



## FINAL REPORT

# **KABOOM!! Computerized Simulator for Nano-Delivery for Pancreatic Cancer**

Submitted by:

Capital High School Team

**Liliana Reza**

**Brenda Zamarron**

**Cristina Medina**

**Yesenia Diaz**

**Angelica Chacon**

Sponsor Teacher:

**Irina Cislaru**

## **Abstract:**

During the first five decades of the 20<sup>th</sup> century, the discovery of chemotherapy has been seen as a solution to treat and eradicate the proliferation of cancer cells. Although chemotherapy is efficient in the “cancer cells killing<sup>1</sup>,” it weakens the healthy cells and therefore the systems of the body. Oncologists<sup>2</sup> around the world are working and implementing new strategies to solve the side effects of chemotherapy through new treatments such as Target and vector<sup>3</sup> virus Therapies. Both treatments are innovating strategies to solve and possibly cure cancer through the help of nanotechnology. Scientists have identifying many concerns in the manipulation of nanotechnology since it is not able to prove efficiency for Target therapy and Viro-therapy.

Another challenge that is seen as an interesting and concern in the medical field is the proliferation of Pancreatic Cancer. The diagnostic of Pancreatic Cancer is being a mystery for medicine, since it is detected most of the times in the final two stages, and chemotherapy is not enough to stop its own metastasis<sup>4</sup>. Doctors refer to Pancreatic Cancer as a “silent killer.” According to Dr. Julie Sharp of Cancer Research UK, the pancreatic cancer produce symptoms such as weight loss and abdominal pain and they are associated with many other conditions "These symptoms could be linked to many more minor illnesses and many patients never have symptoms while the cancer is progressing, so by the time most people are diagnosed the cancer is advanced and has often spread so it is difficult to treat."

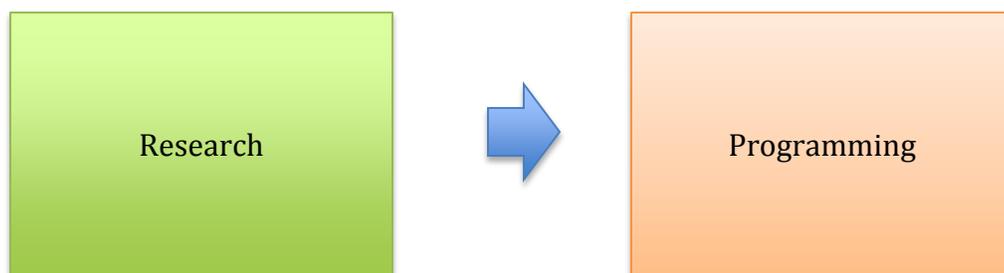
1. **Cancer cells Killing:** Term used by medical professionals referring to the action of eradicating cancer cells by chemotherapy.
2. **Oncologists:** Medical Professionals specialized in the field of Cancer.
3. **Vector:** Biological tool used to deliver material into the cells.
4. **Metastasis:** Spread of Cancer cells around other parts of the body.

Although there are chemotherapy and radiotherapy to treat Pancreatic Cancer, just 8% percent of the patients diagnosed with Pancreatic Cancer survive.

### **Introduction:**

Demonstrating a concern and identifying a possible outcome, Pancreatic cancer treatment was chosen to prove alternatives that might help experimental studies to succeed. The objective of KABOOM!! Computerized Simulator for Nano-Delivery for Pancreatic Cancer is to show analytical data of the efficiency of the combination Target therapy and Viro-therapy in the treatment of Pancreatic Cancer. Using Star logo nova as the computer language, KABOOM!! Computerized Simulator for Nano-Delivery assumed the characterization of a vector virus reaction in the environment of pancreatic cancer. The Computerized simulator shows a close relationship between the cancer cell and the viruses by eliminating themselves once the chemotherapy is inserted in the membrane of the cancer cell. The Computerized Simulator will approach as a solution to fix or add possible strategies of implementation in the treatment of possible clinical trials.

### **Project Design:**



## Research

Sources from libraries, websites and professionals were fundamental in the science behind the Computerized Simulator for Nano-Delivery for Pancreatic Cancer Project. For instance, according to the National Center of Biotechnology Information (NCBI), many studies have been working in experimental studies, which objectives are to investigate target therapy, virotherapy, nanotechnology as a treatment to cure or control cancer. Studies such are: *Expression of growth factors, growth inhibiting factors, and their receptors in invasive cancer; Nanotechnology for targeted cancer therapy, Oncolytic herpes simplex virus and chemotherapy: are combinatorial strategies more effective for cancer?* are some examples of experimental studies that medical doctors are working on. These studies haven't reach success since there is no a concrete virus, chemotherapy medication, and a special cell receptor to work in the behalf of the targeted therapy. Since Virotherapy is a new treatment, scientists are manipulating different types of viruses to be the vectors to deliver chemotherapy medications. According to NCBI, one of the viruses that seem to be an option is the human virus, herpes as a simplex virus vectors. "Oncolytic viruses such as oncolytic herpes simplex virus (oHSV) represent a exciting biological approach to cancer therapy." The virus and chemotherapy achieve efficiency in cancer "cell killing than either single agent alone."

Considering the experience of nurses in the Oncology field in Christus St. Vincent Regional Hospital of Santa Fe, NM, there are some possibilities that cancer might be cured through the targeted therapy and virotherapy. According to the clinical supervisor and Register Nurse, with an experience of more than 20 years in

the field of cancer, the nurse shared her thoughts over the coming treatment, supporting the ideology that a “virus will be a nice idea, since they will be designed to kill cancer cells at a Nano size without harming the healthy ones.” Her thoughts about the target therapy and virotherapy made her conclude that “ cancer do not have a concrete treatment at all, and all we have is chemotherapy...is not too late to start working in a new treatment that might save the lives of many patients with cancer, specially pancreatic cancer.” Patients diagnosed with pancreatic cancer in the Regional hospital, spends almost three days of chemotherapy and two days at least receiving radiotherapy. There is a week without chemotherapy and radiotherapy, where the patient relaxes and consumes iron and many other nutrients such as potassium, magnesium to be ready for chemotherapy for the next week. Both nurses and doctors are not able ensure the efficiency of chemotherapy since it works differently in every type of cancer. Medications of chemotherapy might differ from the same reason, and they try to do their best to make the patient feel comfortable, incorporating pain medications and kidney failure medications.

In conclusion, it is important to show an alternative to treat pancreatic cancer. Exploring different types of viruses, chemotherapy medications and the patient immune response, KABOOM!! Computerized Simulator for Nano-Delivery for Pancreatic Cancer will assume an analysis of the previous research sources to describe the potency of the combination of a vector virus and chemotherapy through the use of a computerized simulator.

### Programming:

Star logo nova is the selected computer language to create a computerized simulator. The design of the program takes as a priority the statistics of the cancer cell killing and the efficiency of the virus. Based in the previous research, and assuming the characterization of the vector virus and the cancer cells, the simulator will read and show the relationship between them by counting cancer cells and their own decay as the virus lose their straight. Around two weeks of programming, it could be implemented a new strategy that will lead the project throughout graphics. The graph that was implemented in the simulator, will guide the statistics and therefore the efficiency of the Nano-delivery. The levels such are energy and cancer cells replication are not written at a scale, but still shows clearly the relationship of the virus and the cancer cell. Also, a clock was implemented to guide the time that might take the virus to destroy cancer cells. The time that is seen in the clock is adjusted in seconds, assuming the acceleration of the virus and the cancer cells in the simulator. Factors that might affect the final simulator are the realistic reactions of the virus that will be identified once studies are done with their experiments, type of chemotherapy medication, and circumstances that might distract the virus from giving out the chemotherapy, such might be blood stream, enzymes or any other substance in the pancreas.

### **Data Analysis and Interference:**

The simulator is divided in three main sections: the world, virus and cancer cells.

## The World:

```
when setup pushed
  clear terrain
  set Count of Cells data box to 0
  set time data box to 0
  clear line graph Graph
  set clock to 0
  delete everyone
  create 200 Cancer cells (s)
  do
    set my shape to built-in shape: Sphere
    set my eneegy to 10
  scatter
```

```
while forever toggled
  if clock <= 300
    set Count of Cells data box to count Cancer cells within 200 steps
    set time data box to clock
    Add data to line graph Graph for Cancer Cells
    x-axis: clock y-axis: count Cancer cells within 200 steps
    Add data to line graph Graph for virus cells
    x-axis: clock y-axis: count virus within 200 steps
```

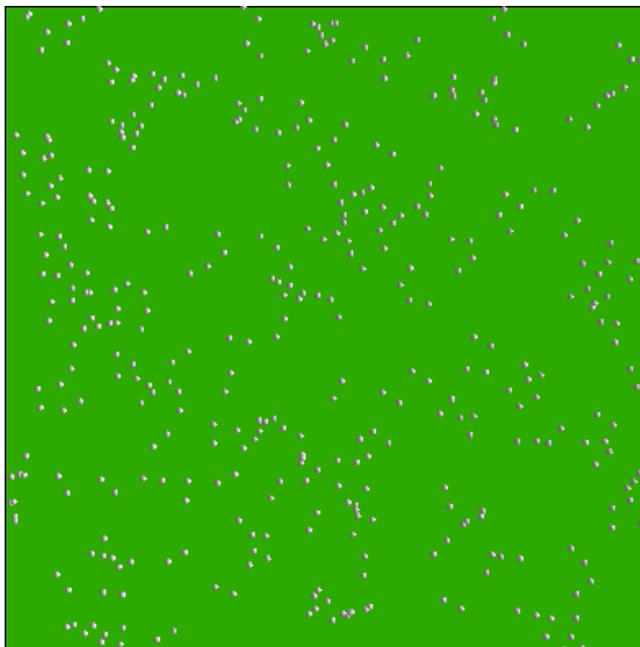
```
when inject pushed
  create 200 virus (s)
  do
    set my shape to built-in shape: Pyramid
    set my color to color: lime
    set my x to 0
    set my strength to 10
```

The world consists in the amount of cancer cells, starting with 200 cancer cells. The cells are spherical, and every time they reach level 10 of energy they duplicate. This will be seen when the set up widget is on. Once the forever widget is on, the clock starts running no more than the time of 300 sec. During the time, the world shows the count of cells, a graph showing the cancer cell killing as the virus spreads around the world.

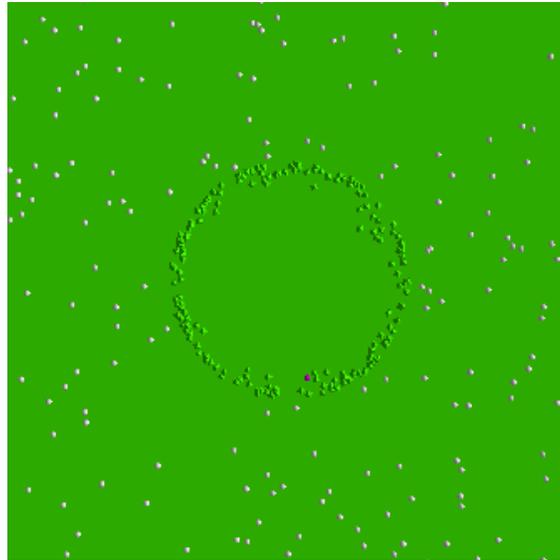
**Set up Widget: Cancer cells (Starting with 200 cancer cells)**



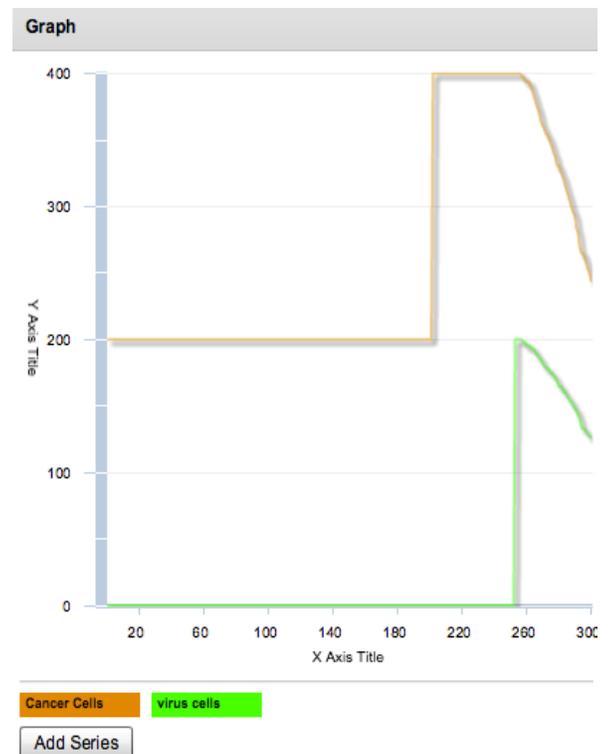
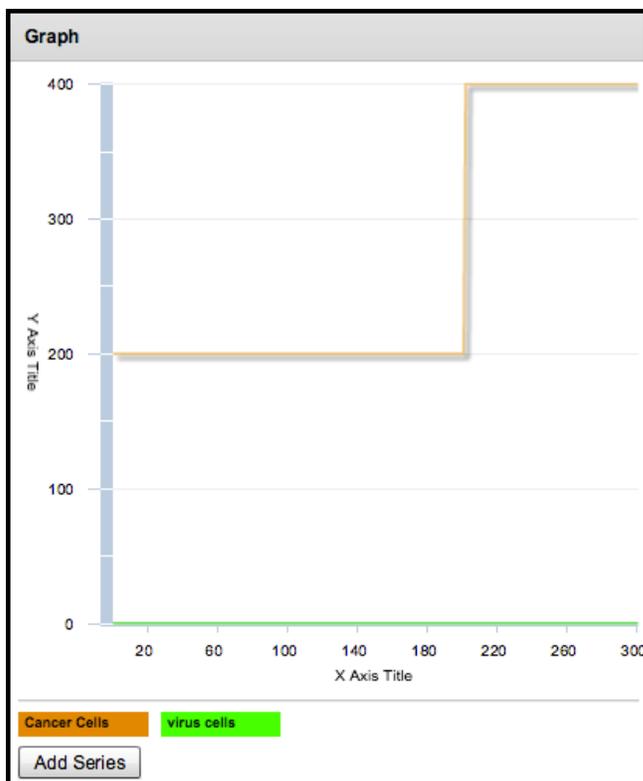
**Forever Widget: Duplication of Cancer Cells (400 cancer cells)**



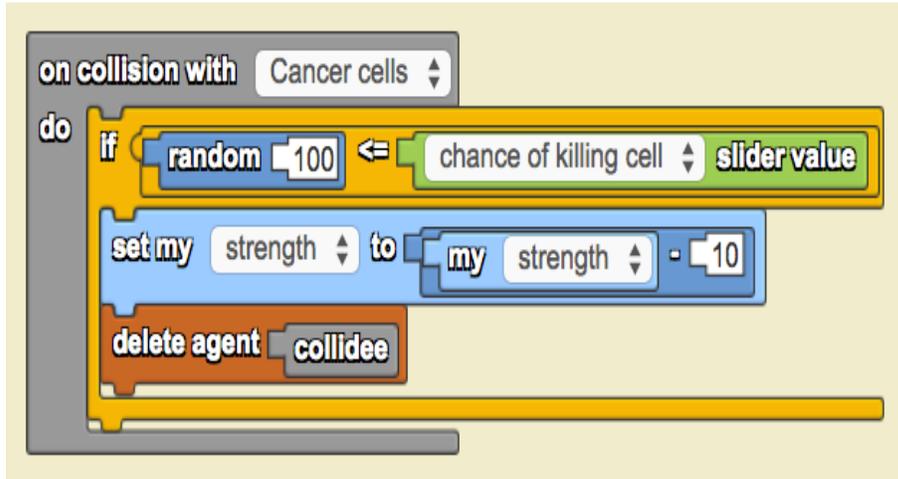
### Injection Widget: Vector Viruses are spreading and destroying cancer cells.



### Graph: Duplication of Cancer Cells and Decrease of Cancer Cells and Virus.

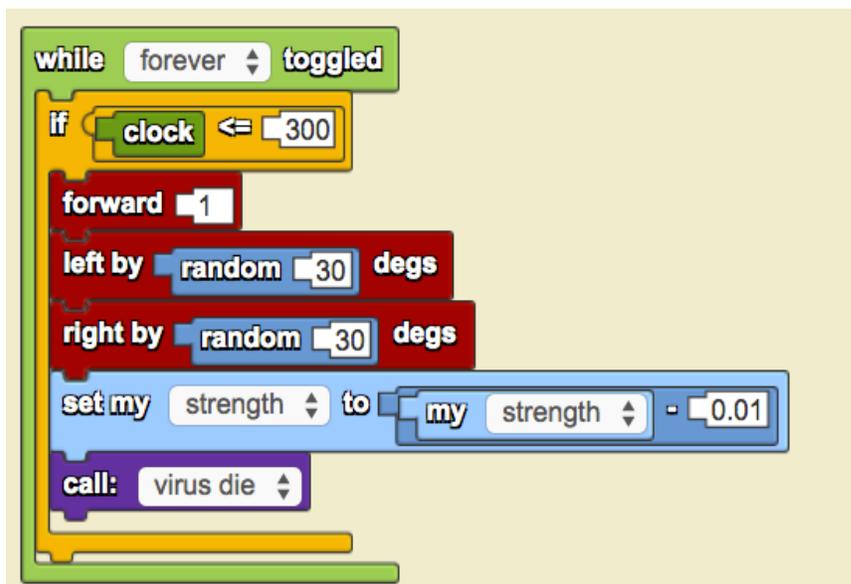


## The Virus:



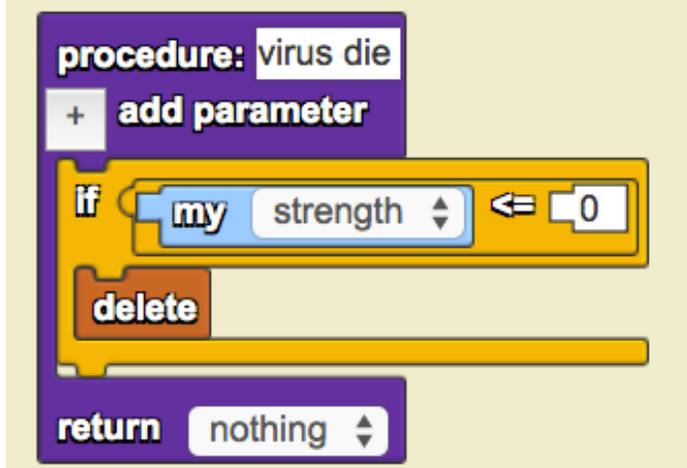
```
on collision with Cancer cells
do
  if random 100 <= chance of killing cell slider value
  set my strength to my strength - 10
  delete agent collidee
```

This code block is triggered when the virus collides with a cancer cell. It contains an if-statement that checks if a random number between 0 and 100 is less than or equal to the 'chance of killing cell' slider value. If true, the virus's strength is reduced by 10, and the cancer cell (the 'collidee') is deleted.



```
while forever toggled
  if clock <= 300
  forward 1
  left by random 30 degs
  right by random 30 degs
  set my strength to my strength - 0.01
  call: virus die
```

This code block runs in a 'while forever' loop. It checks if the 'clock' is less than or equal to 300. If true, the virus moves forward by 1 unit, turns left or right by a random angle between 0 and 30 degrees, and its strength is reduced by 0.01. Finally, it calls the 'virus die' procedure.

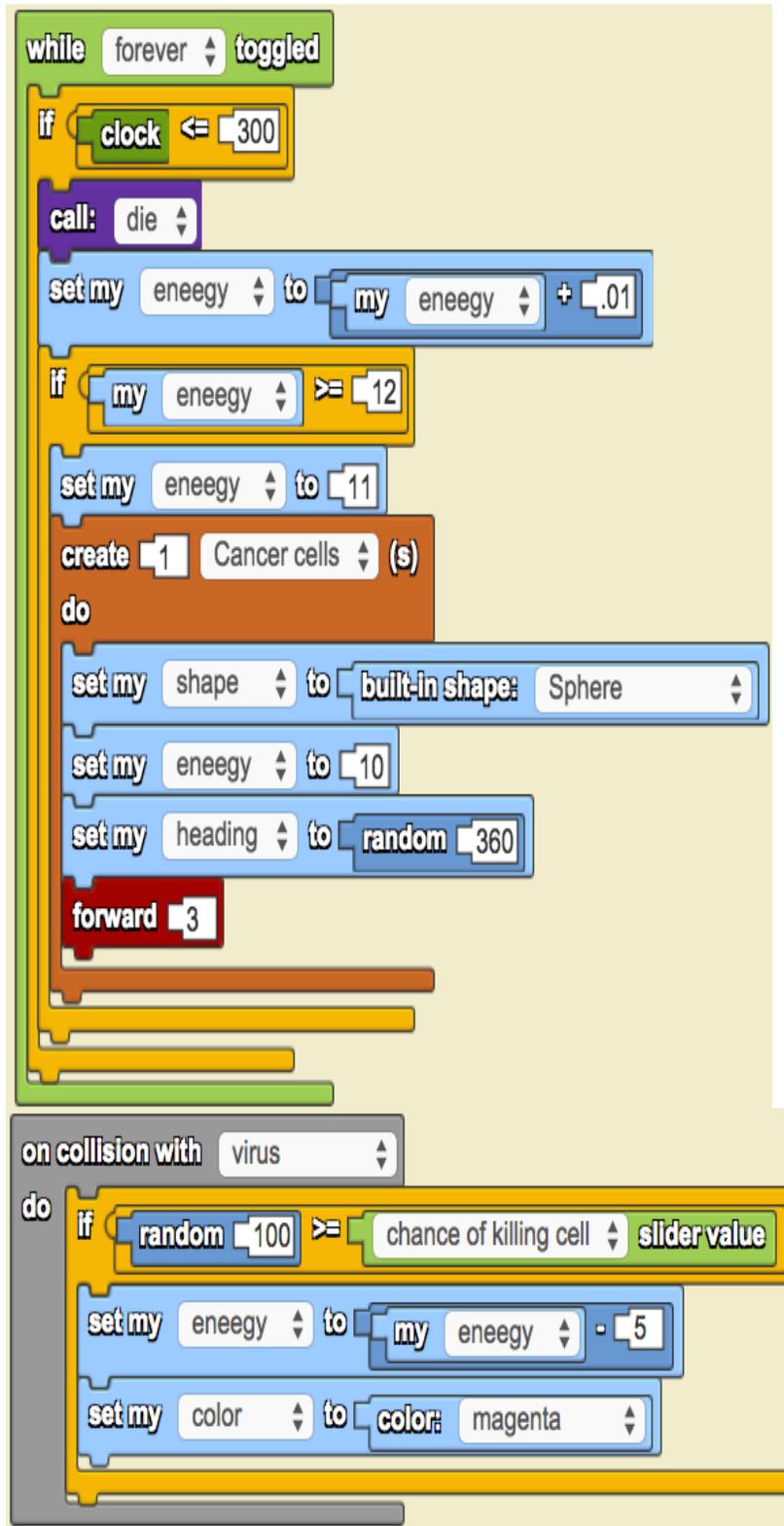


```
procedure: virus die
+ add parameter
  if my strength <= 0
  delete
return nothing
```

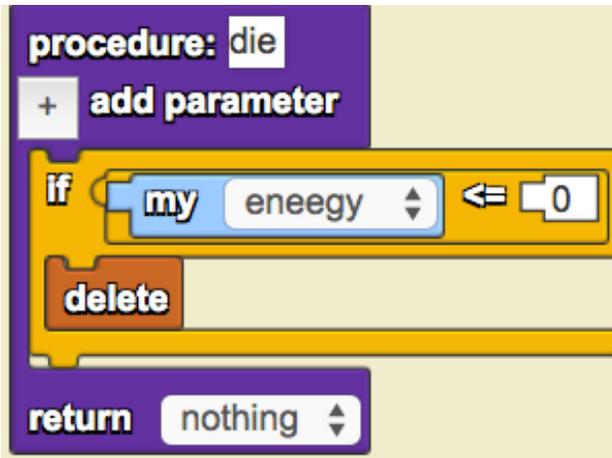
This is a procedure named 'virus die'. It has an 'add parameter' button. The code inside checks if the virus's strength is less than or equal to 0. If true, it deletes the virus. The procedure returns 'nothing'.

When the virus collides with the cancer cells it destroys it, and the virus inactivates itself. If the virus does not collide with the cancer cells, it will become immune until it hits a cancer cell. Assuming that the cancer cell is destroyed, the virus will become weak, and it will keep losing its strength until it dies.

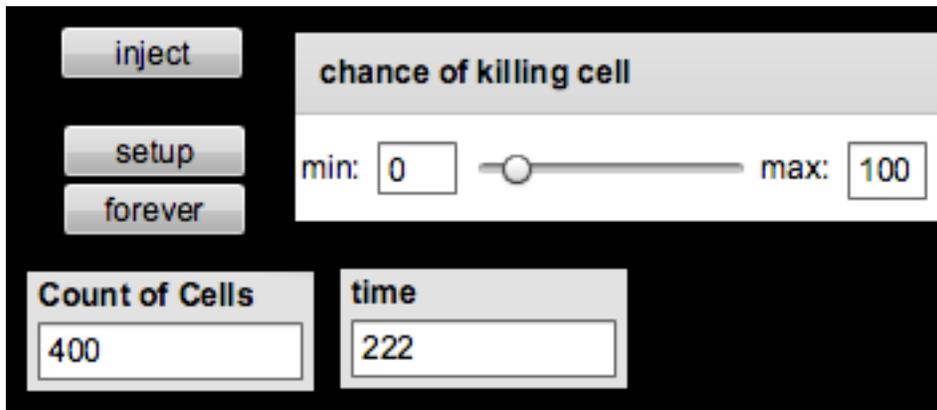
## Cancer Cell:



When the forever widget is on, cancer cells will duplicate. Once the clock widget is on, and a virus hits the cancer cell, but for some circumstances the virus do not insert enough chemotherapy, the cancer cell will loose straight (it is represented by a magenta color in the world). If the cancer cells recover its own energy reaching the level of 12, the cancer cell will be able to duplicate and obtain more energy. If the cell reaches 0 level of energy, it will die.



Widgets:



**Change of Killing cell data box:** This widget represents the efficiency of the cancer cell killing, as the virus destroys them. It can be manipulated to demonstrate the doses of virus, and how it will eradicate statistically the cancer cells.

**Count of Cells:** This widget represents the number of cancer cells that duplicates.

**Time:** Represents the time in seconds to accelerate the reaction of the virus as it destroys the cancer cells. In a real scenario it might take months. In the simulator is resumed in seconds.

## **Results and Discussion:**

The results that can be seen along the computerized simulator are the statistics that might show different probabilities as the experimenter tries different doses of virus injections and numbers of cancer cells. For instance, an experiment might demonstrate that 75% as the efficiency of 200 viruses in one injection, while the 25% represents the inability for viruses to inject chemotherapy for different types of circumstances (discussed in the Programming section). The graphs will represent the increase of the duplication of cells, and the decrease of viruses and cancer cells when they interact to each other. KABOOM!! Computerized Simulator is open to change and add new reactions, as the experimenter plays with different variables. The computerized simulator will be able to change numbers, such are the dose of virus, total amount of cancer cells, and even the energy levels that a cancer cell might reach since it is instable. The final results will show how efficient will be the Nano-delivery at different perspectives as the experimenter identifies and alternates his findings to the computerized simulator.

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<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC150520>

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