**This is a bacteria-phage simulator.**

**This can simulate the bacteria-phage therapy to treat sepsis.**

**You can generate different stories of the battle between bacteria, bacteria-phages and immune cells with different parameters.**

**Input:**

plasmaSize, bacNum, phageNum, immuneCellNum, bacLifespan, bacReplicateRate, lysisRate, phageOffspring, numGens (all integers)

**Output:**

An animation of "numGens" generations.

**Some basic rules for this physiological system:**

1. Bacteria (green cycle):

(1) A bacteria has its lifespan as specified by the parameter "bacLifespan", the brightness of the green circle indicate its lifespan. If it is dying, then it becomes darker and darker. If it is dead, then it disappears.

(2) A bacteria can replicate itself after some random rounds specified by "bacReplicateRate" parameter. The smaller "bacReplicateRate" is, the faster bacteria replicate themselves.

2. Bacteria-phage (small yellow dot):

(1) If a bacteria-phage meets a bacteria, then it will identify whether the bacteria can be infected. If the bacteria can be infected (according to the type of the bacteria), then the phage will enter into the bacteria and the bacteria will turn from green to orange indicating that this is a infected bacteria. If the bacteria cannot be infected, then it swims away.

(2) After a random rounds within "lysisRate", the infected bacteria will be lysed and produce the number of "phageOffspring" children bacteria-phages.

3. Immune cell (big white cycle):

(1) Immune cells have specificity for bacteria or infected bacteria or bacteria-phage. That means they will track the organism they have specificity for. But they will eat whatever they encounter along the way.

**How the program was structured:**

For each generation, there are 4 list: healthy bacteria list, infected bacteria list, free bacteria-phage list and immune cell list. Several things have to be done sequentially: check whether any organisms was eaten by the immune cells, if yes, then kick the corresponding organism out of the list; check whether any bacteria was infected by bacteria-phage, if yes, move the bacteria from the healthy bacteria list to the infected bacteria list; the lysis-starting timer in all bacteria-phages inside a bacteria minus 1 and check whether the timer is equal to 0. If so, the phage will lyse the host bacteria and produce offspring. Then, all the healthy bacteria's lifespan timer minus 1 and check whether the bacteria is dead. Next, all the healthy bacteria's replicate timer minus 1 and check whether the bacteria should replicate itself. At last, all organisms move one step.

Bacteria, infected bacteria, bacteria-phages move to a random direction by 1 step. The immune cells will move towards the nearest prey by 1 step. All steps repeat again to generate next generation.

**Future improvement:**

When the number of the organisms becomes larger and larger, especially under the situation where the bacteria-phage and immune cells fail to control the number of the bacteria, then the computing speed will become slow. In the future, this can be solved by parallel programming.