Plant Inhibition Simulation - Biology Teacher Instructions
PLEASE NOTE: There are specific instructions on how to use this in AP® Biology/IB Biology as well as AP® Environmental Science / IB Environmental Systems and Societies.

What you will need:

For the Class:

- Presentation file – Please note, you also need to make sure that the presentation assets folder is in the same location as the presentation file.
  Biology Inhibition Sim Presentation powerpoint
- Shared Data file
  Class Data Share Sample Spreadsheet
  Class Data Share Spreadsheet

For Each Group:

- 1 – Four-sided dice
- 1 – Ten-sided dice numbered 0-9
- Student instruction sheet
- Reference Sheet
- Handout #1 Inhibition Data Table
- Handout #2 Inhibition Data Sheet (flowchart)
- Handout #3 Determination of Inhibition Probability

Versions of die rollers are available online. This one can be used on mobile devices and shows both dice at the same time.
Online Die Roller http://www.brockjones.com/dieroller/dice.htm

Creating Groups:
This is ideally constructed with groups of four with the following responsibilities being designated:

1. ***Farm Hand*** – the one who does a lot of manual labor; in this case it is the rolling of the dice
2. ***Agronomist*** – the one who will be looking specifically at the causes of plant mortality (Handout 2)
3. ***Farm Manager*** – one who will be looking at the plant growth and looking at the yields that are being produced within the simulation (Handout 3)
4. ***Seed Representative*** – this person is responsible for reporting yields to the whole class, they will be interested in overall patterns that are occurring throughout the region. (Handout #3)

If your class does not have all groups of four, eliminate the Seed Representative in this exercise.

Stages of Growth in Soybeans:
Students may be unfamiliar with the stages of growth in soybeans.
-Seeds are planted
-Germination
Vegetative stages:
VE stage emergence occurs when the cotyledon (sprout) comes through the soil.
VC Stage - unrolled unifoliolate leaves
V1 Stage - first trifoliate set of leaves unfold, followed by V2, Vn (number of trifoliate leaves unfolded)
Reproductive Stages:
R1 - Beginning of flowering
R2 - Full flowering
R3 - Beginning Pod - 3/16th of an inch in one of the four uppermost nodes
R4 - Full Pod - 3/4 of an inch in one of the four uppermost nodes
R5 - beginning seed - seed is 1/8 inch long in one of the four uppermost nodes
R6 - Full seed - pod containing a green seed that fills the pod at one of the four uppermost nodes
R7 - Beginning Maturity - one normal pond on the main stem has reached it's mature pod color
R8 - Full Maturity - 95% of the pods have reached their full mature color

Sequence of Events for class:
Pre-planning
Know how groups will be assembled and at what point this will happen.
Be sure to have enough copies of the materials listed above.
Slide #16 has an animation in it. You will want to make sure that it is working properly when you click on the image. The file is called "receptor_site".
Notes for Presentation:
Leading Questions (Slide 2)
Have the presentation up and running with SLIDE 2 Leading Questions on your screen as students come into class. Students should be answering these questions in writing either in their lab journal or on a sheet of paper. (3-5 minutes) Encourage students to do their best to answer the questions before you review the questions at some point they should have been exposed to some of the concepts.
Review of the Leading Questions.
Elicit the information from the students on the questions being sure to listen closely for common misconceptions that come out in the answers. It is not necessary for them to know all that is listed below because by the end they should be able to explain it more clearly. (3-5 minutes)

What environmental factors are required for a plant to sprout?
ANSWER:
MISCONCEPTION:

What environmental factors are required for a plant to grow?
ANSWER:
MISCONCEPTION:

What cellular factors are necessary for a plant to grow?
ANSWER:
MISCONCEPTION:

Overview of the Roles within the simulation (Slide 5)
Explain the general roles that each student will have in the group. (2 min max)
It may take some more explaining in each group, but keep this section very short.

Explanation of Data Collection (Slide 6-8)
These show the parameters in which data will be collected. This is written in the instructions that students have on their reference sheet. (2 minutes)

Conduct the Rolling of the Dice (20 times for both)
This is somewhat tedious but it is necessary to enable the probability to work out nicely. Be sure to circulate the room to make sure this is being done. Data should be recorded on both Handout #1 and Handout #2. (10 min)

Evaluation of what is being inhibited (Slide 9)
Students should collaboratively look through the data to see what happened to the plant. NOTE: If the environmental die indicates that the plant is not viable there is no way that an inhibition can occur so do not evaluate. (5 minutes)

Explanation of Handout #3 (Slide 10-14)
Slides 10 – 13 show how probability works. Not only does it show how the percents work, but it illustrates how to make a probability tree.
Slide 14 shows how the calculation of percent error is determined. (3-5 minutes)

For additional information on probability, visit the following:
http://ncalculators.com/statistics/probability-calculator.htm
http://www.mathsisfun.com/data/probability.html

Students complete Handout #3 (10 minutes)

Class Data Share
While students are completing their data collection, project the class data share file on the board. When the *Seed Representative* has the outcome, have him/her enter the data in the data table on the board. This should allow for students to see how the probability changes as the sample size goes up. (Dead plants due to the Environmental Die are added to the total to get the 40 total rolls for each team.)

------------------------------ DAY 2 ------------------------------

Slide 14 – Closure or opening
This slide can be used at the end of a class, or it can be used to start day #2 of the class. Either way it is important that students write individually before they discuss out loud. Encourage them to annotate in a different color, or in the margins. Classroom practices vary on how to conduct this type of reflection.

Slide 16– Receptor Site Animation

Slide 17 – Receptor Site Specificity

- Receptor sites are often specific to a certain molecular shape (These are simplified shapes in many animations to make it easier to illustrate. In reality they look very different)
- Signal sequences and specific chemical interactions make each receptor chain unique to triggering only under certain conditions
- When receptor sites are shut down, malformed, or inhibited, the reaction pathway cannot complete

Slide 18 – Class question: Why would you want to keep something from catalyzing at the receptor site?

- Inhibitors are important because they hinder the normal functioning of enzymes and the correlated reaction pathways.
- Specific inhibitors can prevent the creation of amino acids and lipids for example, hindering the creation of proteins and the repair of the cellular membrane and other organelles
- Depending on point of introduction, reference the importance of lipids and amino acids. They act as building blocks for these more complex structures. Without these basics protein creation and then organelle development would be severely stunted.
- More clarification of importance of specific inhibitors on following slides

Rest of script is verbatim on the presentation slides…

Slide 20 – Important Types of Inhibitors

Enzyme Inhibitors:

Decreases enzymatic activity
Can prevent substrate binding to enzymatic active sites

Reaction Inhibitors:

Shuts down specific reaction pathways
Can prevent catalyst functioning
Can prevent creation of necessary reactants

Slide 21&22 – Lipid Synthesis Inhibitors

Slide 21: picture

Lipids are the building blocks of cell membranes and necessary for all organelle production
Lipid synthesis occurs primarily at the root and shoot meristems where growth is primary

Slide 22: animation

Lipid synthesis inhibitors prevent the development of new lipids for membrane repair, replenishment, and growth
New lipids are required for new cell division and cell growth

Slide 23 & 24 – Cell Membrane Disruptors

Slide 21: Picture

Cell membranes in plants are dependent on proper functioning of the Electron Transport Chain (ETC) in the photosynthesis process

Cell Membrane Disruptors convert the superoxide (O2-) to H2O2

Slide 22: Picture

These molecules can yield hydroxyl (OH-) ions, the most potent of biological oxidants

Cell Membrane Disruptors overload cellular processes and OH- oxidation can lead to cell membrane lysis and the leakage of cellular contents

Slide 25 & 26 – Amino Acid Synthesis Inhibitors

Slide 25: Picture

Amino acids are the building blocks of proteins

Humans utilize 22 standard amino acids, 9 of which cannot be produced by the body

New protein production is prevented by the lack of available amino acids

Slide 26: Picture

Amino acid synthesis inhibitors prevent the development of new amino acids

The amino acid chain is referred to as the primary structure of a protein

Slide 27 - 30 – Seedling Growth Inhibitors

Slide 27: Picture

Seedling Growth in the roots is highly dependent on rapid cell division in the root meristem

Root elongation and lateral root formation is prevented by these inhibitors

Slide 28: Picture

Seedling Growth Root Inhibitors prevent cellular division in meristem regions

These inhibitors prevent microtubule formation

Slide 29: Picture

Seedling Shoot Growth is dependent on the rapid cell division in the apical meristem of the growing stem as well as the root

The shoot apical meristem is responsible for stem elongation

Slide 30: Picture

Specific site of action is unknown

Seedling Shoot Inhibitors prevent the elongation and further growth of the seedling shoot

Possible Discussion Point: What are the possible action sites based on seedling growth root inhibitors?

Slide 31 – Seedling Growth

Follow up questions:

1. What keeps a plant from growing?
2. Is there anything we can do to make plants grow better?
3. Why is molecular structure so important in biology?

If more information about inhibitors is required, please see attachment

Further information on inhibitors