



Bioforensics

What is a pesticide?

- Pesticides are a class of chemicals that are used to kill destructive and unwanted pests.
- These pests include rodents, microbes or insects that eat or destroy plants.
- Pesticides are commonly used in the production of grains, fruits, and vegetables to increase the amount of food produced per acre, enabling farmers to keep up with the growing demand of a growing population.



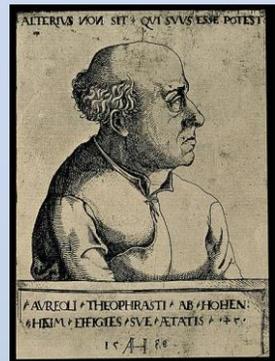
The Silent Spring

- In 1962, Rachel Carson wrote what many consider one of the most important science books of all time.
- Early pesticides were not developed with a consideration or understanding of their environmental impact. Some of these pesticides were very persistent. Persistent organic compounds are chemicals that resistant to environmental degradation through chemical, biological, and photolytic processes.
- That meant these chemicals would linger long (sometimes decades or more) after their intended use was over; and would bioaccumulate in apex species.
- The book laid out the impact widescale use of these more dangerous and persistent pesticides was having. This included large scale bird deaths from eating fruits and insects laced with DDT.
- This book led to the eventual US ban on the use of DDT and other very toxic and persistent pesticides.
- Importantly, this has led to the development of safer, less persistent and less toxic alternative crop treatments.



But aren't all chemicals bad for you?

- Everything you see, feel, taste, and smell is made of chemicals. In fact, you and all living things are dependent on and are made of all kinds of fabulous chemicals including water, proteins, carbohydrates, lipids, and nucleic acids.
- Paraphrasing the Swiss Renaissance physician, Paracelsus (1493-1541) – the father of toxicology, the **dose** is what determines if a chemical is a poison.
- In fact, many common nutrients if ingested at high concentrations would be considered toxins. Eating the appropriate amount of these nutrients is necessary to keep your body healthy.





How do we Detect Pesticides on Crops?

SEPARATION SCIENCE!

Ok, so some pesticides are toxic chemicals, but we are surrounded by chemicals and all our food is made of chemicals...

How Do We Know if Our Food Contains a Pesticide or Another Chemical we Should be Concerned By?

- Analytical chemists use a separation technique known as gas chromatography (GC) separation to separate the chemicals from one another.
- The chemical mixture is first warmed up rapidly and injected into a separation column.
- The column is coated a material that some of the chemicals like more than others.

Imagine a marathon race, the runners start the race at the same time but finish the race at vastly different times. Chromatography is like that where the analytes in the mixture are injected at the same time, but due to differences in the boiling point (how fast they evaporate), how well an analyte mixes into oil or water, or even the shape of the molecule. At the finish line we count the molecules that come thru at the same time.

For GCxGC, imagine if at the end of the marathon, there was a 1000 m swimming race that started every 15 minutes, so that everyone who finished the marathon within that 15-minute window started the swim race at the same time. The faster swimmers are not necessarily the faster runners so they would finish in a different order than they did in the marathon. That's how GCxGC works, the chromatogram below (the blue box) separates from left to right based on how fast the molecules evaporate, and from bottom to top based on how well they mix with water.

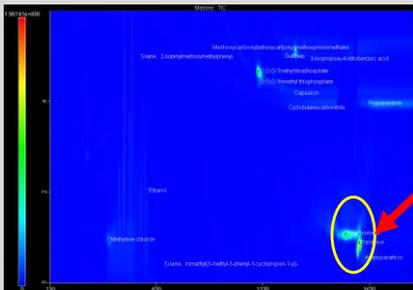
To demonstrate separation science, we will determine if Parathion was present on the strawberries.

PARATHION

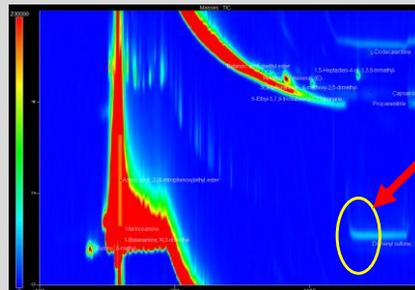
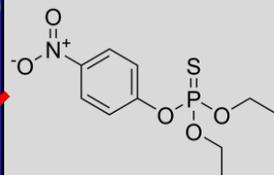
- Parathion developed in Germany in the 1940's. It is a highly toxic insecticide banned in most countries and is persistent organic compound identified as an extremely hazardous chemical by the World Health Organization (WHO)

What Does Organic Mean?

- When it comes to grains, fruits, and vegetables, it means the farmers certify that no synthetic fertilizers or pesticides have been used on the field for at least three years.
- Because of the persistent nature (the chemical doesn't breakdown quickly in the environment) of some banned pesticides even organically grown produce can contain some traces of these chemicals.
- The best way to ensure your produce – no matter it's source - is both healthy and tasty is to wash it with soap and water before eating.



Parathion signature



Strawberry sample that lacks the parathion signature in their GC x GC chromatogram.



Does your strawberry have pesticides on it?

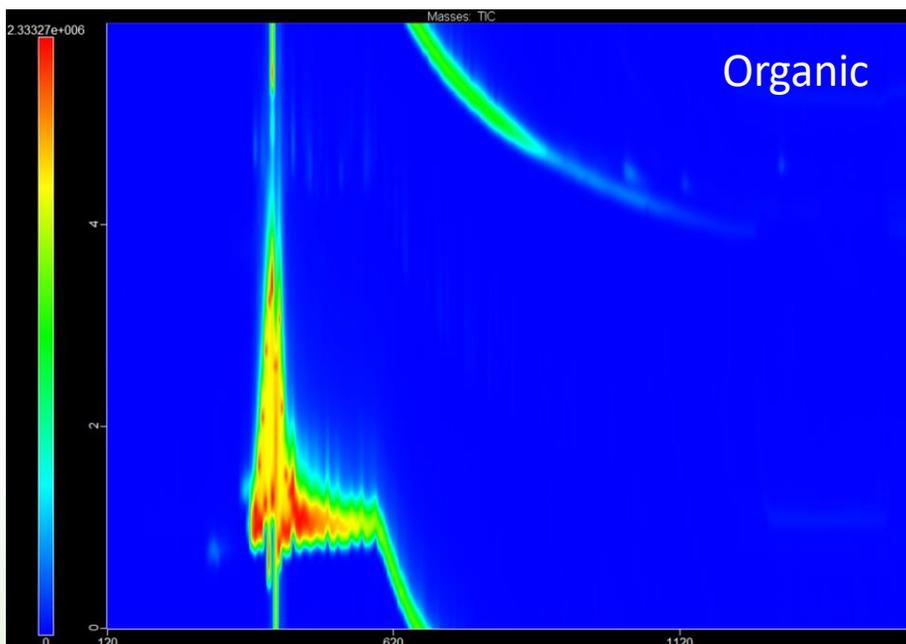
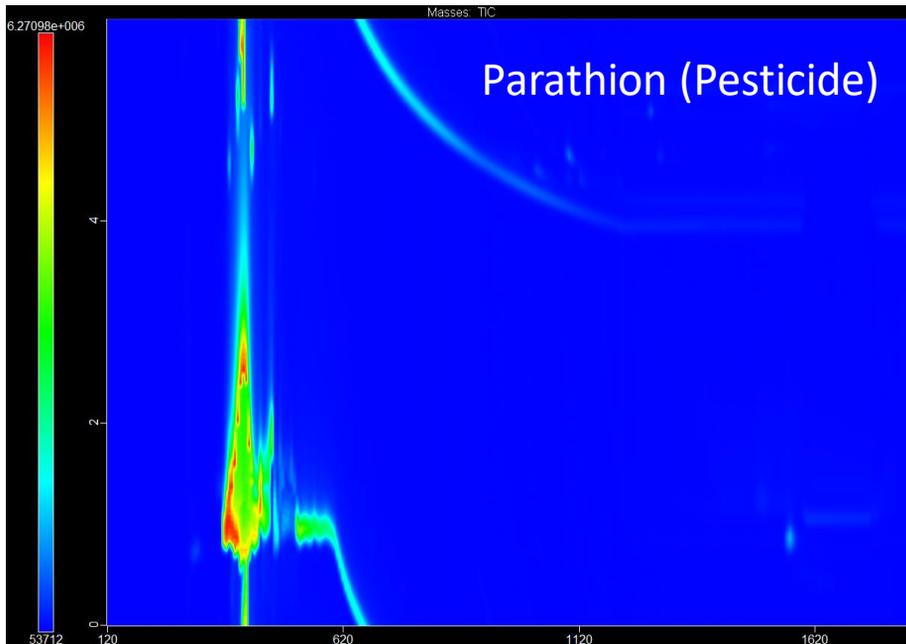
[Watch Video](#)



Does your strawberry have pesticides on it?

You completed gas chromatography and you got the following spectrum.

Does your strawberry have pesticides on it? Match your spectrum found in your participant packet with pictures below to answer that question.



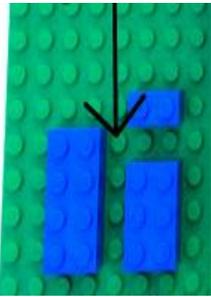


Make your own two-dimensional separation with LEGOs

1

Grab a small pile of LEGO Bricks Pick two separation methods

Separate by length



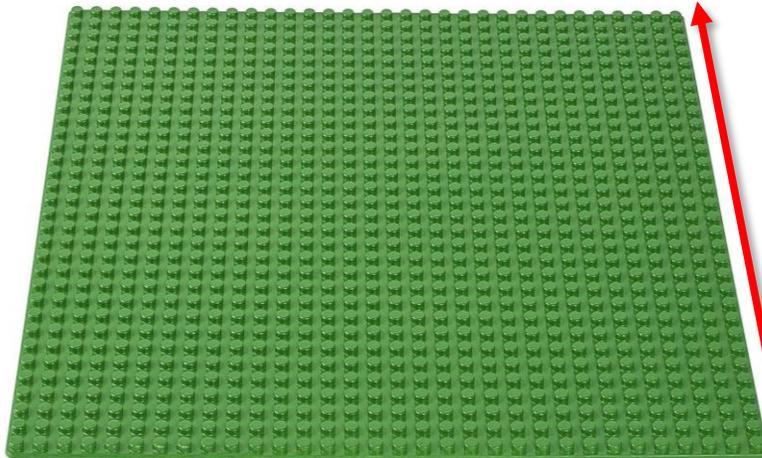
Separate by color



Separate by width or thickness



Or create your own ideas....



3

Separate bricks by second method, i.e. by color: red, orange, yellow, green, blue, etc.

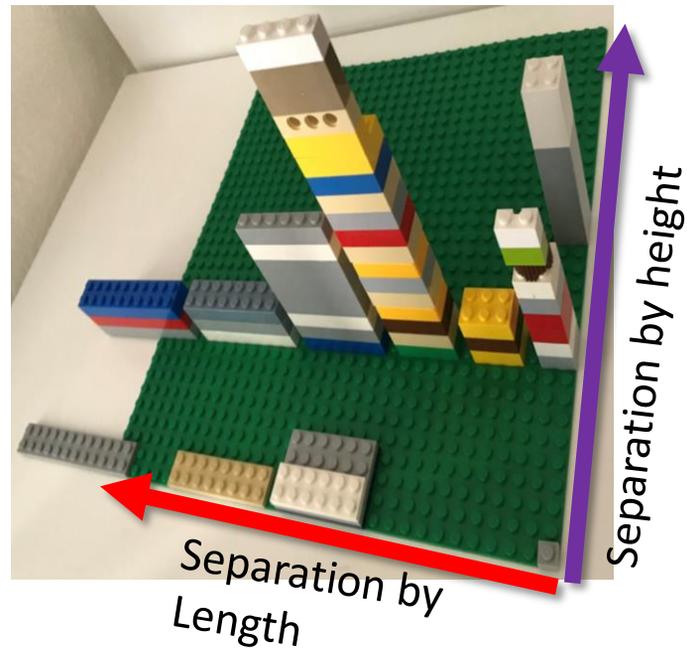
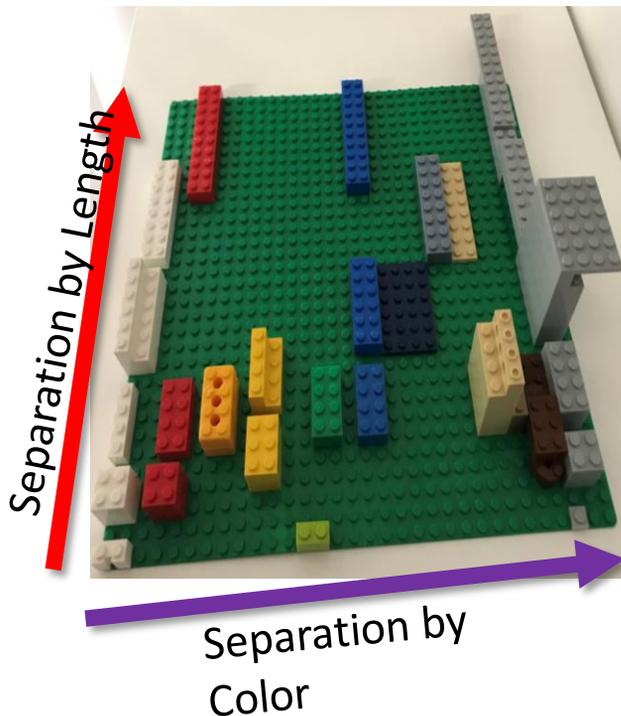
2

Separate bricks by first method, i.e. from shortest to longest



Examples

Below the same pile of LEGOs was separated by two different pairs of separation parameters:



Which one did a better job of separating out the blocks?

How did your separation strategy compare?

Does it matter what the composition of the pile of blocks was?

What does the height of the blocks tell you?