

GM Crops Really Are Safe

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I was ----

reared on a farm in Central New Jersey,
studied crop science at Rutgers ag
school and West Virginia University
and spent more than 50 years working
in the chemical industry.

In recent decades ---

GM crops were subject of much criticism.

Protest rallies were held.

**Fast food restaurants shunned buns made from
GM grains.**

**TV ads touted that advertised products do not
contain GM ingredients.**

Fast food restaurants shunned buns made from GM grains.

Media used the term “Frankenfoods”.

Many countries banned importation of GM crops even though their people and livestock were starving.

There are concerns that GM crops are dangerous to humans and livestock consuming the GM crops.

My Goals

Describe the science of GM crops.

Address environmental and health concerns.

Enumerate the benefits of GM crops.

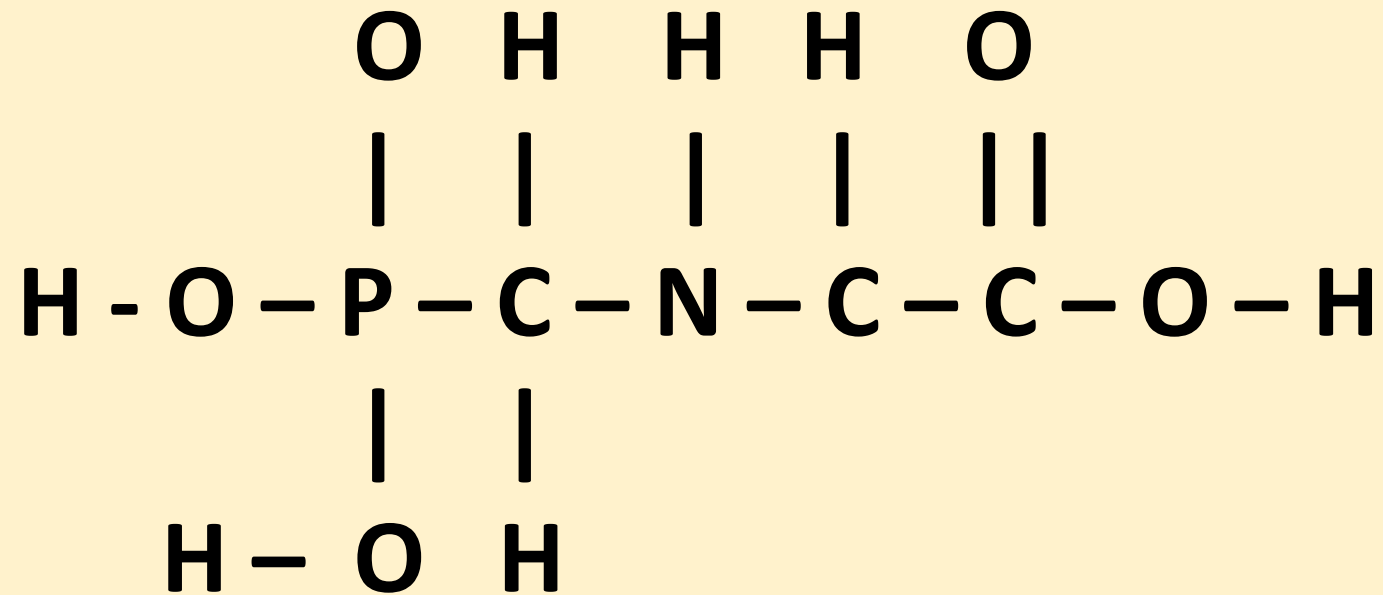
Particular Concern

Crops where genes from other organisms have been added to impart herbicide resistance or insecticidal activity.

Genes that areG

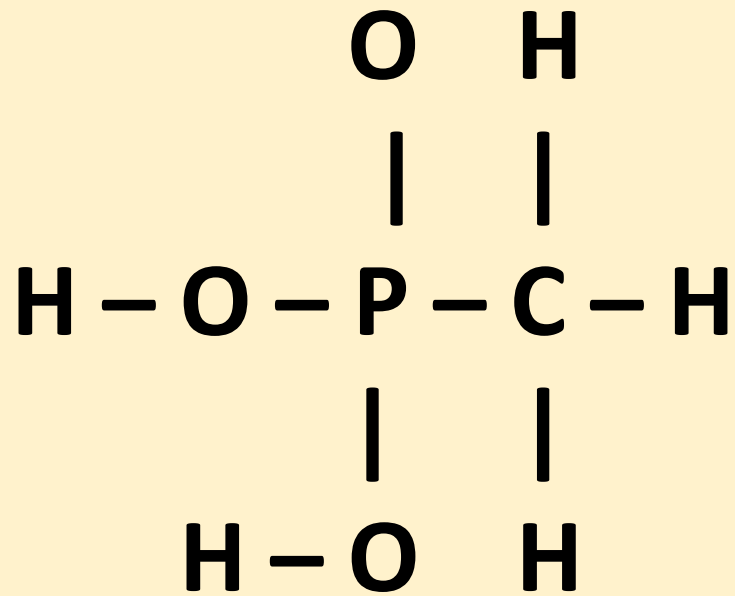
Genes were added to allow glyphosate herbicide to be sprayed overtop of corn, soybean, cotton or canola plants to kill weeds without damaging the crop.

Glyphosate Herbicide

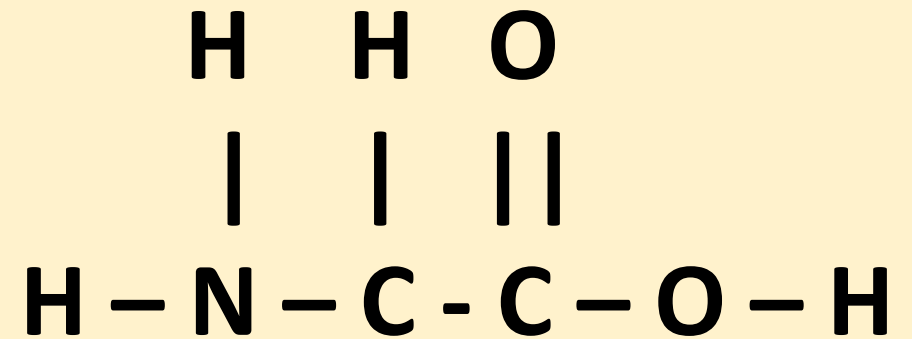


N-(phosphonomethyl) glycine

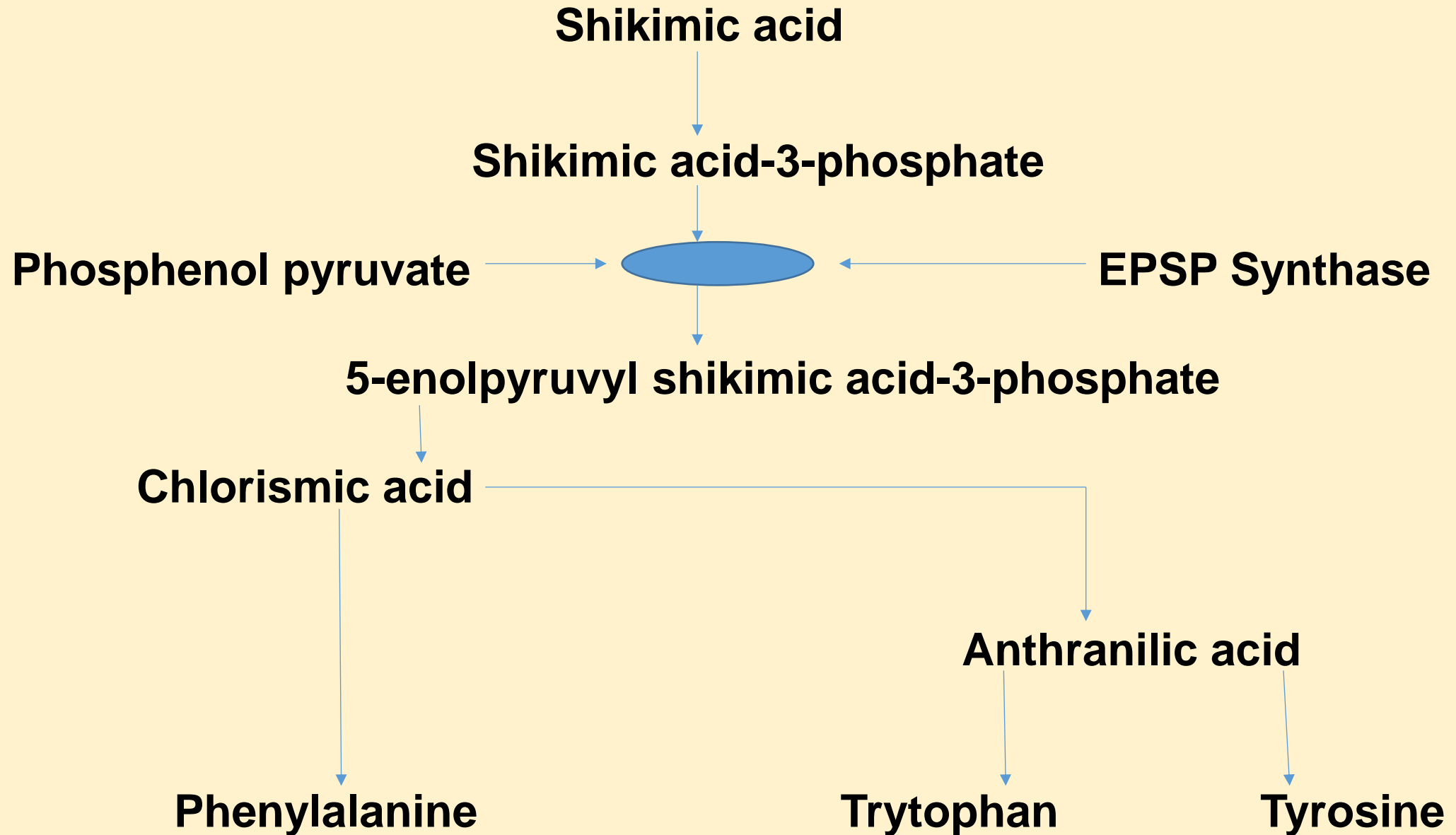
Glyphosate is a derivative glycine, the smallest amino acid.



Phosphonomethyl



Glycine



Creating Glyphosate Resistant Crops

Some plants are naturally resistant to glyphosate.

Monsanto scientists discovered a strain of bacteria resistant to glyphosate.

Could not produce crop plants resistant to glyphosate at doses needed for weed control.

Found a strain of bacteria in the glyphosate waste pond that could tolerate higher doses.

Isolated the appropriate genes and began inserting them into crop plants.

**Various glyphosate
crops became
commercially available
in the mid-1990s.**

Controlling Crop Insects

Another example of GM technology is adding genes of *Bacillus thuringiensis* (Bt), a bacteria, to corn to kill the larva stage of corn rootworm, corn earworm and corn borer.



Bt sprays have been used for many decades on a variety of crops.

Insect larva eat foliage containing Bt spores which contain toxic protein crystals.

The toxin binds to specific receptors in the gut and the insect stops eating.

The toxin causes holes to form in the gut wall allowing spores and normal gut bacteria to enter the insect's body.

The insect dies as spores and gut bacteria proliferate in the insect's body

Each spray provided very effective insect control.

But, rains washed Bt off and had to be reapplied.

Foliar sprays had no effect on soil insects.

So, scientists incorporated toxin genes into corn plants to produce toxins that would kill the three major corn insects.

The Bt genes have been inserted into many other crops.

Now, farmers can safely spray glyphosate the foliage of insect resistant crops to kill weeds.

ISAAA reported that in 2016, GM crops were grown in 26 countries.

The global area of biotech crops was 457.4 million acres grown by 8 million farmers.

The top 10 countries

<u>Country</u>	<u>Million Acres</u>	<u>Percent</u>
USA	175.1	39
Brazil	109.2	27
Argentina	60.5	13
India	28.6	6
Canada	27.2	6
China	9.1	2
Paraguay	8.9	2
Pakistan	7.2	2
South Africa	5.7	1
Uruguay	2.7	1

From 1996 through 2016, the cumulative total of all GM crops grown was 5,312 billion acres.



Soybeans (2.47 billion acres)



Cotton (74.1 billion acres)



Corn (1.48 billion acres)



Canola (24.7 billion acres)

So, vast quantities of corn and soybeans have been grown that were used to feed livestock and to produce a variety of human food.

ISAAA predicts that 24.45 billion acres of GM crops will have been grown by 2050.

If GM crops are so dangerous, why haven't adverse ill effects been identified.

Because GM crops
really are safe.

Let's see why

Glyphosate

Chemical analyses have shown that glyphosate residues in crop seeds (corn, soybeans and granola) are less than 1ppm (0.01%).

Mammals do not have a shikimic acid pathway and so any residual glyphosate exhibits no biological activity.

Bt Toxins

The very low levels of Bt Cry and Cyt toxins in corn kernels are proteins that are readily broken down in the digestive system of livestock.

Cooking corn kernels during human food processing denatures all proteins including the toxin proteins thus destroying any biological activity.

Biochemistry of Genes

Genes in GM crops are held in chromosomes in the cell's nucleus.

Each chromosome contains two strands of DNA linked together in a helical structure.

Each strand contains a series of nucleotides.

Each nucleotide contains a phosphate group, a sugar and one of four nitrogen bases (adenine, cytosine, guanine and thymine).

Biochemistry of Genes (contd.)

Genes responsible for glyphosate resistance and Bt toxin production are composed of the same types of nucleotides as all other genes in the chromosomes of GM crops.

Digestion and manufacturing processing breakdown the DNA leaving individual molecules of nucleotide components which are used by livestock and humans to make more DNA or RNA when corn is consumed.

Government Oversight

Before GM crops are released for sale, extensive amounts of data must be submitted to government agencies to prove their safety. In the US, three federal agencies are responsible for regulating GM crops:

Environmental Protection Agency (EPA)

Food and drug Administration (FDA)

US Department of Agriculture (USDA)

Information Required by EPA

Product Characterization

Identification of the transformation event

Identification of PIP components

Spectrum of pesticide activity

Mode of action

Certification of limits

Characterization of inserted DNA

Characterization of protein(s) efficacy, expression levels and physiochemical properties

Demonstration of protein equivalency

Information Required by EPA (contd.)

Human Health

Mouse acute oral toxicity

Toxins - protein database analysis

**Allergenicity – stability to heat, SGF, SIF, and
bioinformatics database analysis**

Information Required by EPA (contd.)

Environmental – Nontarget Organisms

Avian acute oral toxicity (quail/duck)

Avian dietary toxicity (broiler/duck)

Freshwater fish toxicity

Freshwater invertebrate toxicity

Honeybee toxicity (larva/adult)

**Beneficial insect toxicity – predators and parasitic
wasps**

Non-arthropod invertebrate toxicity – earthworm

Synergistic effect from multiple PIPs

Information Required by EPA (contd.)

Environmental – Environmental Fate

Soil degradation fate

Resistance Management Data Requirements

Target organism susceptibility

Simulation models

Potential for resistance

Resistance monitoring program

Remedial action plan

Compliance assurance/grower education

Information Required by EPA (contd.)

Conditions of Registration

Annual report on compliance

Annual report on grower education

Annual report on IRM monitoring

Annual sales report

Other

Analytical detection method

Public interest document

Environmental Benefits of GM Crops

The recommended dosage of glyphosate is 24 to 32 fluid ounces (0.75 – 1.0 pound of active ingredient) per acre in sufficient water to achieve thorough coverage of the weeds.

The 32 ounce rate delivers 0.000022956 ounce of active ingredient per square foot.

Not much chemical!

The carpet of growing weeds and crop intercepts the spray and so very little, if any, glyphosate reaches the soil.

Environmental Benefits of GM Crops (contd.)

Corn containing the Bt genes does not have to be treated with insecticides that have to be mixed into the soil.

The chlorohydrocarbon insecticides that were used in the 1950s and 1960s (the Rachel Carson era) really did have some adverse environmental effects.

Those harsh products were replaced with environmental friendly insecticides that were mixed into the soil.

Now, use of Bt corn has eliminated the need to mix chemical insecticides into the soil.

Fuel that was used to spray Bt spores is no longer burned.

Conclusions

Based on biochemistry considerations , government oversight and the fact that billions of tons of GM crops have been consumed by livestock and humans over the last 20 years, consumers have nothing to fear (except maybe obesity) when consuming food products made with GM crops.

Conclusions (contd.)

The GM critics should stop scaring the general public with their false allegations.

Especially Dr. Steven M. Druker, an activist lawyer, who authored the book *ALTERED GENES, TWISTED TRUTH* where he makes so many groundless allegations against GM crops.

The sad part is that Dr. Druker's unsuspecting audiences are being hoodwinked if they only read this book and do not read the many critical reviews.

The Future

Growing of GM crops will continue to expand as more and more farmers throughout the world begin to use them.

The gene splicing technology that has produced the first generation of GM crops will be supplemented with new technology where specific individual bases in DNA can be changed (gene editing).

But, that is the subject of another paper.

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