This experiment was designed by employee exhibitors not the MONSANTO CORPORATION to demonstrate the properties of chlorophyll. You, the requester, assume ALL liability for personal and property damage that may occur as a result of you repeating this experiment. You, the requestor, also assume responsibility for repeating this experiment in a safe manner. You, the requester, understand that this Chlorophyll Extraction Experiment as performed at the Minority Science Fair-St. Louis Science Center 2003 involves the use of a flammable solvent and that this experiment should be conducted with adult supervision and should not be conducted around open flames or heating elements. You, the requester, understand that the chlorophyll extracted in this experiment is NOT FOR HUMAN OR ANIMAL CONSUMPTION and that consumption will cause severe harm or death.
ALWAYS CONDUCT THIS EXPERIMENT WITH ADULT SUPERVISION AND CAUTION. ETHANOL AND OTHER SOLVENTS ARE EXTREMELY FLAMMABLE. DO NOT CONDUCT AROUND OPEN FLAMES OR HEATING ELEMENTS.

Items needed:
1. leaves from corn plant (not husk) make excellent chlorophyll source or any green leaves will be ok such as fresh spinach
2. 1L bucket
3. 70% Ethanol or 70% Isopropanol (rubbing alcohol)
4. plastic holding containers with lids
5. disposable bowls
6. glitter of different colors
7. paint brushes
8. microscope
9. test tubes
10. small flashlight with bright illumination
11. paper whole punch
12. Elmer’s® all purpose school glue or any other school
13. 2 squirt bottles with: 70% EtOH, and water

(2 days) prior to exhibition
1. Set bucket in a sink
2. Fill bucket with leaves
3. Add ethanol (EtOH) to bucket and let soak for 1 hour to allow chlorophyll leach out of leaf
4. After 1 hour, pour off extract into holding container and close lid
5. Repeat steps 1-3 until 1L of chlorophyll or desired amount has been extracted
   Note: chlorophyll is a molecule, which breaks down within a couple of days after extraction, and the color gradually fades.
Morning of exhibition

1. Create work areas (stations) by blocking off areas on a 5x8’ table
   a. Station #1- demonstrate extraction
      i. using the hole punch take samples from leaf and place in Petri dish
      ii. using squirt bottle filled with EtOH, fill dish with ethanol
      iii. as sample are cleared of chlorophyll transfer some another dish with water
           for viewing at station 2
      iv. refresh dish (i) with newly punched samples
   b. Station #2- microscope viewing
   c. Station #3- properties of chlorophyll
      i. pour some of the extracted chlorophyll into test tubes and seal with cap
   d. Station #4- painting with chlorophyll
      i. Add approximately 2 tablespoons to disposable bowls and mix enough
         extracted chlorophyll so that the glue “thins” and becomes more like paint
      ii. Add a little glitter
      iii. Repeat steps 2-3 for different glitter colors

Note: Station #4 is for creative freedom. The chlorophyll paint can be used to paint
trees, flowers, etc. For more of a sparkling effect, add glitter after painting as well.
Exercise #1- Chlorophyll extraction:

Chlorophyll can be removed (extracted) from plants by soaking the leaves or chlorophyll-containing parts in an alcohol such as ethanol (EtOH).

Try it......................

1. Use hole punch tool to clip (2) leaf samples into Petri dish

2. Apply ethanol to leaf sample with squirt bottle

3. Let set for few minutes until you see the green chlorophyll leach into the plate

4. Do you know why chlorophyll can be removed from the leaf by ethanol?

   Ethanol is an organic solvent that causes the plant cells to become leaky. The chlorophyll inside the cells become available and dissolves in the ethanol.

Congratulations!!! You have just completed your very own chlorophyll extraction.

Go on to Exercise #2 to view your leaf sample under a microscope.
Exercise #2- View Leaf under Microscope:

Once the chlorophyll is removed (extracted) from a leaf sample, some parts of the leaf cell structure can easily be viewed under a microscope.

Try it........................

1. Place petri dish with leaf samples under microscope and carefully focus to view your sample.

2. Can you identify any of the parts in the diagram?

   The epidermal cells of the corn leaf are visible. Epidermal cells allow respiration. Yes, plants breathe too. Plants breathe in carbon dioxide (CO₂) and release oxygen (O₂). Human breath O₂ and release CO₂.

Congratulations!!! You have just completed microscope training.

Go to Exercise #3 to learn more about chlorophyll.
Exercise #3- The Wonders of Chlorophyll:

Chlorophyll is visible as a green color. However, when white light is shined on extracted chlorophyll other colors become visible.

Try it........................

1. Pick up a tube of chlorophyll (do not open).

2. Shine the flashlight on the tube.

3. What color(s) do you see?
   - Red/violet

4. Do you know why those colors are visible once the flashlight is shined on the chlorophyll?
   Chlorophyll is a photoreceptor made up of two molecules: chlorophyll a, chlorophyll b. As a photoreceptor, it absorbs light energy from a source such as the sun. Once captured, light energy breaks molecular bonds within the chloroplast and turns it into a chemical energy that the plant needs to grow.

   Light energy, measured in nano-meters (nm), comes in different lengths. These wavelengths are part of the visible light spectrum which is actually a combination of different wavelengths from 700-400nm. If separated, these wavelengths appear to humans as different colors: red (700-650nm), yellow(650-600nm), green (600-500nm), blue/violet(500-400nm). Chlorophyll has the unique ability to separate and absorb energy from some wavelengths and reflect others.

   Chlorophyll is seen as green (600-500nm) because it does not absorb this color but reflects it. However, it absorbs quite well in the red light spectrum (700-650nm). When chlorophyll is contained in the plant, it converts this to chemical energy so that the red light is not visible. However, extraction stops this cycle when chlorophyll is removed from the plant and other components needed for this conversion. Therefore, instead of absorbing and converting the energy, it can only absorb and reflect it.

Congratulations!!! You have just completed Junior Scientist training.
Go to Exercise #4 to paint a leaf and add your name to the tree.
Exercise #4- Add your name to our Friendship Tree:

1. Write your first name on two leaves then
2. Paint them (hand wipes available)

Once your leaves dry, we will add one to our “Friendship Tree” and you can take the other one home with you.
Visit these sites for more information about plants, chlorophyll, corn, and solvents:

http://www.monsanto.com

http://www.cheminst.ca/ncw/experiments/epigments.html

http://www.organicworldwide.net/solvents.html

http://scifun.chem.wisc.edu/chemweek/ethanol/ethanol.html

http://users.erols.com/jkimball.ma.ultranet/BiologyPages/C/Chlorophyll.html

http://users.erols.com/jkimball.ma.ultranet/BiologyPages/C/Chloroplasts.html

http://users.erols.com/jkimball.ma.ultranet/BiologyPages/L/Leaf.html

http://imers.gsfc.nasa.gov/ems/visible.html