The GM Transgenic Process and Its Risks

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(see also: http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=957879329)

1. **Background** -- understanding how the GMO process can cause dangerous damage
    a. Protein
        1. What is it?
            a. It's made up of a long string of subunits called amino acids
            b. The arrangement of these is determined by "genes" in the DNA
            c. It folds itself into a particular shape necessary to perform its function
        2. What do proteins do?
            a. Structural (muscle, cell walls, etc.)
            b. Biochemical
                1. Enzymes are proteins
                    a. They control almost everything that happens in an organism
                    b. Many rely on a particular "trace" mineral to function: iron, cobalt, etc. (note: Monsanto's glyphosate is a *chelator* that ties up such minerals)
                2. Hormones -- many are proteins
        3. If a protein's structure is altered, it can
            a. fail to do a necessary job
            b. do something destructive (toxins -- i.e., poisons)
            c. create an allergic reaction (allergens; can be life-threatening)
    b. DNA and Genes
        1. Made up of thousands of subunit molecules -- whose initials are G, C, T, A
        2. Each amino-acid (protein building block) is "coded for" by a unique set of these
        3. A gene is a particular functional sequence of these, which might:
            a. code for the sequence of amino acids used to build a particular protein (and have special markers indicating the beginning and end of the sequence)
            b. control (on/off) whether such a gene will actually create a protein
            c. identify that the gene is from a plant, or a bacteria
        3. Genes are very complex
            a. They function in "families" or "networks"
            b. It's not "one gene makes one protein" -- a theory that was out of date decades ago
            c. The GMO transgenic process is based on that misunderstanding, hence dangerous -- you can't drop a bomb into a network without unpredictable consequences.
            d. Inserted promoter genes can control many genes not involved in the insertion; having genes turned on 24/7 (out of control) is potentially dangerous
            e. It turns out that truly desirable traits (tolerance of droughts, heat, flooding, salinity, etc.) are beyond the reach of GMO technology, because they are governed by complex gene families, not a single or pair of genes

2. **Step 1: Tissue Culture I -- growing cells of the species that has the desired trait**
    a. Tissue culture is known to have the potential for a large number of mutations.

3. **Step 2: Extract the "desirable" genetic material**
    a. DNA is removed from cells of plant with desired trait and broken into pieces
    b. Pieces are incorporated into bacterial plasmids, which can infect cells
    c. Bacteria are shocked (heat or electricity) to allow infection by plasmids

d. Each bacterium is cultured, cultures tested to find which have desired trait.
e. Those that do have plasmids with the right sequence in addition to their known structure.

4. **Step 3: Creation of the "insertable" DNA packet containing**
   a. The desired gene(s)
   b. An antibiotic-resistant marker gene (see Step 5, below)
   c. A promoter gene from a virus (on/off switch set to always-on)
   d. If putting bacteria gene into a plant, you need a marker that will trick the plant into thinking the gene is a plant gene.

5. **Step 4: Insertion of the genetic material**
   a. Two techniques
      1. Gene gun
         a. A compressed-gas gun
         b. Shoots particles of tungsten or gold or silver, coated with DNA
         c. Blasts into a clump of cells on a petri dish, destroys most, some get DNA
      2. Bacterial infection
         a. Special crown-gall bacterium
         b. Has a ring of DNA called a "tumor plasmid"
         c. Designed to break through plant cell walls to transfer DNA
   b. Blanket assault on thousands of cells.
   c . Lack of precision
      1. Only a part of the DNA packet may be inserted
      2. No way to control (or determine) where the packet winds up
   c. Potential problems with ultimate location
      1. In the middle of a plant gene -- destroys the function of that gene
      2. Anywhere where it breaks up or causes another gene to break up, creating truncated proteins (of unknown and possibly extremely dangerous function)
      3. In a location where the promoter activates normally de-activated genes (such as dormant viruses that have inserted themselves into the DNA, or allergens previously unknown in the plant)
   d. Old technology -- regardless of accuracy, assuming one gene has one effect is wrong.

6. **Step 5: Identifying successes**
   a. Treat the petri dish of assaulted cells with antibiotic
   b. Survivors have the antibiotic-resistance marker gene, indicating probable success

7. **Step 6: Tissue culture II**
   a. Survivor cells (originally "undifferentiated") are grown out into whole plants using plant hormones
   b. As mentioned above, this has the capability of producing large numbers of mutations.
   c. Those with the desired trait are selected out.
   d. The "best" among these are used as the basis for creating GM seeds.

8. **Environmental variability** -- All this uncertainty is aggravated by the observed fact that the genetic structure of GM plants changes, so that in different areas of the country and different environments, the plants end up with gene sequences different from the registered sequence.