Teachers in Residence

The Brain and Spinal Cord

Primary Level Lesson Plan

cúram Research Ireland Centre for Medical Devices

Taighde Éireann Research Ireland

"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: https://curamdevices.ie/public-engagement/teachers/. 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

Brain and Spinal Cord Lesson Plan

Primary School Curriculum Links

Strand:

Environmental Awareness and Care

Strand Unit:

Science and the Environment

Content Objectives:

- 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:

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

Strand:

Living Things

Strand Unit:

Human Life

Content Objective:

Develop a simple understanding of the structure of some of the body's major internal and external organs.

Learning Outcomes

Children should be enabled to:

1. Understand what a neuron is.
2. Understand how a neuron sends and receives a message.
3. Know the general function of neurotransmitters.
4. Be familiar with some of the symptoms of Parkinson's disease.
5. Know the cause of Parkinson's disease - lack of dopamine.
6. Be familiar with the concept of Deep Brain Stimulation as a treatment for Parkinson's disease.
7. Understand the importance of using appropriate biomaterials to design medical devices.
8. Recognise why the design of a medical device is important for its function.
9. Design a medical device.

Keywords and Definitions

	Keyword	Definition
1.	**Neuron**	A specialised cell that can send and receive messages using neurotransmitters.
2.	**Synapse**	A gap between two neurons that a message must jump across.
3.	**Neurotransmitter**	Chemicals made by neurons that carry messages across synapses.
4.	**Dopamine**	A type of neurotransmitter made by neurons in the brain.
5.	**Vesicle**	In a neuron, a vesicle releases neurotransmitters at the synapse.
6.	**Receptor**	In a neuron, a receptor receives neurotransmitters at the synapse.
7.	**Symptom**	A sign indicating the presence of an illness.
8.	**Tremor**	Involuntary, rhythmic shaking of the muscles.
9.	**Diagnose**	Identify the nature of an illness or other problem by examining the symptoms.
10.	**Treat**	Give medical care or attention to.

11.	**Substantia Nigra**	Area located in the midbrain that plays an important role in movement.
12.	**Biomaterial**	A material that can be engineered to help the body heal itself.
13.	**Minimally Invasive**	Can be inserted into the body without causing damage.
14.	**Biomedical Engineering**	The combination of engineering and medicine to help improve people's health.
15.	**Deep Brain Stimulation**	Use of electrical activity to stimulate neurons.
16.	**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.

Learning Activities

Children will:

- Complete the K and W parts of the KWL chart.
- Watch a video with Michael J. Fox discussing symptoms of Parkinson's disease.
- Discuss what it might be like living with Parkinson's disease.
- Learn about neurons communicating using neurotransmitters, in particular dopamine.

- Demonstrate how dopamine carries a message across a synapse with students acting as neuron vesicles and receptors.
- Engage in talk and discussion on medical devices to treat Parkinson's disease using Deep Brain Stimulation.
- Participate in a group activity to construct a medical device which is minimally invasive to treat Parkinson's disease.
- Present their work to the class.
- Evaluate their work using a worksheet.
- Fill in the L part of the KWL chart.

Extra Info / Files

	Web Address	Brief Description
	www.webmd.com/parkinsons-disease/ss/slideshow-index	"Slideshow: A Visual Guide to Parkinson's"

Resources Provided

- Teacher Lesson Plan
- PowerPoint to guide lesson
- Interactive KWL worksheet
- Evaluation worksheet
- Optional: "Draw My Parkinson's"-An 8 minute stop motion animation made by CÚRAM researcher, Joelle Bizeau, explaining the cause of Parkinson's disease and treatments being developed by CÚRAM using biomaterials. The film can be viewed using the following link: https://www.youtube.com/watch?v=aNND-ORY4tI.

Materials Needed

- In advance of the lesson to make jelly "brains":
    - Blocks of 135g jelly depending on how many "brains" you are making (1 block makes 200mL)
    - Muffin liners
    - Muffin tin
    - Black marker (**Note:** Must be permanent)
    - Liquid measuring cup (up to 100mL)
    - Water
    - Microwave
    - Microwave safe bowl

- For the demonstration:
    - Three plastic eggs
    - A piece of paper with "Jump" written on it
    - A piece of paper with "Three times" written on it
    - A piece of paper with "Forwards and backwards" written on it
    - Optional: Long piece of string

- For the activity:
    - Straws
    - Pipe cleaners
    - Ice lolly sticks
    - Toothpicks
    - Paper clips
    - Scissors
    - Tape

Instructions

- In advance of the lesson, prepare the jelly "brains":
    - Place muffin liners into a muffin tin.
    - Using the black marker, make a dot on the bottom of the muffin liner approximately ½cm in diameter.
    - Break up the block of jelly into cubes.
    - Place the jelly cubes in a microwave safe bowl.
    - Add 100mL water and heat for approximately 1 minute or according to the recommendations on the package.
    - Stir until completely dissolved.
    - Make up to 200mL with cold water. **Note:** The jelly needs to be concentrated so make up to 200mL rather than the amount recommended on the package.
    - Pour the mixture into muffin liners and refrigerate to set. **Note:** Make sure enough jelly is poured into to the muffin liner so that the brain is deep enough for the students to work with.
    - Repeat until enough jelly "brains" are made for the class.

- For the demonstration:
    - Prepare three plastic eggs carrying separate parts of the message:
        - Egg 1 = "Jump"
        - Egg 2 = "Three times"
        - Egg 3 = "Forwards and Backwards"
    - Form a first line of three students-This line represents neuron 1, each student represents a vesicle on neuron 1.

- Form a second line of three students-This line represents neuron 2, each student represents a receptor on neuron 2.
- Optional: You can put a large string around the three students in each line to emphasise that they are part of one neuron.
- Only two of the students in neuron 1 get a plastic egg containing a message inside of it. **Note:** The two plastic eggs represent low levels of dopamine:
  - Egg 1 = "Jump"
  - Egg 2 = "Three times"
- The two students in neuron 1 throw the plastic eggs across the "synapse" to two students in neuron 2.
- The students in neuron 2 perform the task given by combining the messages in the two plastic eggs.
- Since only two plastic eggs crossed the synapse, the students in neuron 2 did not receive the entire message and will not be able to perform the task properly. (They will "jump three times", but not "forwards and backwards")
- All three of the students in neuron 1 get a plastic egg containing a message inside of it. **Note:** The three plastic eggs represent correct levels of dopamine:
  - Egg 1 = "Jump"
  - Egg 2 = "Three times"
  - Egg 3 = "Forwards and Backwards"
- The three students in neuron 1 throw the plastic eggs across the "synapse" to three students in neuron 2.
- The students in neuron 2 perform the task given by combining the messages in the three plastic eggs.

    - Since three plastic eggs crossed the synapse, the students in neuron 2 received the entire message and will be able to perform the task properly. (They will "jump three times forwards and backwards")

- For the activity:
    - Divide the class into groups of two, three or four depending on class size and amount of materials.
    - Each group is given scissors, tape, and a "Biomedical Engineering Kit" containing any assortment of the following: Straws, pipe cleaners, ice lolly sticks, toothpicks, and/or paper clips.
    - The students plan and build a medical device for Deep Brain Stimulation to treat Parkinson's disease on their jelly brain.
    - **Note:** The medical device must: 1) Be able to reach deep into the brain, 2) Not cause damage to the brain, and 3) Be easy for the surgeon to use.
    - Once the medical device is built, each group is given a jelly brain.
    - Using the black dot at the bottom of the muffin liner as a target, the students test the medical device on their jelly brain. The human brain feels the same as jelly!
    - The students examine the damage caused to their jelly brains after testing their medical device.

Teachers' Tips

- Flashcards can be used to introduce new language for younger children at the beginning of the lesson.
- Brain moulds can be used in place of muffin liners and can be purchased from www.amazon.co.uk. Just make sure to line the moulds with a little bit of olive oil before filling with the jelly mixture. Ones that we have found that work well can be viewed using the following link: https://www.amazon.co.uk/dp/B003AQB2XK/ref=pe_3187911_185740111_TE_item.
- Do not hand out the jelly brains until after the students have designed their medical devices, otherwise they will just play with the jelly.
- Have some extra jelly brains as they tend to get seriously damaged!

Methodologies

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

Assessment

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

Linkage and Integration

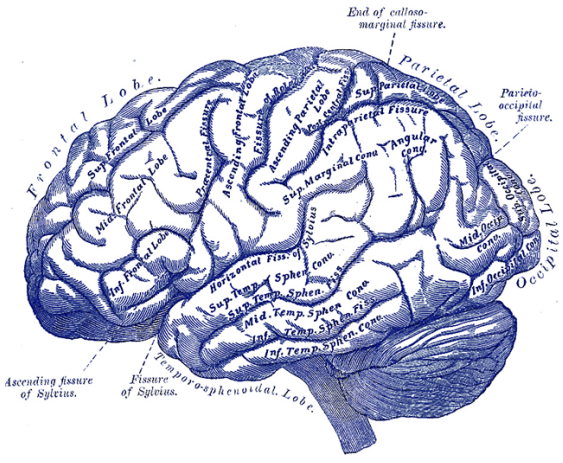
- **Maths** – problem solving
- **STEM** – I.T. / Engineering
- **Art** – construction
- **S.P.H.E.** – working together co-operatively
- **English** – oral language through talk and discussion and presenting their work

Differentiation by:

- Teaching style
- Support
- Task

PowerPoint Presentation – Brain and Spinal Cord

Slide 1



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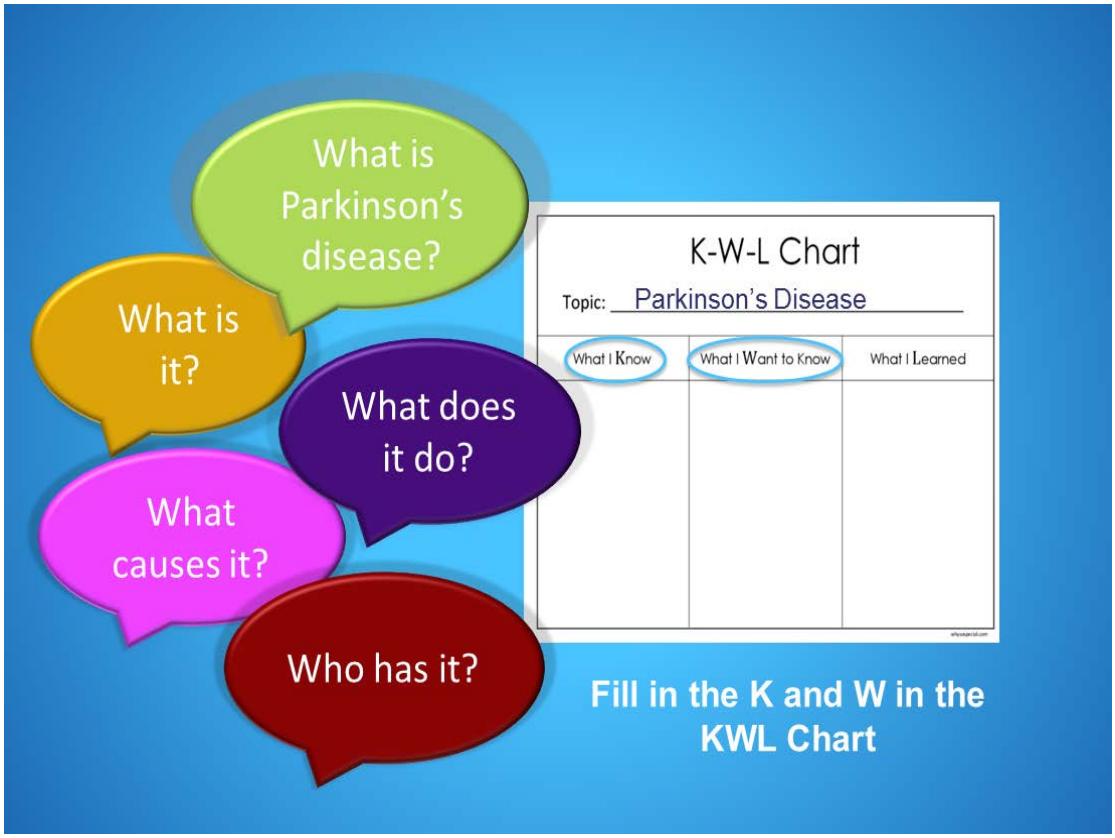
Centre for Research in Medical Devices

Teachers in Residence Programme
Carmel Rourke and Ann McGreevy

Slide 2



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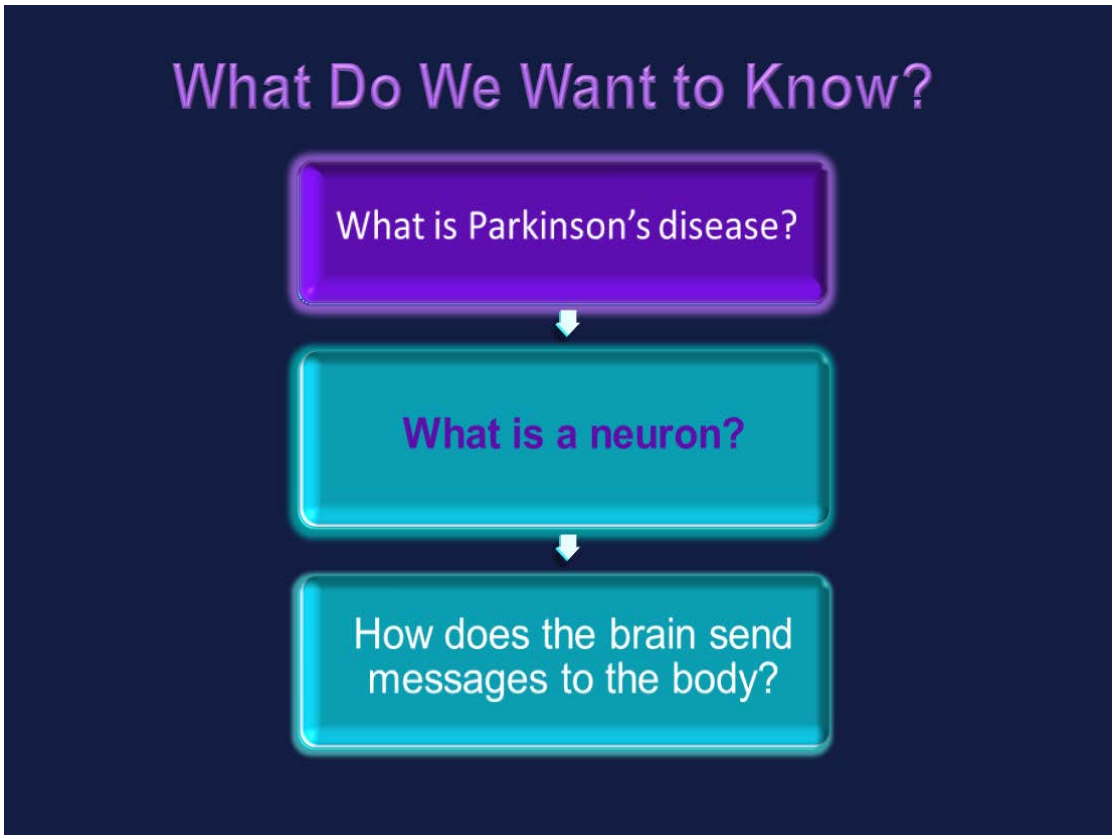

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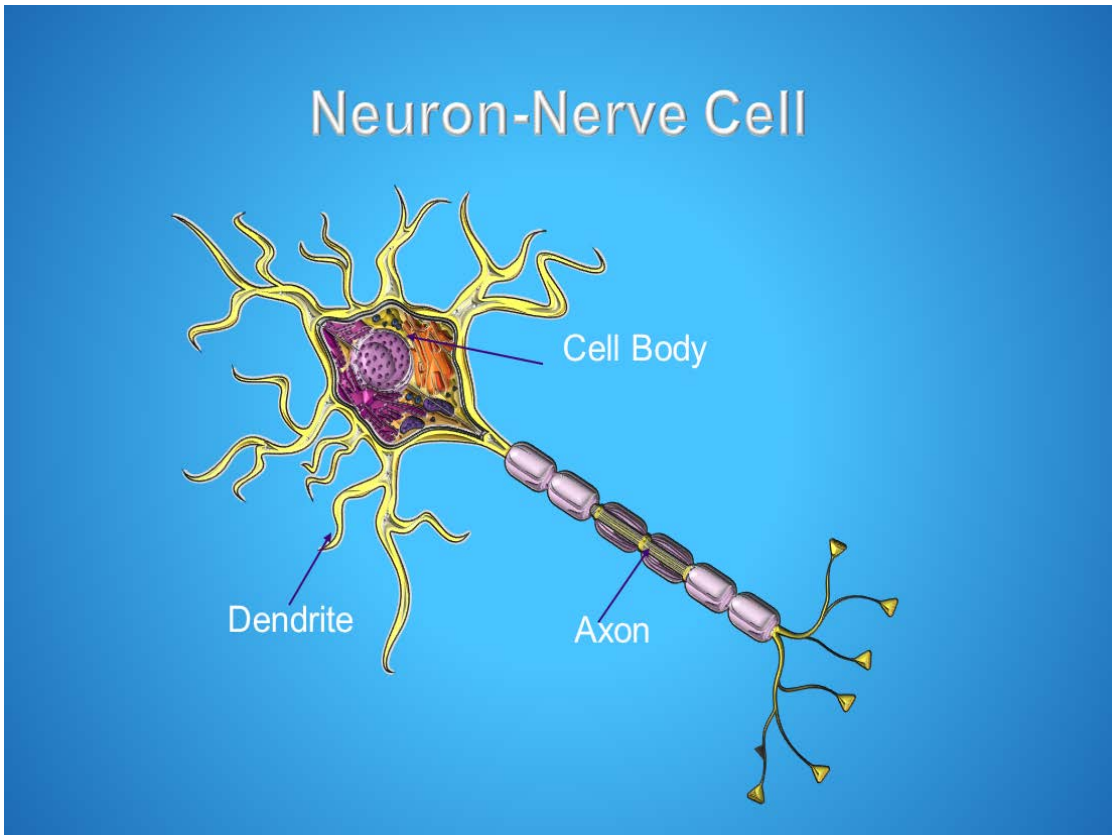

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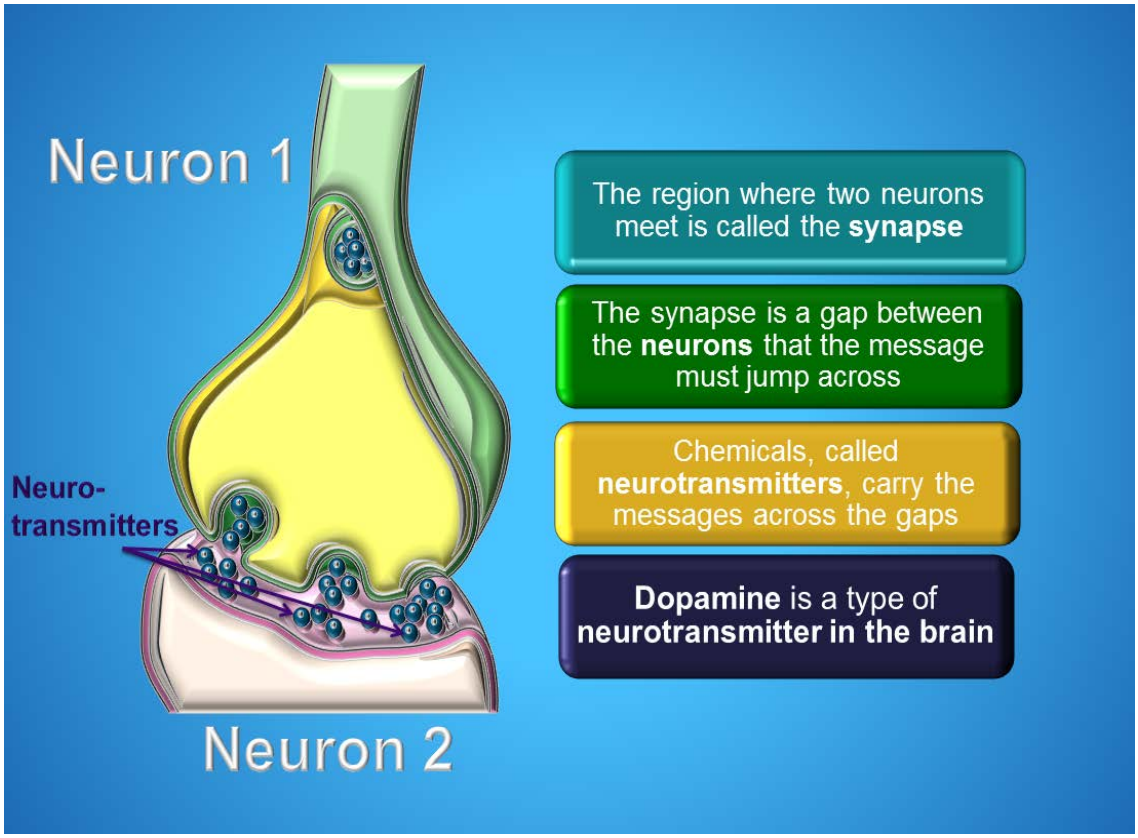

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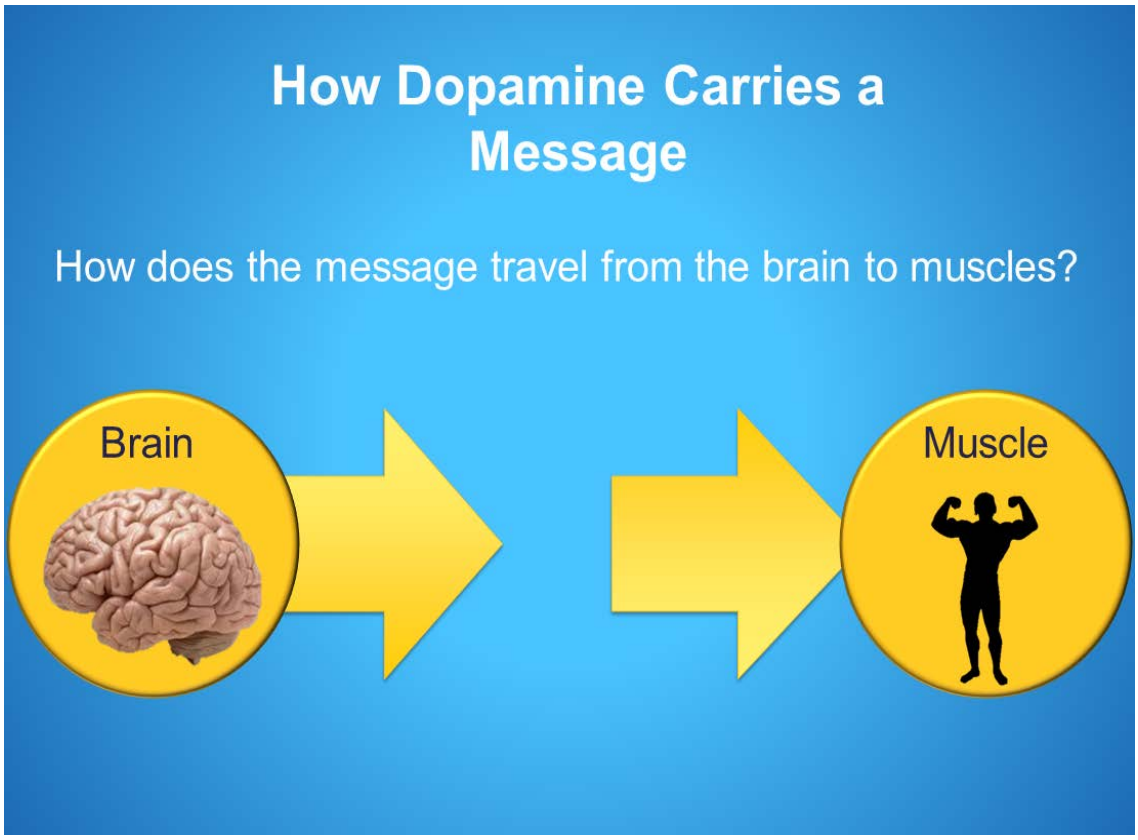

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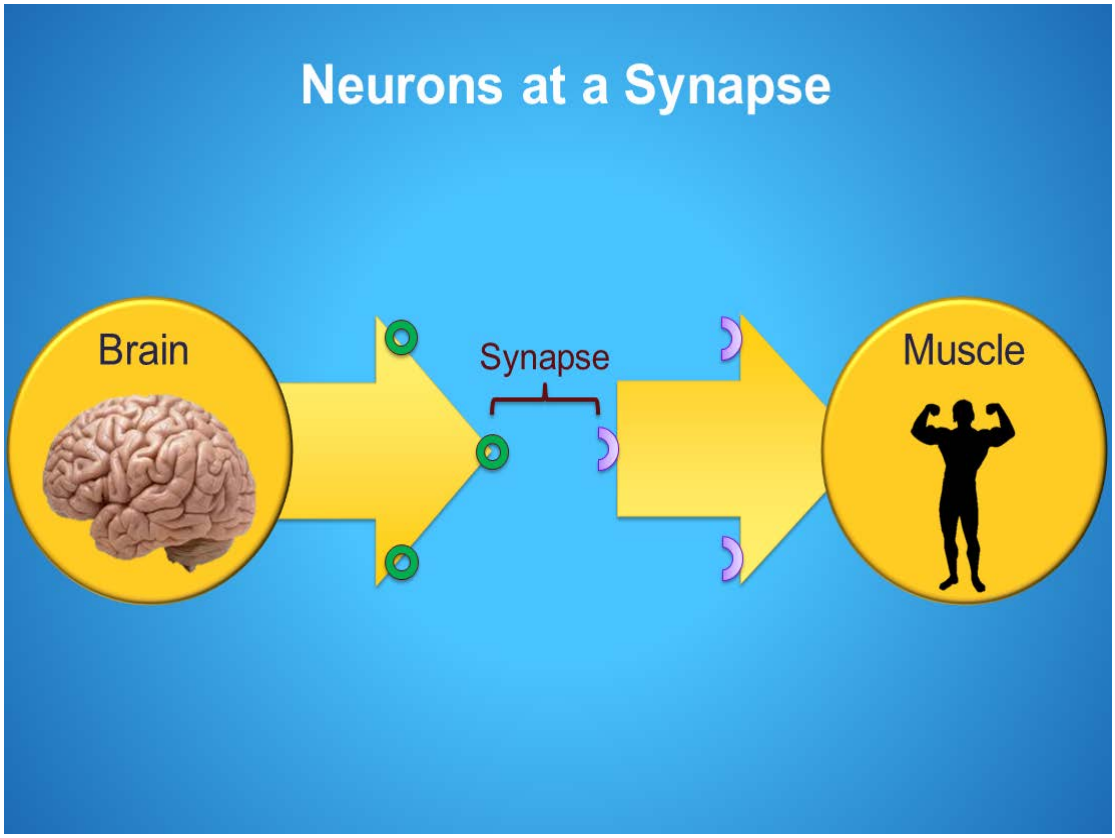

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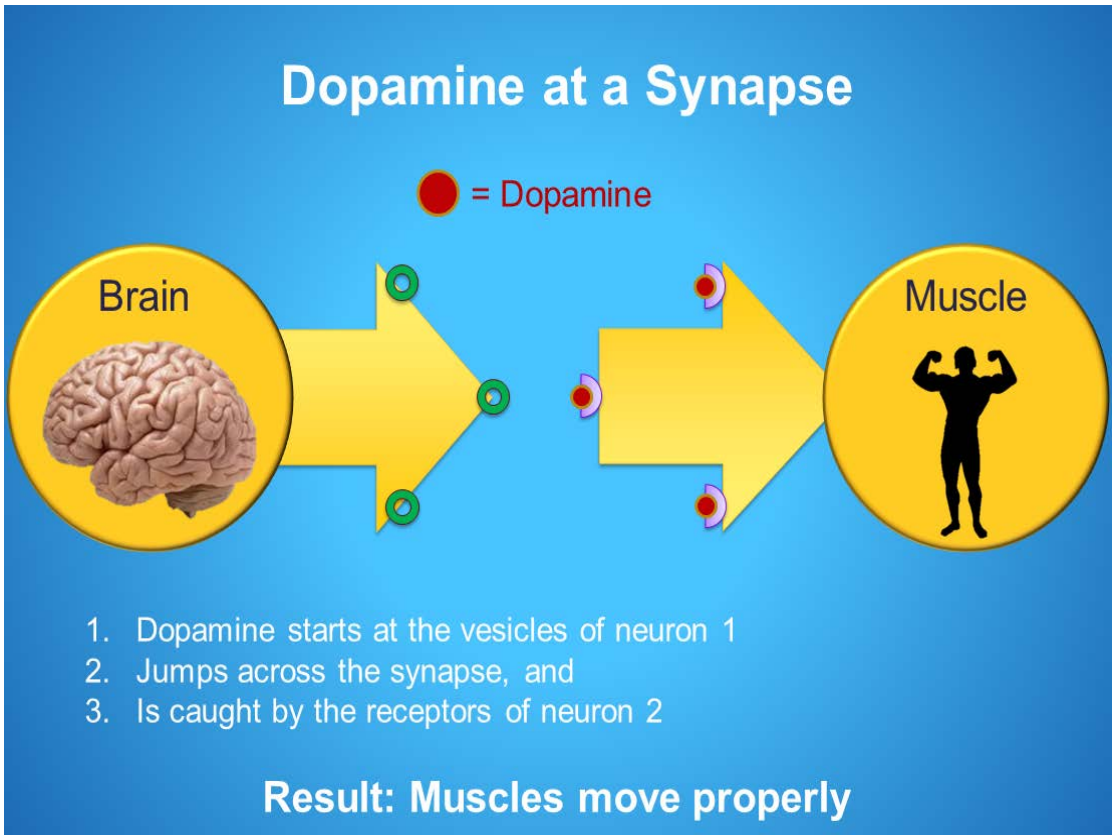

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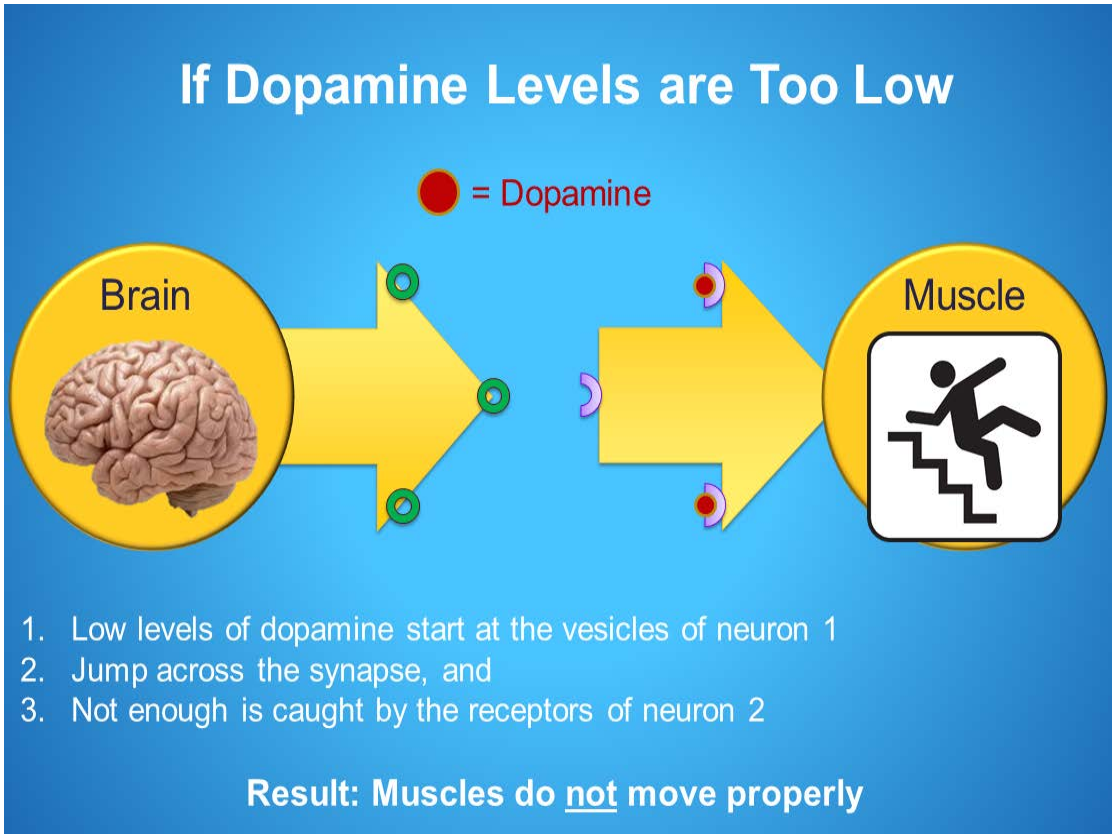

Slide 11

Demonstration: Students Act as Neuron Receptors

1. Form a first line of three students
   - The first line represents **neuron 1**
   - Each student represents a **vesicle** on neuron 1
2. Form a second line of three students
   - The second line represents **neuron 2**
   - Each student represents a **receptor** on neuron 2

Slide 12

If Dopamine Levels are Too Low

3. Two of the students in **neuron 1** get a plastic egg containing a message inside of it. The two plastic eggs represent low levels of **dopamine**.
4. The two students in **neuron 1** throw the plastic eggs across the "**synapse**" to two students in **neuron 2**.
5. The two students in **neuron 2** perform the task given by combining the messages in the two plastic eggs.
6. Since only two plastic eggs crossed the **synapse**, the students in **neuron 2** did not receive the entire message and will not be able to perform the task properly.

Slide 13

If Dopamine Levels are Correct

7. Three of the students in **neuron 1** get a plastic egg containing a message inside of it. The three plastic eggs represent correct levels of **dopamine**.
8. The three students in **neuron 1** throw the plastic eggs across the "**synapse**" to three students in **neuron 2**.
9. The three students in **neuron 2** perform the task given by combining the messages in the three plastic eggs.
10. Since three plastic eggs crossed the **synapse**, the students in **neuron 2** received the entire message and will be able to perform the task properly.

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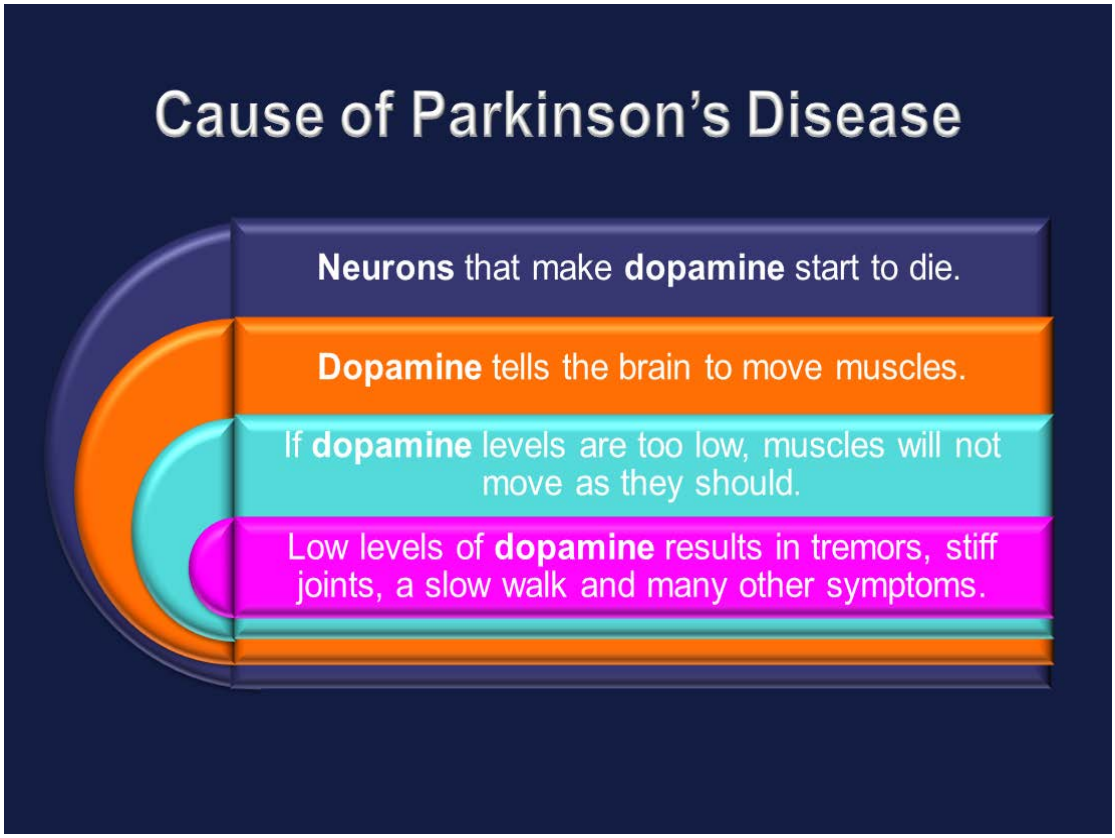

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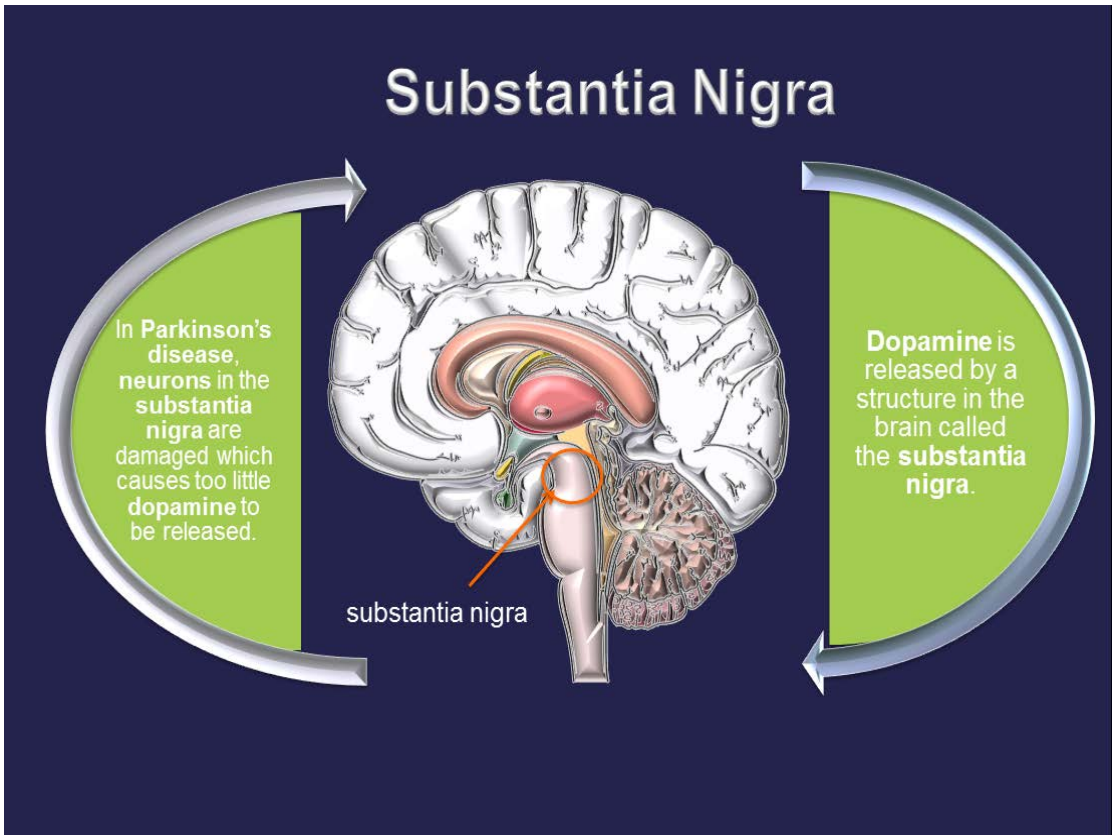

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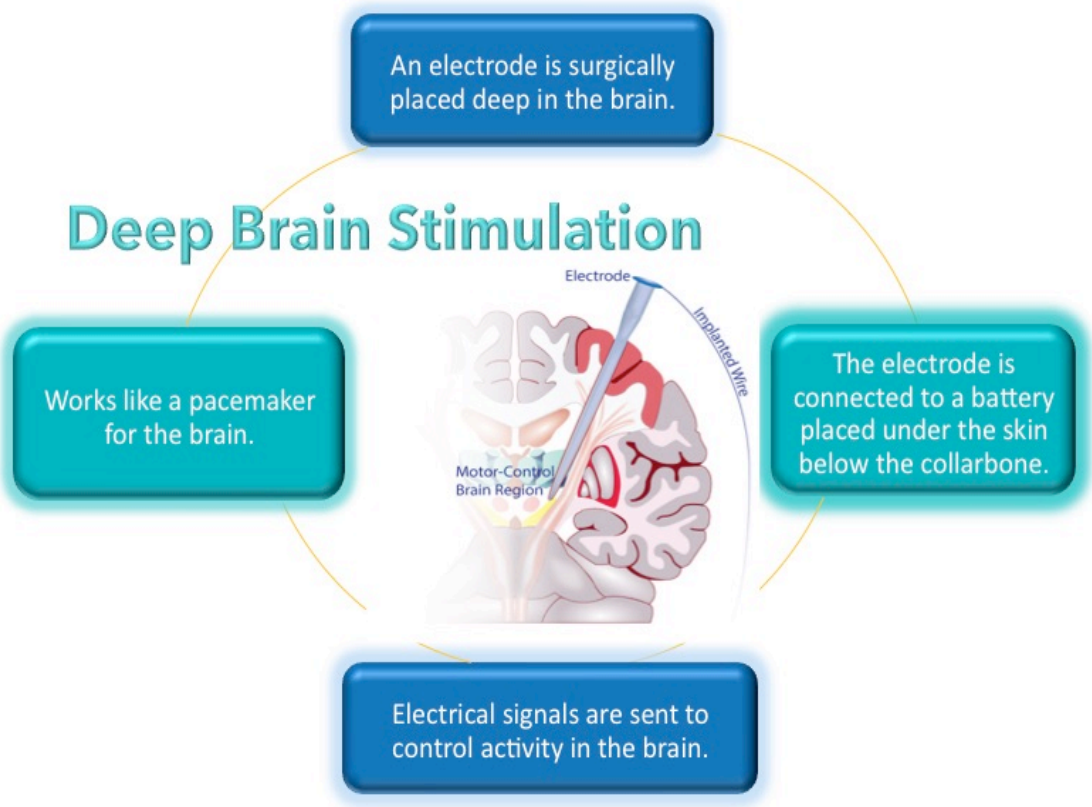

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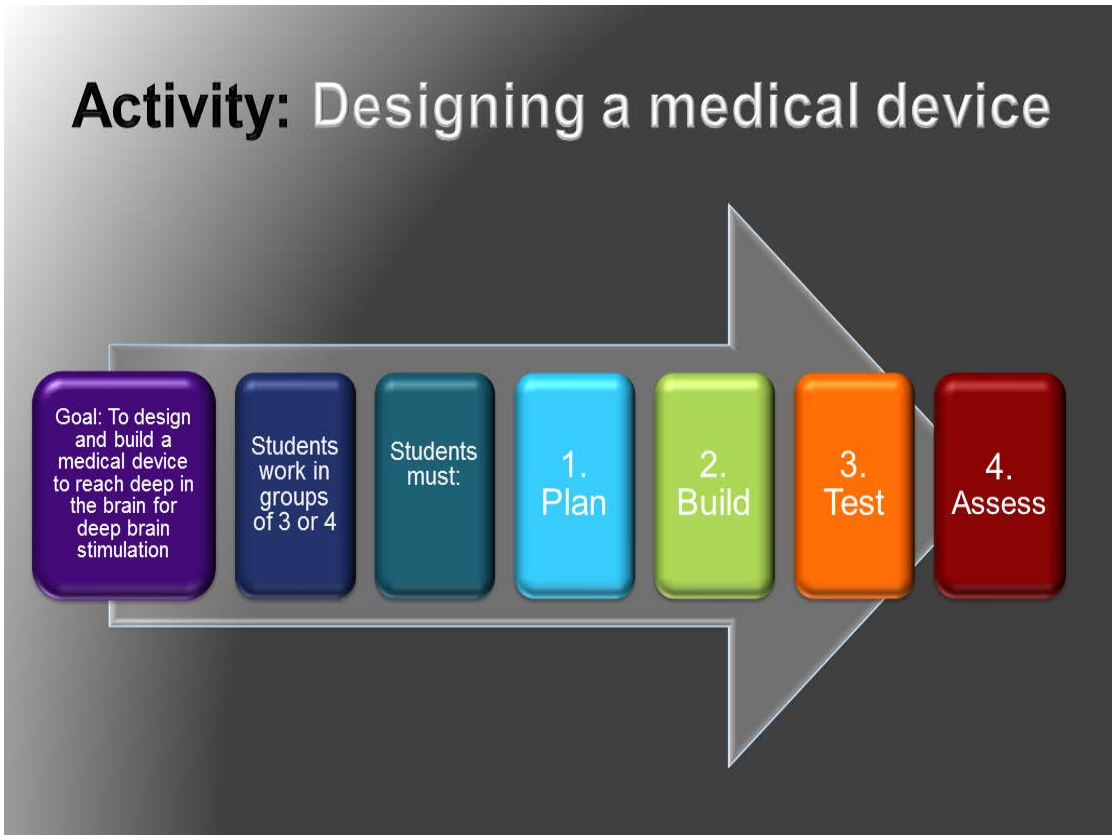

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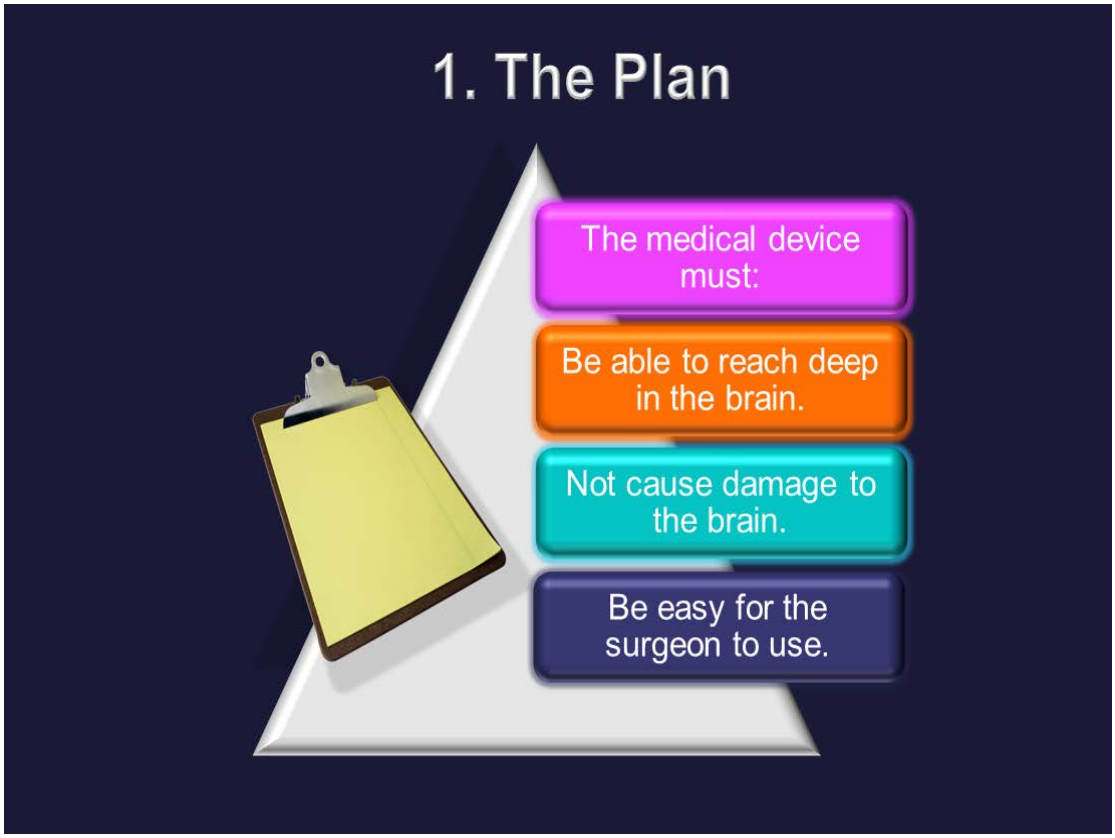

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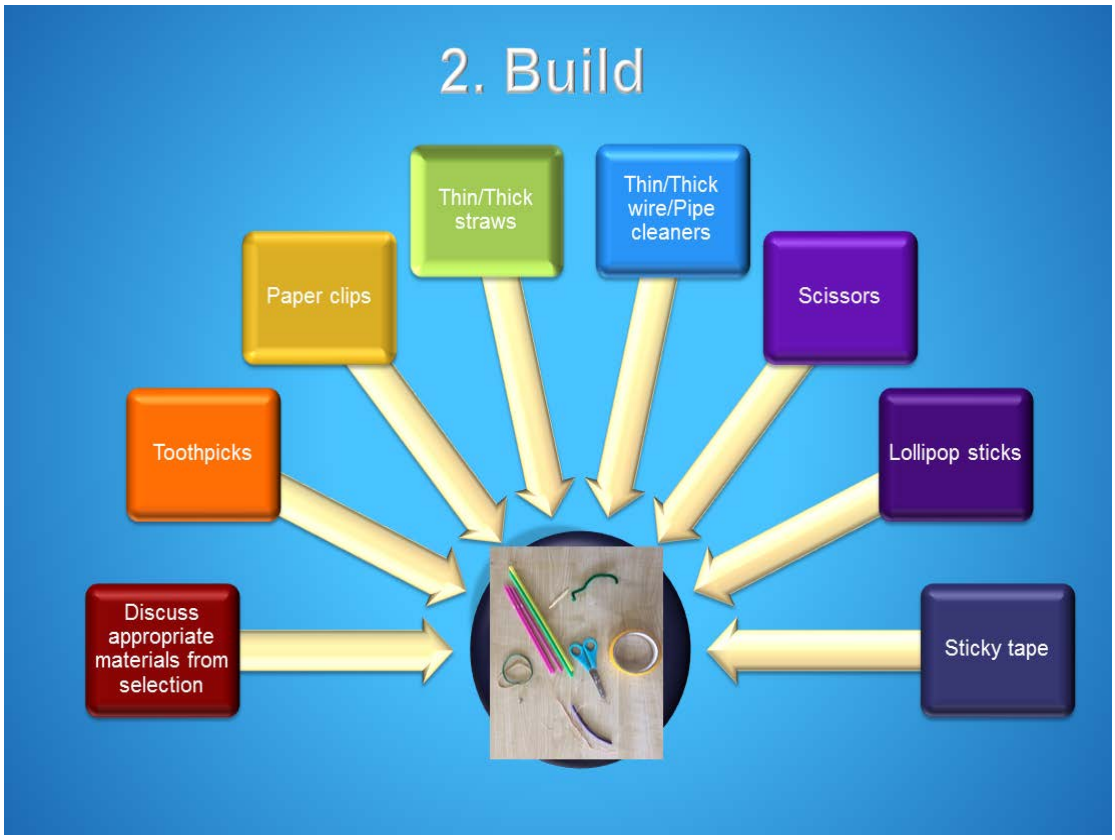

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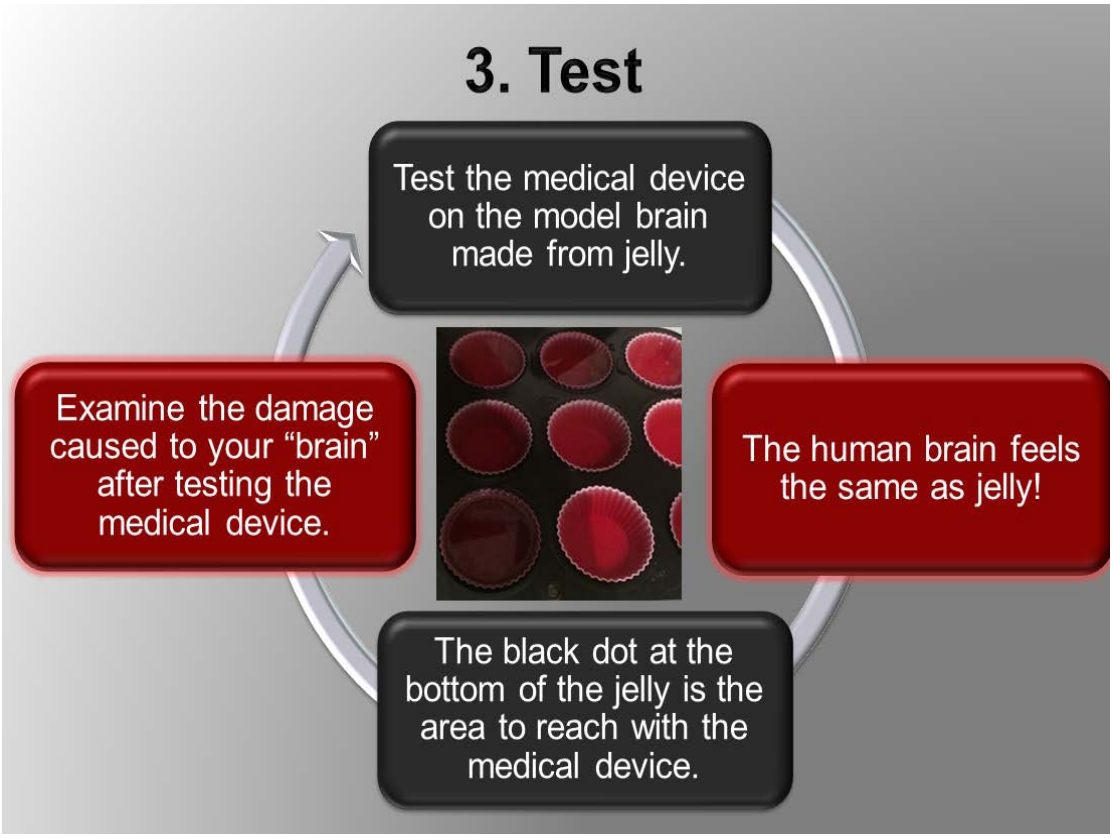

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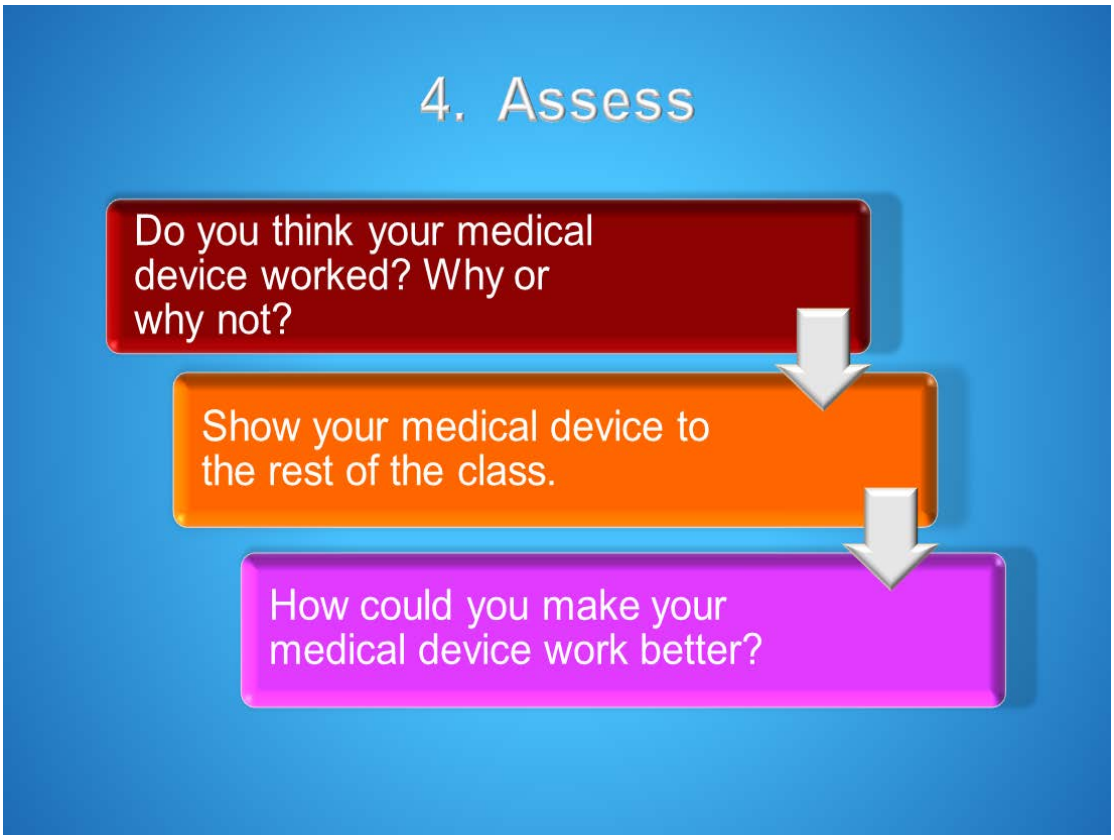

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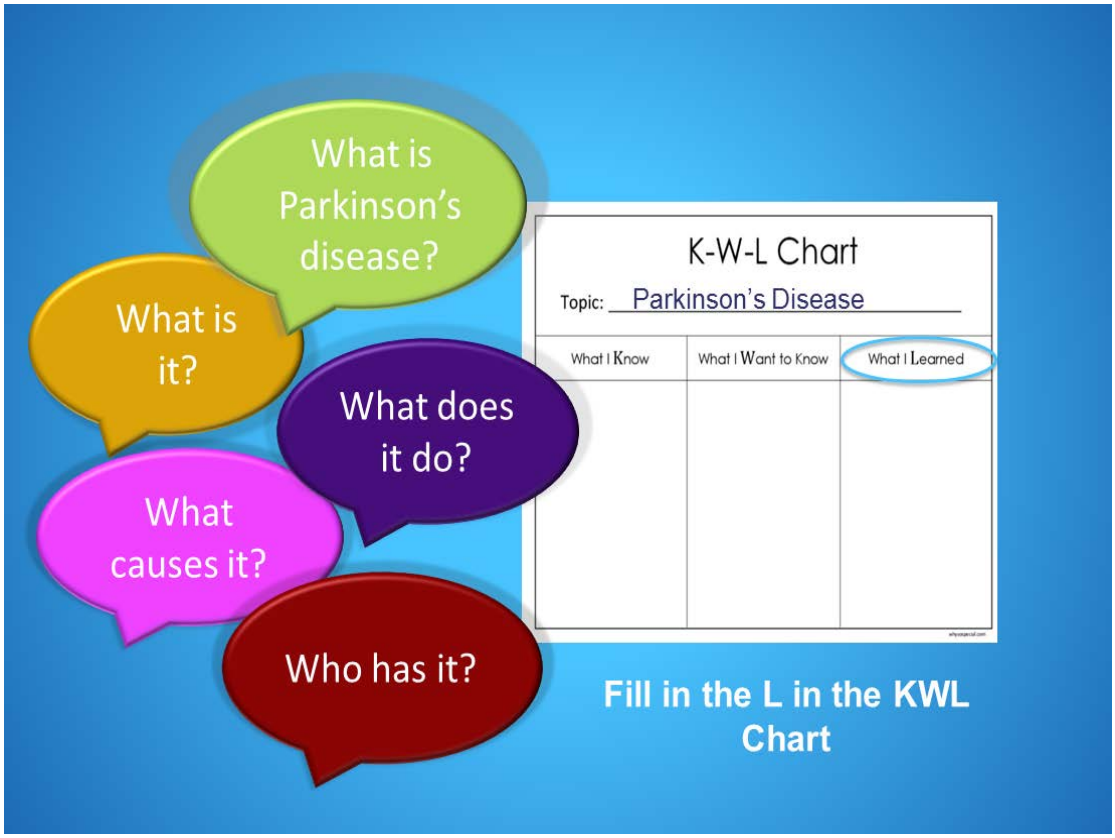

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Slide 25

This publication has emanated from research conducted with the financial support of Science Foundation Ireland (SFI) and is co-funded under the European Regional Development Fund under Grant Number 13/RC/2073.

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AngioMatTrain brain mattrain Tendon Therapy Train
Engineering *in vitro* microenvironments for translation of cell-based therapies for tendon repair

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
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European Union
European Regional Development Fund

Science Foundation Ireland sfi For what's next

Slide 26

K-W-L Chart

Topic: Parkinson's Disease

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

BRAIN AND SPINAL CORD

Draw a picture of the medical device that you created to reach deep in the brain for deep brain stimulation.

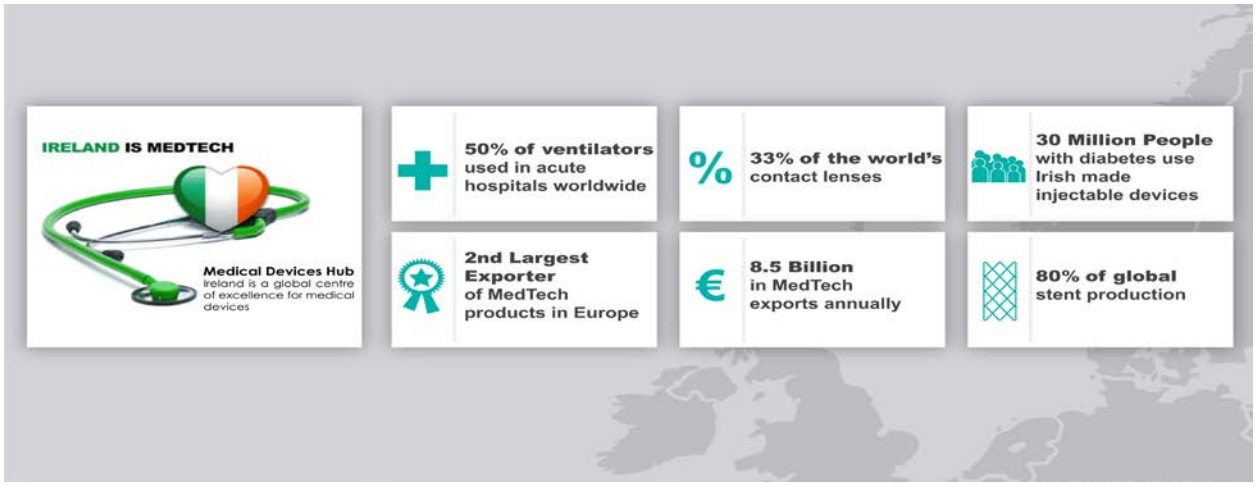
Do you think your medical device worked? Why or why not?

How could you make your medical device work better?

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.

MedTech companies with bases in Ireland produce Medical Devices to repair damage to both the Central Nervous System and Peripheral Nervous System. Boston Scientific's branch in Clonmel designs, develops and manufactures Deep Brain Stimulators and Spinal Cord Stimulators. Medtronic, headquartered in Dublin, is also a producer of Deep Brain Stimulation and Spinal Cord Stimulation products. Additionally, Stryker (with branches in Cork and Limerick) produces two conduits to repair peripheral nerve damage.



Source: IDA Ireland, 2017

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