

Audiobook Transcript

One cool fresh morning, Raghu was awake long before the sun was up. The day starts early on his father's farm, and Raghu is eager to help.

In the shed where all their tools were kept, Raghu's father was already hard at work, measuring out a powdery substance and mixing it in a bucket of clean water.

Raghu knew that when this mixture is sprayed on their crops, it kills all the insects and pests that eat the small saplings and destroy Raghu's dear plants. Raghu thought to himself,

"This pesticide is a very useful substance indeed".

Did You Know?

Almost half of India's population financially relies on agriculture.

Raghu's father has been using this pesticide for many days, and always washes his hands and clothes after spraying his fields. He knows that pesticides are poisonous and very harmful to our body.

Suddenly one day, Raghu felt very unwell - he was sweating profusely and was so weak that he could not get up or speak.

The doctor was quickly called and he gave Raghu medicine. Slowly over the next few days, Raghu got better, but it was not just him - several children in the neighborhood fell sick just like Raghu had.

Raghu decided to ask his Science teacher, Mr. Swami, why this was happening.

On his way to school, Raghu noticed how the excess water from the fields was draining into the stream where everyone got their water from. He thought,

"That can't be good, the water must be full of pesticides."

Mr. Swami was very knowledgeable about various pesticides and their harmful effects. He explained to the troubled boy,

"You were absolutely correct in suspecting the water draining off from the fields.

The use of pesticides in itself might not create so much of a problem. Problems arise when we use them more than necessary and without proper disposal. This is happening all around us!

You see, the pesticides that your father and many others use are a very special kind of chemical called **organophosphates**.

Remember when we learnt about phosphoric acid in chemistry?"

"Yes! One phosphorus atom linked to four oxygen atoms, three of which are attached to hydrogen atoms on the other side"

"Precisely. Now if you replace those hydrogen atoms with long chains or rings of carbon, called –"

"**Organic compounds!** That's why the name **organophosphates!**"

"Exactly! Organophosphates are very useful chemicals and have been used as pesticides for decades, but there are dangers to its use as well. They affect our nervous system, that is our brain and all the nerves throughout our body.

This is why you became ill and couldn't move your muscles."

Tell Me More!

Some commonly used organophosphate pesticides are malathion and parathion.

"But Sir, how did these chemicals reach from the fields to everyone's homes? Was it from the excess water from the fields running off into the streams?"

"Well spotted. You see, organophosphates are *soluble*, they easily pass into the water and soil wherever they are applied.

The pesticides in the fields drained off into the streams, and also leached into the ground, contaminating our wells."

Did You Know?

Organophosphate pesticides have been banned or restricted in several countries.

"Then Sir, is it possible to change these chemicals into something that will not harm us? If we could have some way to filter the waste water and remove the pesticide ..."

"You are right, that would indeed be an ideal solution."

This was the very question we asked ourselves.

The entry of organophosphates into waterbodies is a severe problem, but no effective ways to deal with it have been found.

That is, until now.

We are **Team iGEM IISc Bangalore**.

We are making a filter that will capture organophosphates in running water and break it down into harmless products.

Our greatest ally in this mission is the field of **synthetic biology**, where we redesign systems found in nature to do new tasks and create new materials.

We call it **CelloPHane** - a Cellulose biofilter for Organo PHosphates.

Tell Me More!

Synthetic biology involves a number of different branches of science, from biotechnology and molecular biology.

To create this filter we use **cellulose** sheets created by a certain type of **bacterium**.

Cellulose is a strong and durable material made of lots of thin cellulose fibres. It is formed naturally by several organisms in their daily life and is hence eco-friendly as well. Using synthetic biology, we were able to control the microbe in such a way that it formed a large quantity of cellulose, enough for us to make a filter.

Did You Know?

All wood, twigs and leaves from trees are made up of mostly cellulose and a hard waterproof material called lignin

Inside our cells there are tiny machines made out of protein, that perform a variety of tasks necessary for daily life, such as digesting food and helping our cells grow. They are called **enzymes**.

We found a very special kind of enzyme that can grab organophosphates in the water and break it down.

Using a few other kinds of proteins like building blocks, we attached this enzyme to the cellulose sheets we got in the beginning.

And just like that, your biofilter is ready!

Once we place this filter at an outlet of water with loads of organophosphates in it, the water will pass through the cellulose filter.

Imagine when we pour tea through a strainer, the tea leaves are left behind and we get clear, soothing tea - in much the same way, our biofilter grabs all molecules of organophosphates. But instead of getting stuck in the filter, the chemicals are broken down into small harmless products.

What's even more exciting is that, we built it using a number of blocks fitting together, we can even change a few blocks if we want, without having to build the whole filter again.

We can even fit in a new enzyme that can break down some other harmful chemical ... the possibilities are endless!

With the help of the amazing potential of synthetic biology, we can create a revolution in the strategies to remedy our environment, in ways that will be accessible to all - contributing, in our own way, to the **United Nations Sustainable Development Goals**.

With the collective effort of scientists, students and the people of the world, we can strive towards the betterment of Nature, one CelloPHane at a time.