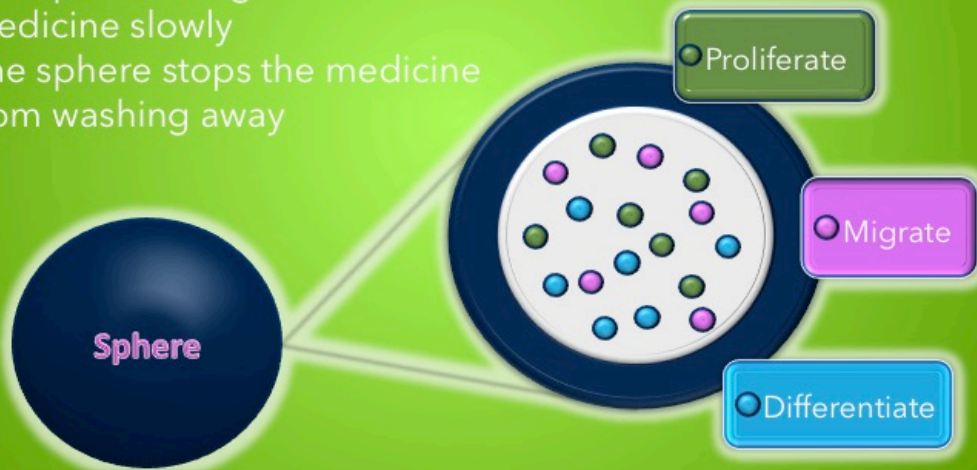


Medicine in a sphere can be released over a long period of time

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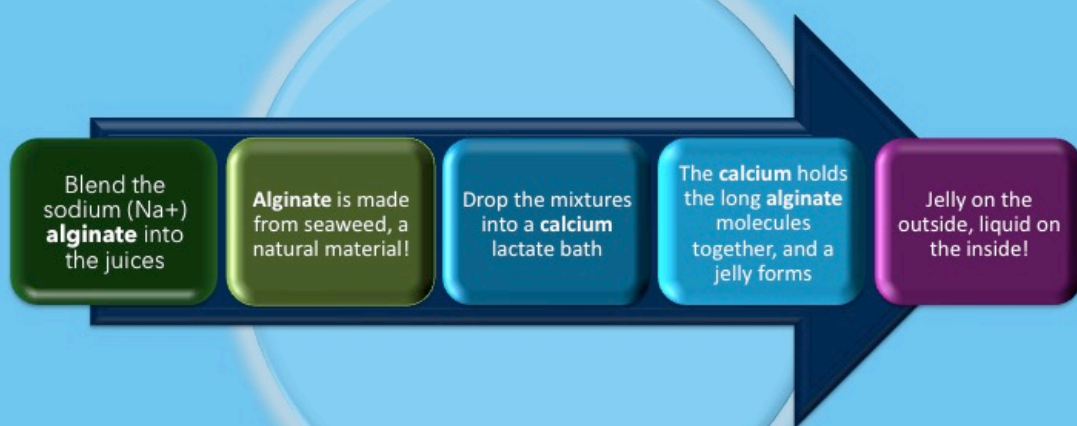
Spheres protect the medicine

- The medicine can be put into a very tiny ball called a **sphere**
- The sphere lets go of the medicine slowly
- The sphere stops the medicine from washing away



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Activity: Make some energy spheres

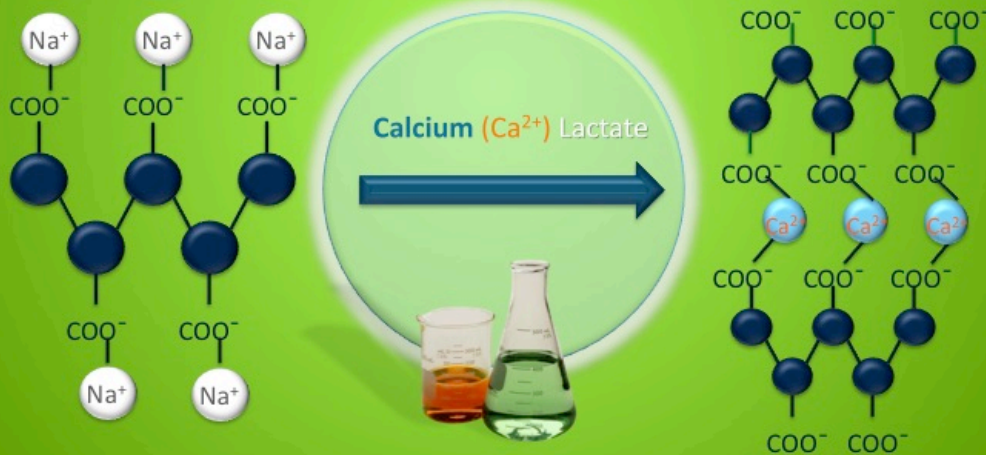


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How a sphere forms

Sodium (Na^+)
holds on to one
alginate

Calcium (Ca^{2+}) holds
on to two **alginates**
to form a jelly

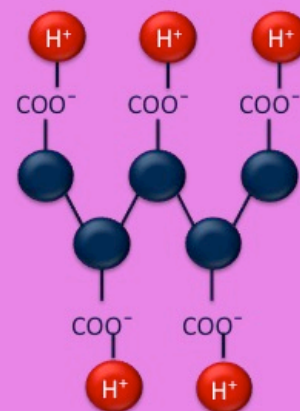


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How a sphere forms

If the pH is too low, the **alginate** binds with **hydrogen** instead of the **calcium** and no jelly forms!

Hydrogen (H^+) Ions	pH	Examples
10,000,000	0	Battery acid
1,000,000	1	Hydrochloric acid
100,000	2	Lemon juice
10,000	3	Orange juice
1,000	4	Tomato juice
100	5	Coffee
10	6	Saliva
1	7	Water



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Did you know?

- A sour taste comes from hydrogen ions (H^+)
- If something is sour, it is acidic
- If you like the taste of things that are sour, such as sour sweets, you actually like the taste of hydrogen ions!

Hydrogen (H^+) Ions	pH	Sweets
400,000	1.6	Warheads
80,000	2.2	Sour Skittles
60,000	2.4	Fruity Mentos
10,000	3	Sour Gummy Bears
10,000	3	Sweet Tarts
1	7	Water

But be careful: The outside layer of your teeth begins to break down when acid levels are below a pH of 4.0!

Slide 15



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Slide 16

References:

1. gpwalsh.com/the-shift/
2. www.gojiberryblog.com
3. animals.nationalgeographic.com
4. www.qmed.com/
5. www.webmd.com/osteoarthritis/ss/slideshow-knee-replacement

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AngioMatTrain



Tendon Therapy Train



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K-W-L Chart

Topic: Biomaterials

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

BIOMATERIALS

Draw a picture of the different spheres that you created.

A large, empty rectangular box with a thin black border, intended for drawing the different spheres created.

Do you think that all the juices created spheres successfully? Why or why not?

If you were making the spheres again, what would you do differently?

State three things that you learned today:

1. _____

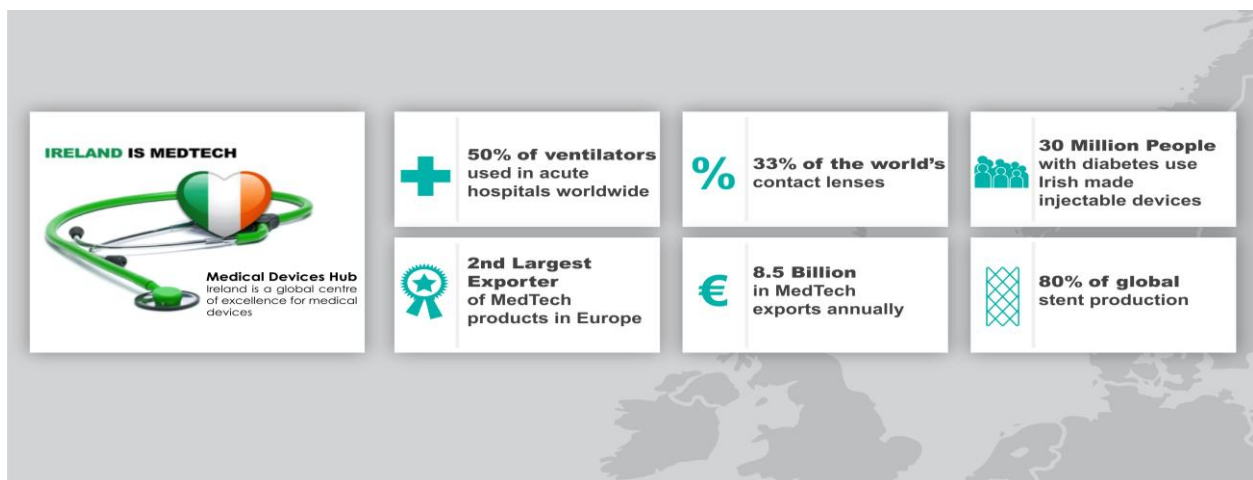
2. _____

3. _____

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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