Western Engineering

Outreach

Biomedical Engineering: The Cure for Cancer

Grade 3-5

Meet Today's ENG HERO!

Wankei Wang – Professor with Western Engineering

Wankei is a professor with the Chemical and Biochemical Engineering Department at Western University. He completed his Bachelor and Masters degrees in Hong Kong before completing his PhD in Buffalo, New York. His research interested include biomaterials, nanomaterials, and medical devices.

To learn more about Dr. Wan visit:
https://www.eng.uwo.ca/chemical/faculty/wan_w/index.html

Learning Goal:

- Students will learn about cancer in the human body and will explore potential cancer treatments.
- Students will apply problem solving skills to create a model to remove cancer cells.
- Curriculum Connections: Grade 5 - Human Organ Systems, Forces Acting on Structures and Mechanisms

Materials Needed:

- Two different sizes of dried beans, e.g. lima beans and lentils
- Cardboard
- Popsicle sticks
- Toothpicks
- Paper
- Different sized cups
- Scissors
- Tape/Glue

These are suggested materials only; successful tools can be made with a wide variety of materials. Be creative!

Engineering and Science Connections:

Today, we will be biomedical engineers. Biomedical engineers design tools, devices and medicines to help prevent people from getting illnesses and injuries or to help them heal from certain illnesses and injuries.

Cancer is very common in North America. In Canada, approximately 220,400 people are diagnosed with cancer each year. There are many different kinds of cancer, which can affect different parts of the body. All types of cancer cause some of the body's cells to start to divide without stopping. Normal, healthy human cells grow and divide (one cell becomes two cells) to make new cells when the old cells are worn out or damaged. This helps keep the body working. However, in cancer, cells start acting strangely and start dividing too much. When cells divide without stopping, a growth called a *tumor* is formed. Most cancers form a solid tumor from all these extra cells. These tumors keep growing, often interfering with normal organ function, which makes people sick.

Cancer cells can also travel to other places in the body and form new tumors. These kind of tumours are called *malignant* or contagious or spreadable. Tumors are not always malignant, sometimes they are *benign*. Benign tumors do not spread into other tissues or organs, though they can still be very large.

Doctors can treat cancer with *chemotherapy,* which is when patients are given chemicals that kill fast-growing cells. Because tumors grow quickly, they are targeted by the chemotherapy medicine. Unfortunately, sometimes fast growing, healthy cells are affected by chemotherapy.

A second way doctors try to make cancerous tumors go away is with *radiation*. In radiation therapy, a machine emits high-energy electromagnetic waves (such as x-rays and gamma waves). The radiation is specifically focused on the tumor so that the high-energy waves kill the cancer cells. As with surgery and chemotherapy, it is challenging to not kill healthy cells while trying to eliminate the cancer. Biomedical engineers help design ways to deliver radiation to patients, whether through designing radiation-producing machines or designing alternate solutions such as small capsules embedded in the body to deliver radiation directly to the tumor area.

A cancerous tumor forms when cells divide many times in an out-of-control way. Though we call it cell division, it is really more like multiplication: one cell splits and becomes two cells. If these two cells both split into two, you have four cells (2 x 2). If these four cells all split, you have eight cells (4 x 2). Each time the cells divide, you multiply the number of cells by two. How many rounds of cell divisions do you think are needed so that just one cell grows to more than one million cells? Do some multiplication to figure it out.

In our activity, we will build a device to remove cancer cells (lima beans) from healthy cells (lentils). To do this, we will have to do some trial and error and use our problem solving skills. To do this, we will use the Engineering Design Process. This is the process engineers use to solve problems. The EDP has 4 steps:

1. **Understand the Problem:** Describe the challenge you are trying to solve and any criteria (the conditions that the design must meet) and any limitations (like cost, time, size of team). Do research to see what others have done to solve that problem.
2. **Design a Solution:** Use the knowledge you have to brainstorm as many ideas as possible. Choose the best design you think will work to solve the problem.
3. **Build a Model:** Using the materials you have, build a model of your design.
4. **Test and Redesign:** See if you model works. If not, what needs to be changed or improved? Does it solve the problem? Build and test until you have success.

Video Recommendation: *Biomedical & Industrial Engineering: Crash Course Engineering #6*

https://www.youtube.com/watch?v=06IENrRANxY

Activity:

Biomedical engineers help medical doctors improve cancer treatment by designing the best tools, medicines and machines that selectively remove the cancer cells while leaving healthy cells. In today's activity, we are going to design a tool to surgically remove cancer cells. The cancer cells will be represented by lima beans. The lima beans will be mixed up with lentil beans, which represent healthy cells. Your engineering challenge is to design a tool that can quickly remove the cancer cells but leave as many healthy cells as possible. If you cannot remove the cancer cells quickly enough, they will start to multiply. This means that the tumor will grow bigger and be even more difficult to remove. In this engineering design challenge, you will brainstorm solutions, build a prototype, test your solution, and then keep improving the solution as best as you can during the activity. Your goal is to make the best tool possible.

Part 1 – Design and Build

Take a look at the materials you have and brainstorm a possible solution. Then, draw out what that solution will look like. Drawing a design first is a great way to think about difficulties that might happen when you build. Then, move onto building your model with the materials. It is okay if it does not look exactly like your design. When your ready, move on to your first trial

Part 2 – Test and Redesign

Trial Rules

1. Each trial should be **one minute** in length. Use your tool to separate 10 cancer cells from 20 healthy cells.

2. Any cancer cells left at the end of the trial are doubled before the next trial.
3. You beat cancer when all the cancer cells are gone after your one minute trial.
4. You lost if the tumour because larger than 100 cells, or if you remove more than 10 healthy cells.
5. If you beat cancer, good job! You can try again with a larger number of cancer cells.
6. You can make modifications to your tool after each trial.

Part of any trial is writing down your results. Use the table below to keep track of your trials. Add more rows if you need to.

Trial	Starting Number of Cancer Cells	Ending Number of Cancer Cells	Starting Number of Healthy Cells	Ending Number of Healthy Cells	Outcome (Beat or Loss)
1					
2					
3					
4					
5					

What Did You Learn?

- What design worked best? Why do you think that is the case?
- What kind of engineer might design these kinds of devices?
- What criteria and constraints does that type of engineer have to consider when designing tools in real life?

Future Learning

- Biomedical engineers create all kinds of tools that can be used in the medical field. One thing they design is prosthetic limbs. Use the engineering design process to create a prosthetic leg out of materials around your home. See if it can hold your weight and if you can walk approximately 2 meters with it.

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

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Twitter: @westernueng
Facebook: @westernueng

Thanks for discovering with us!