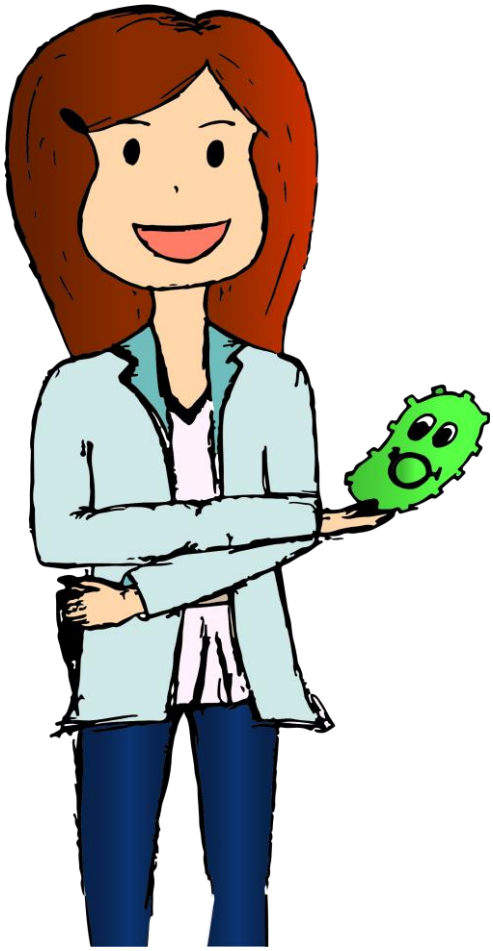
THE ADVENTURES OF UMAY

IN

SYNTHETIC BIOLOGY



STORY

MERVE NİDA BAŞTÜRK & İLAYDA ŞENYÜZ

ILLUSTRATION

AYŞENUR DENİZ ÇAYIRTEPE

We prepared this story book to introduce Synthetic Biology and its applications to younger generations in order to show them a whole different way of viewing and solving problems. We integrated our iGEM project idea to a real-life problem, which we know many people suffer from, to show how synthetic biology can be a tool to improve our lives.

We thank to the teams UFRGS, CPU, Tartu TUIT, Nantes, Ruperto Carola, Athens, IISc Bangalore, Botchan Lab, TU Eindhoven, TAU, Technion, Moscow, UPNA, LiU, and CCU for their contribution in translating this story book to their languages so that we can reach a bigger audience and inspire more young scientists. Thanks to their contribution, our book is also available in Portuguese, Mandarin Chinese, Estonian, French, German, Greek, Bengali, Japanese, Hebrew, Dutch, Basque, Spanish, Swedish, Taiwanese Mandarin, Russian in addition to Turkish and English.

Bilkent UNAMBG iGEM 2019 Team

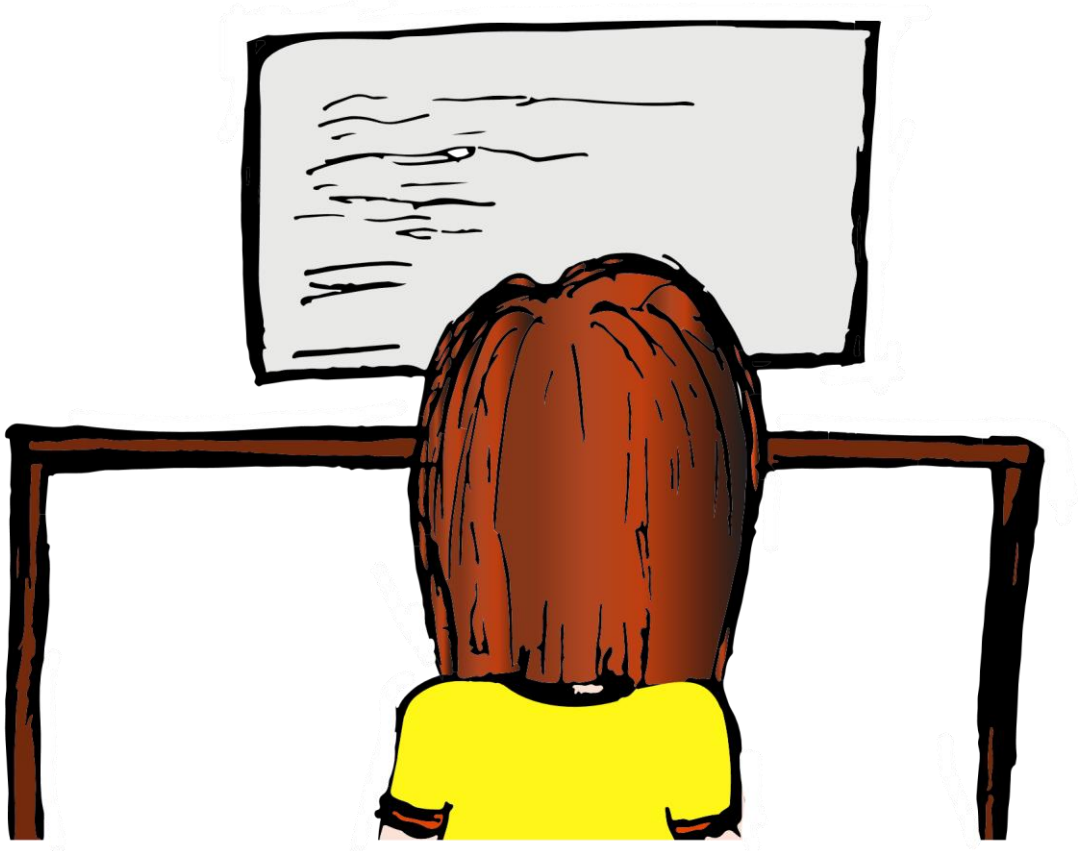
Umay is a little, smart girl. She has a grandfather with diabetes. So, what is diabetes? When we eat food, our body digest this food to very small molecules in our gut. Glucose is one of these small molecules. It is a kind of sugar. Our cells have to utilize glucose to obtain energy. This is the crucial point. How does glucose travel to our cells? Firstly, they travel to our bloodstream from our gut. Then, they start to enter our cells. This entrance is the job of insulin. That is, insulin guides cells to uptake glucose from blood. When a problem occurs in the working of insulin, this leads to the disease diabetes mellitus.

He experiences so many difficulties while dealing with diabetes. He always forgets when to do his injection and his diet.

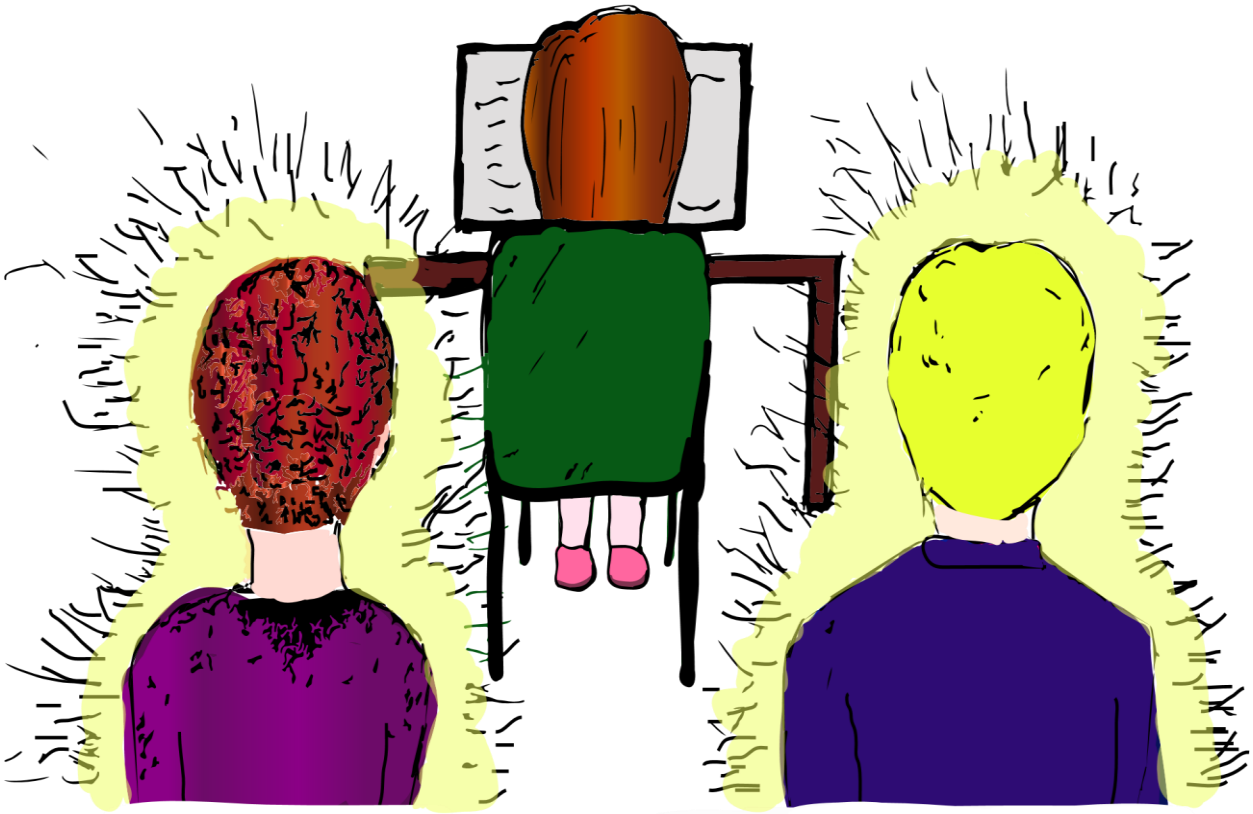
I will make a smartphone application for my grandfather.

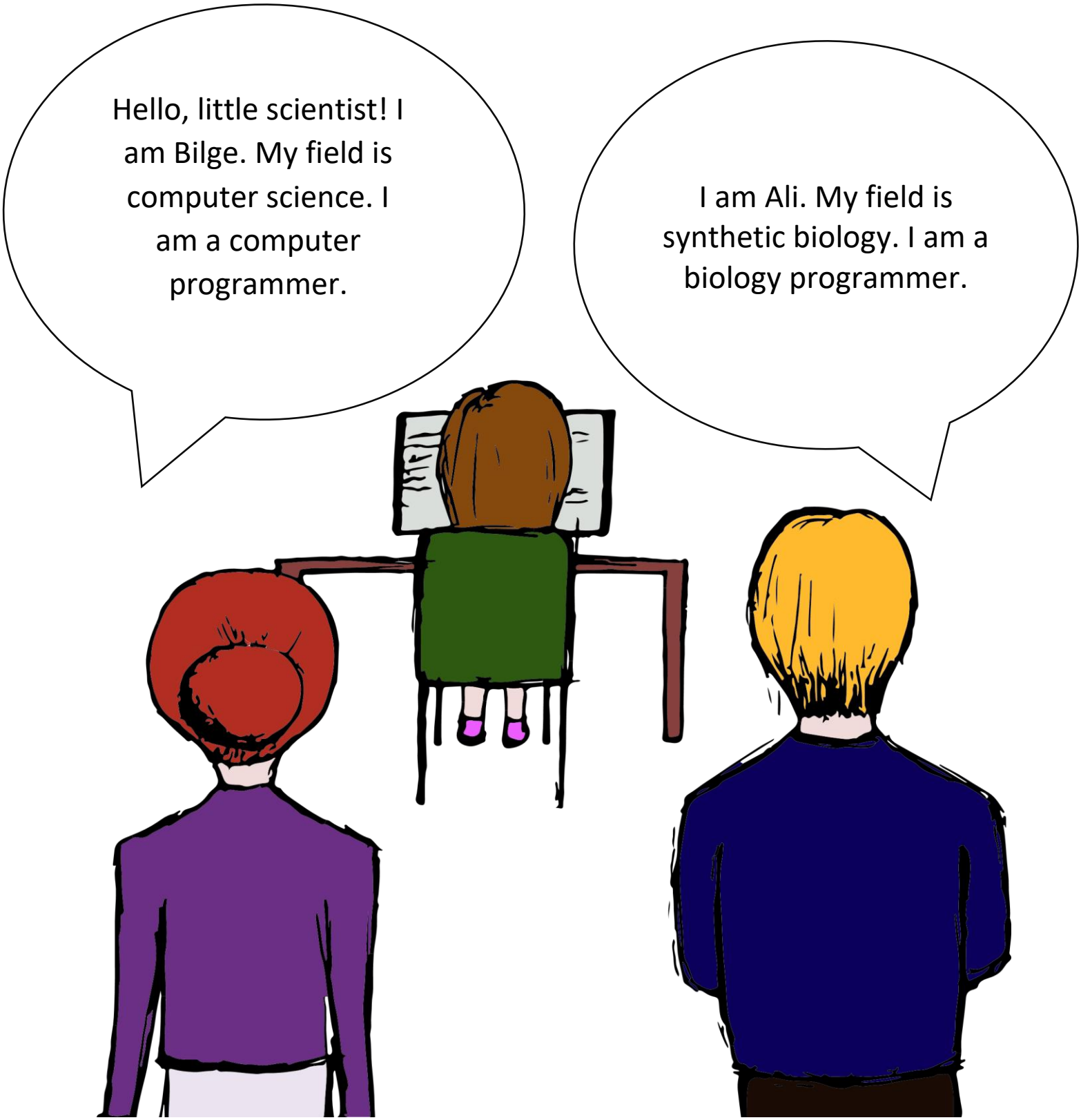
It will remind him his medication time, what he can and can’t eat.

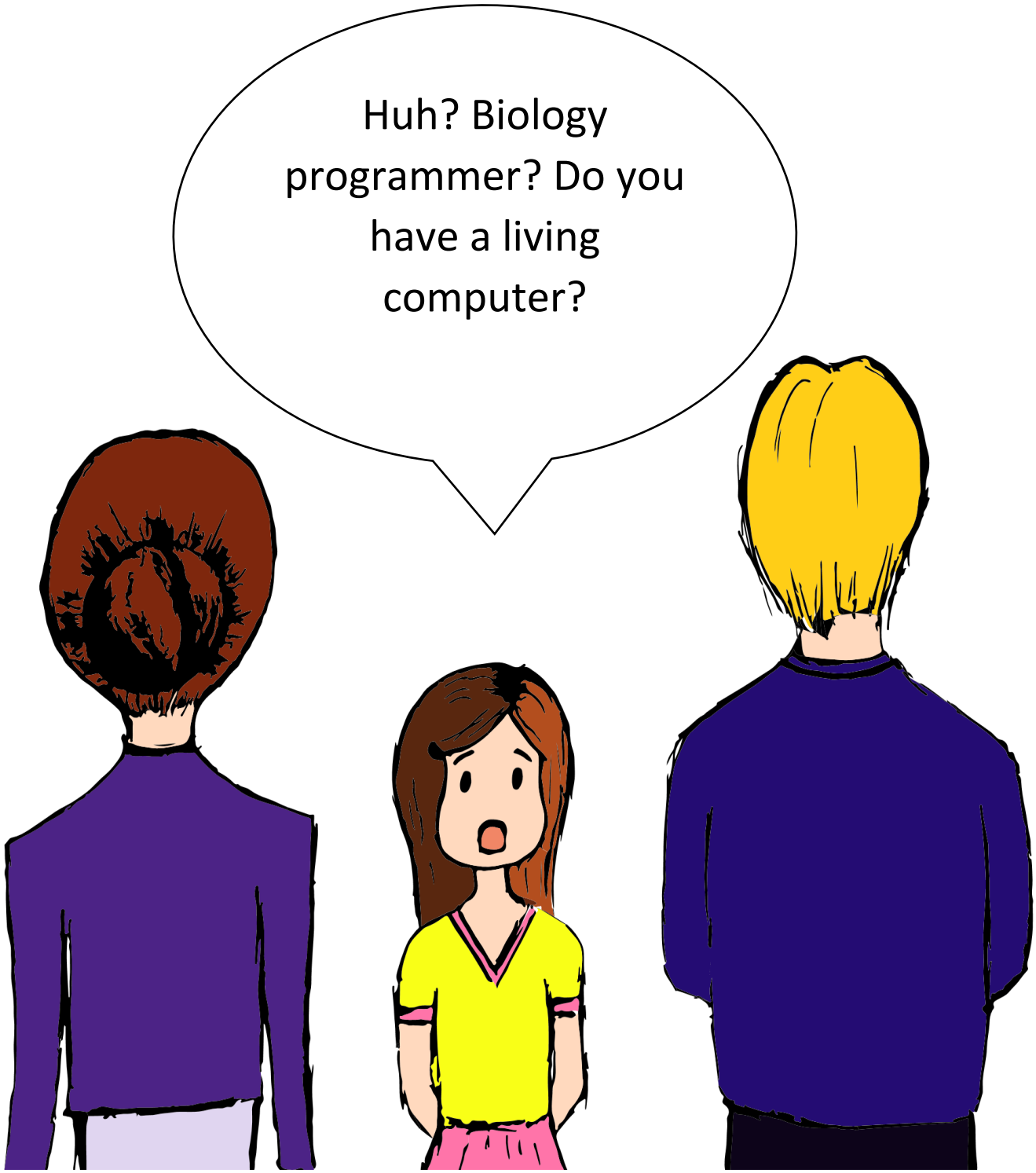
After Umay started to work on computer…

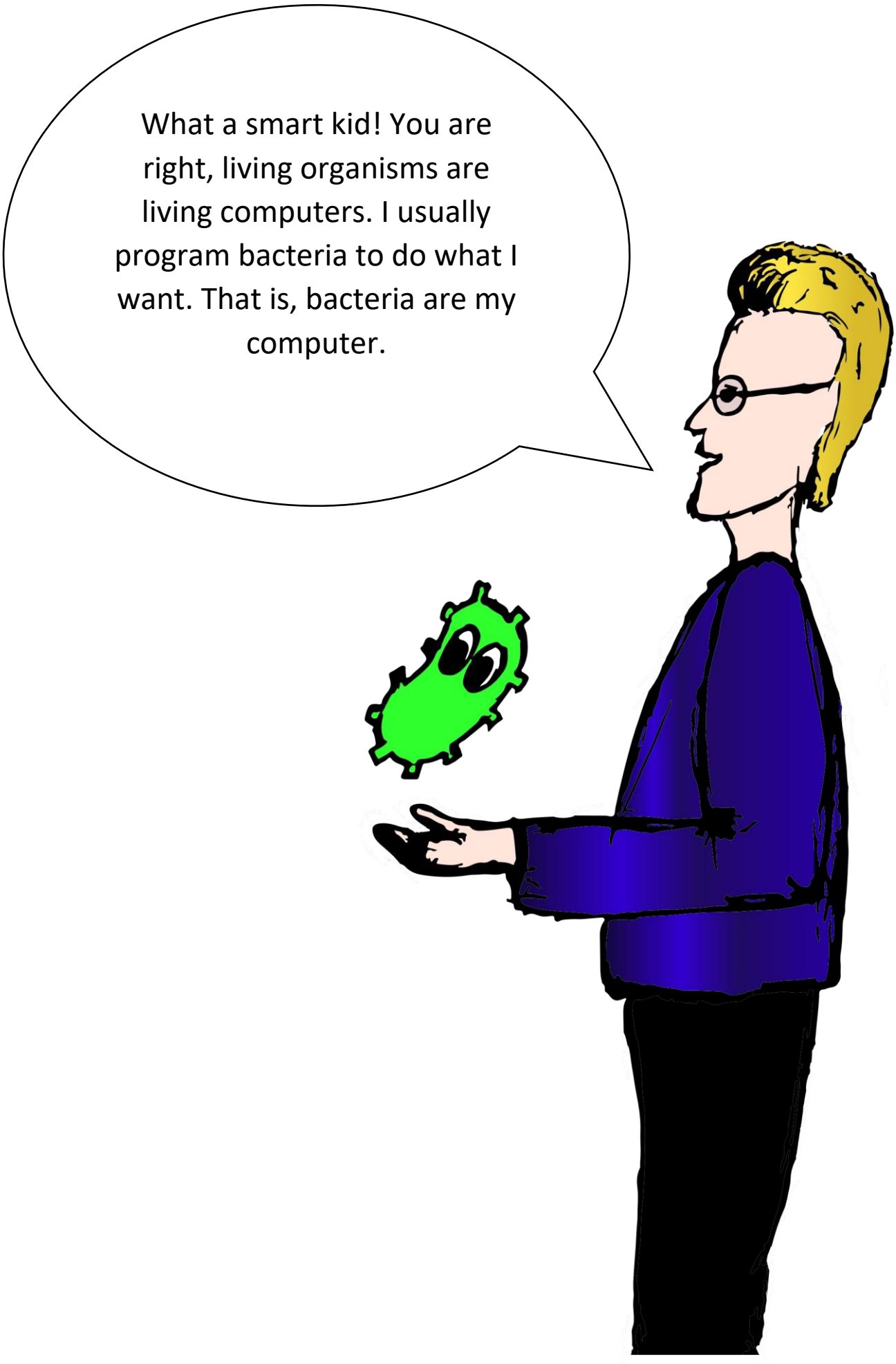


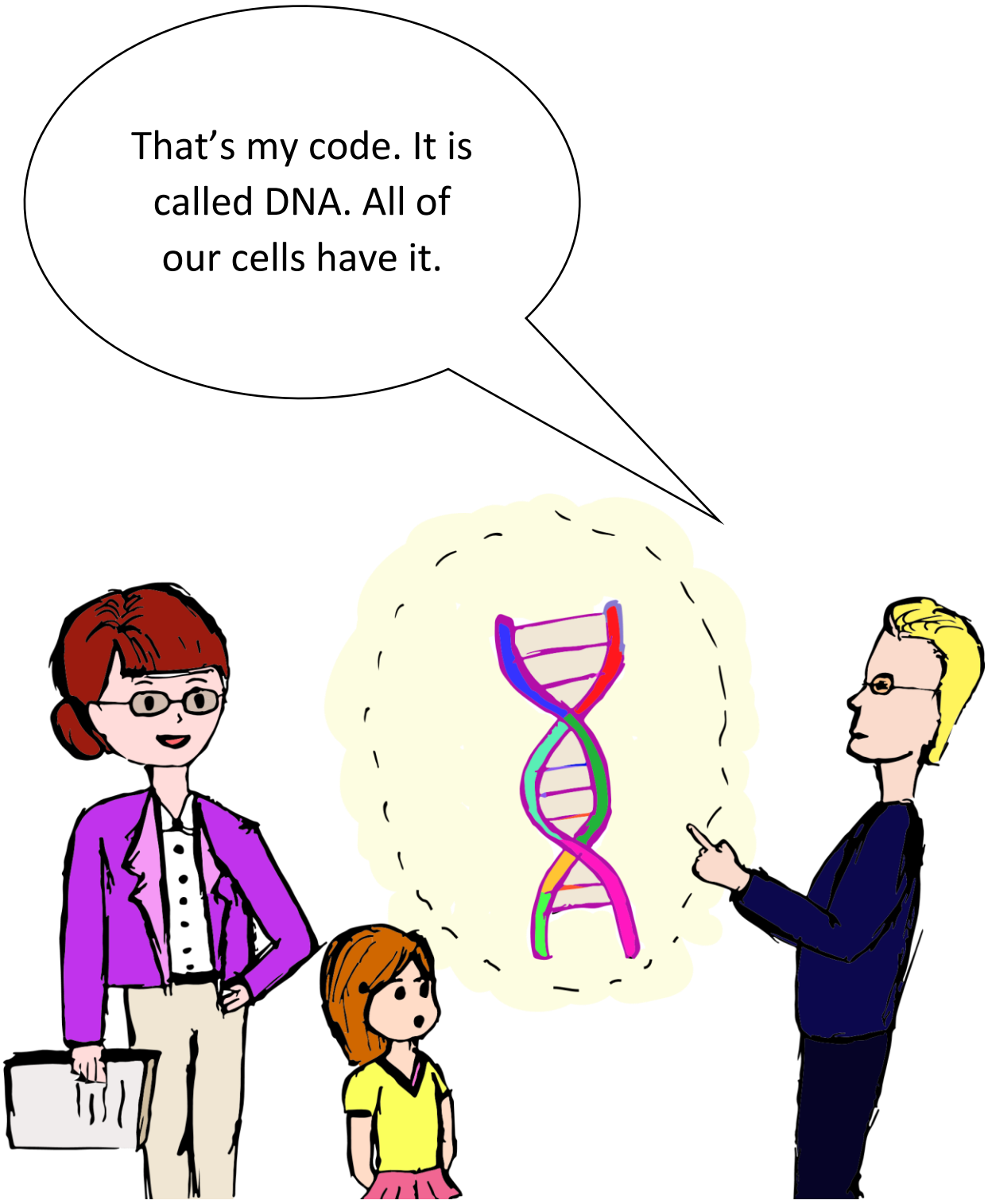
Two people suddenly emerged in her room.

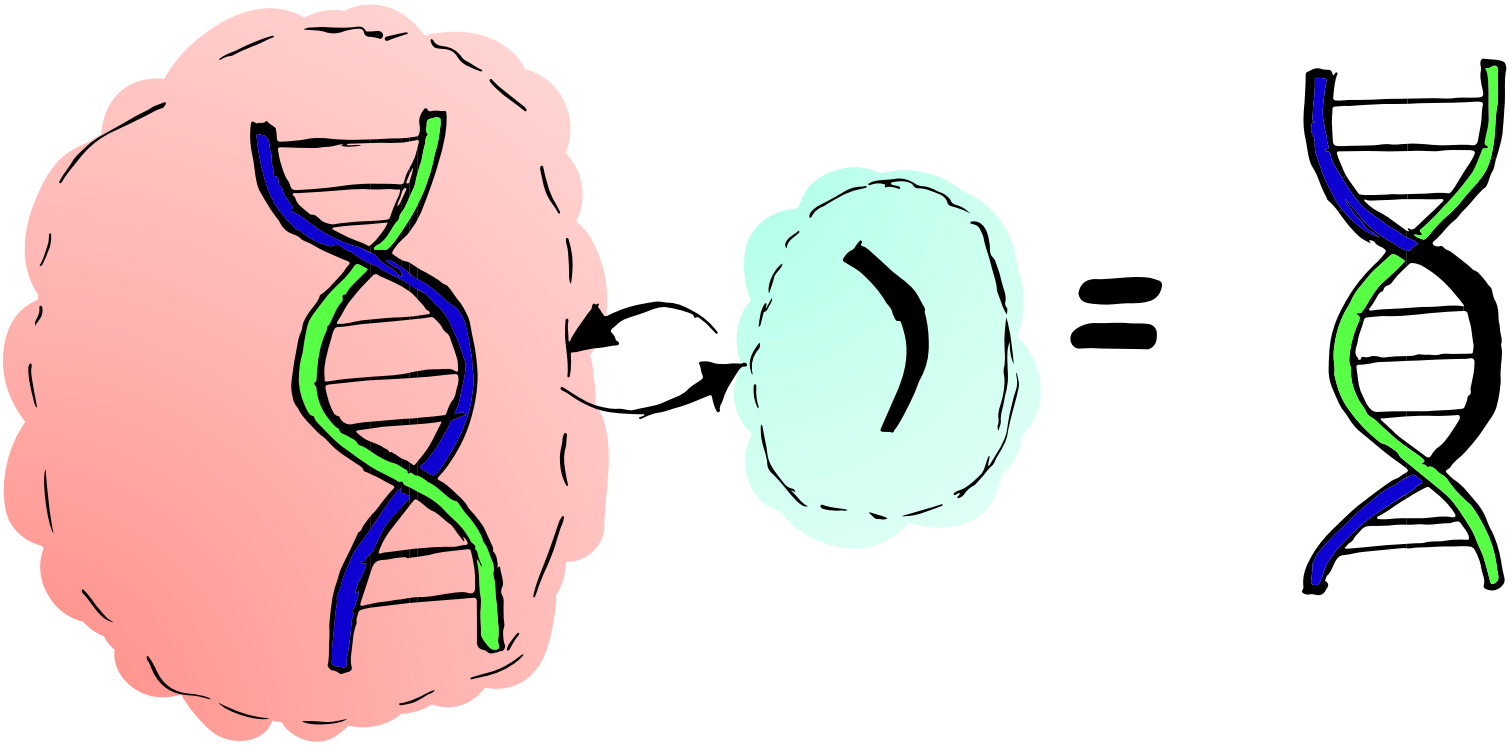



Hello, little scientist! I am Bilge. My field is computer science. I am a computer programmer.
I am Ali. My field is synthetic biology. I am a biology programmer.


Huh? Biology programmer? Do you have a living computer?

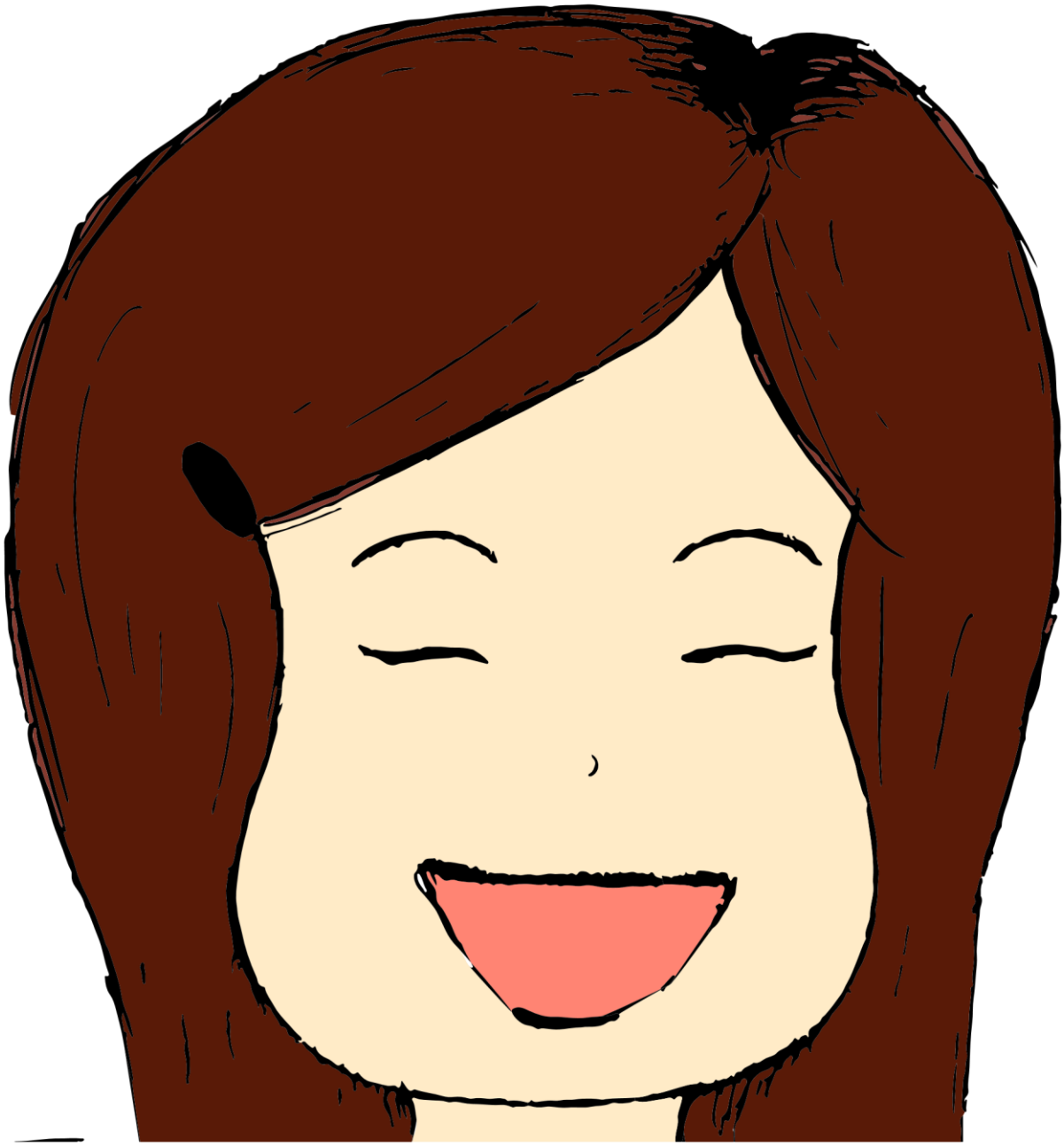

What a smart kid! You are right, living organisms are living computers. I usually program bacteria to do what I want. That is, bacteria are my computer.


That’s my code. It is called DNA. All of our cells have it.

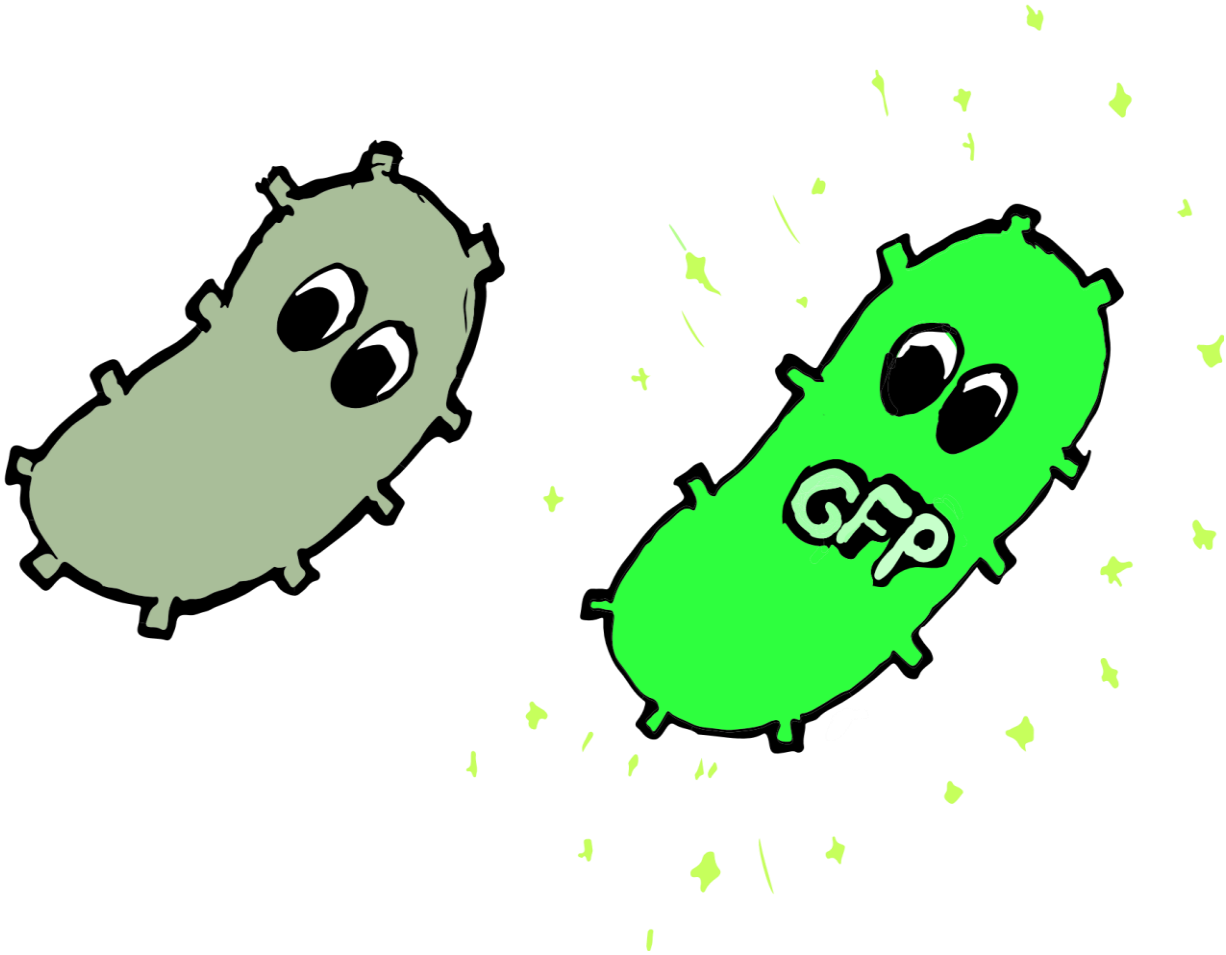


I try to change and control it to get the program I want.

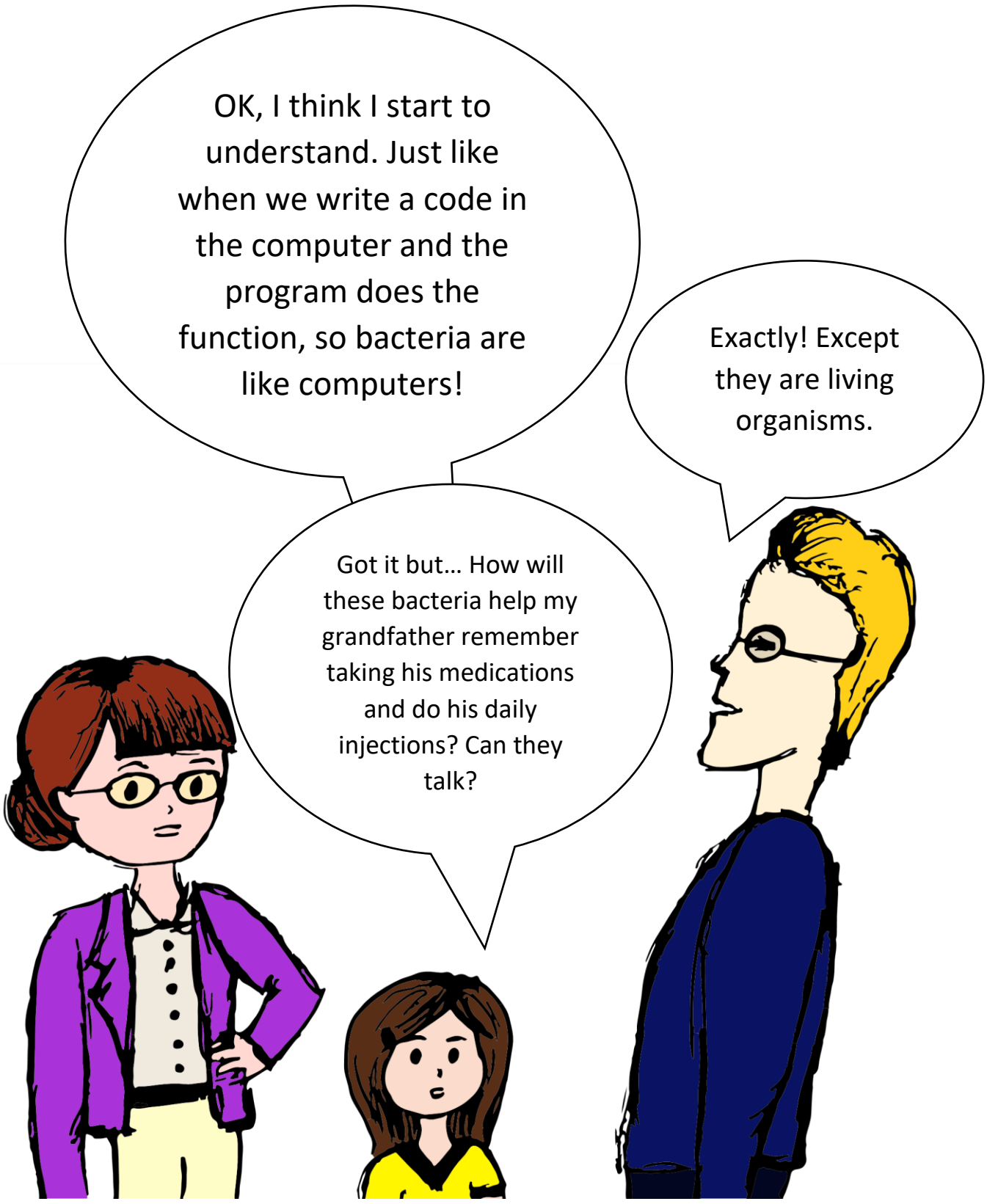
Now, we have another alternative for your grandfather. Your task is to write a code not for a smartphone app, but for bacteria!



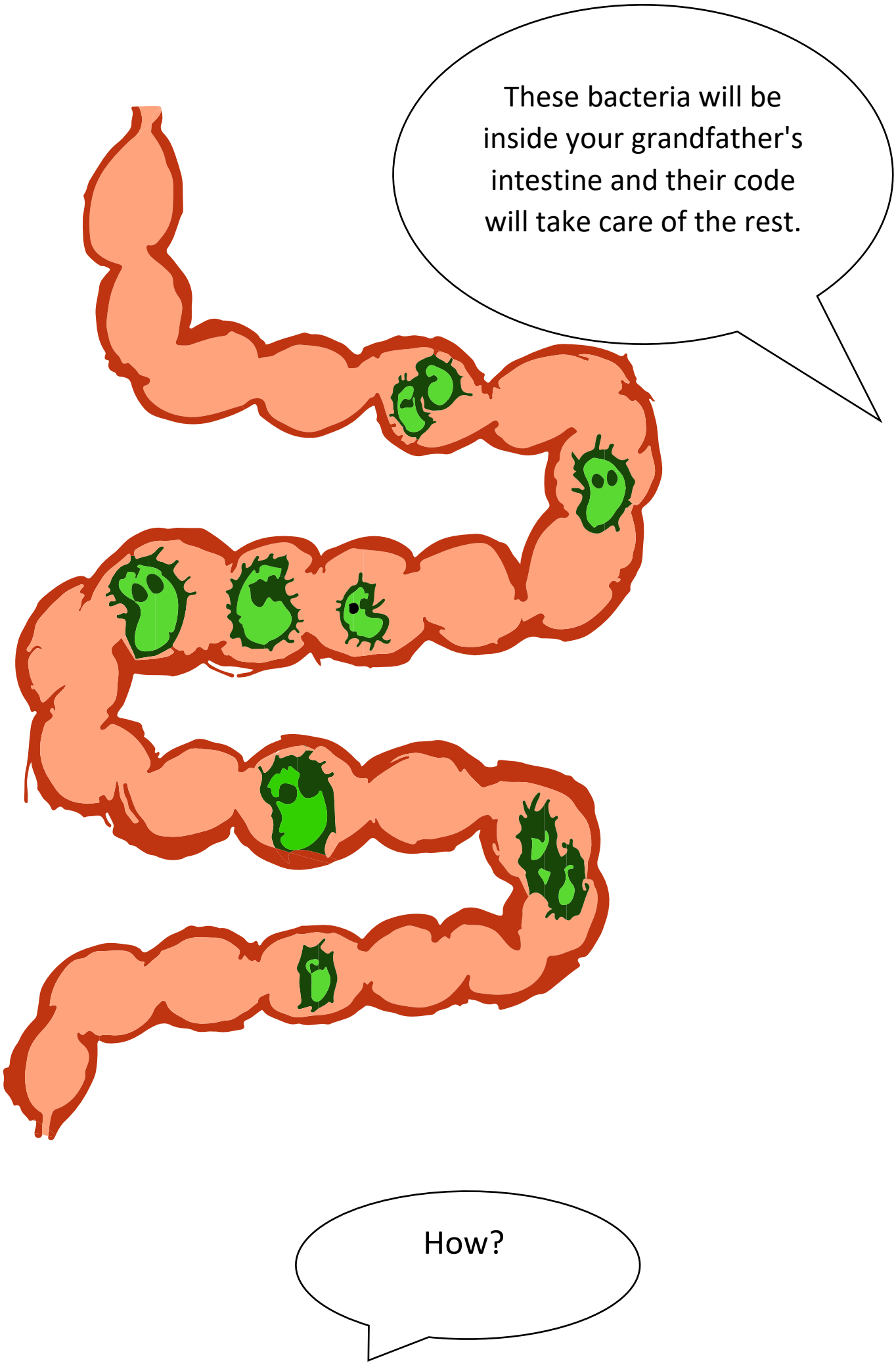
Haha what do you mean?
What will I do with this
bacteria thing?

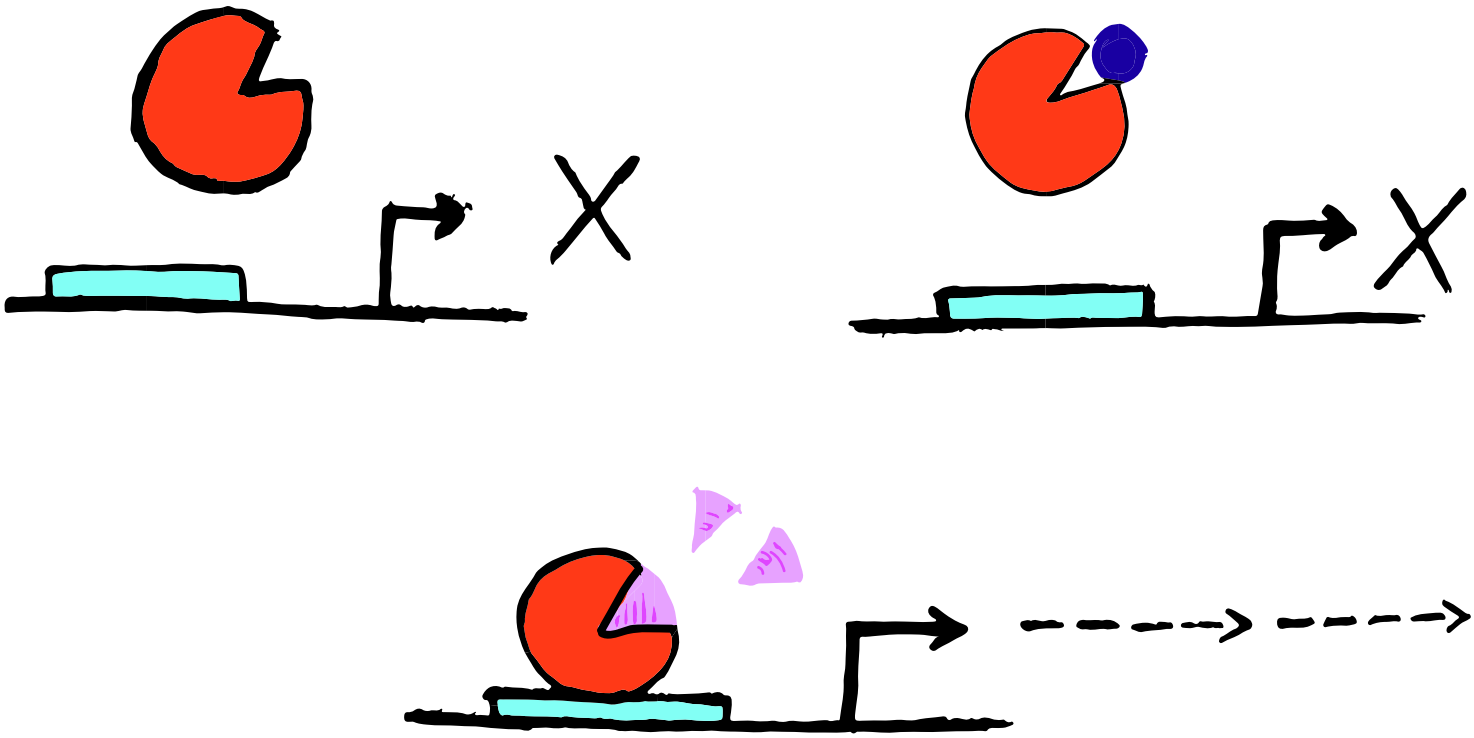


Well, let me explain. I change the DNA code to make the bacteria do what I want them to do. If I write a “shining” code, they can shine bright like a diamond. Or if I write a “reminder” code, they can remind your grandfather to take his medications.

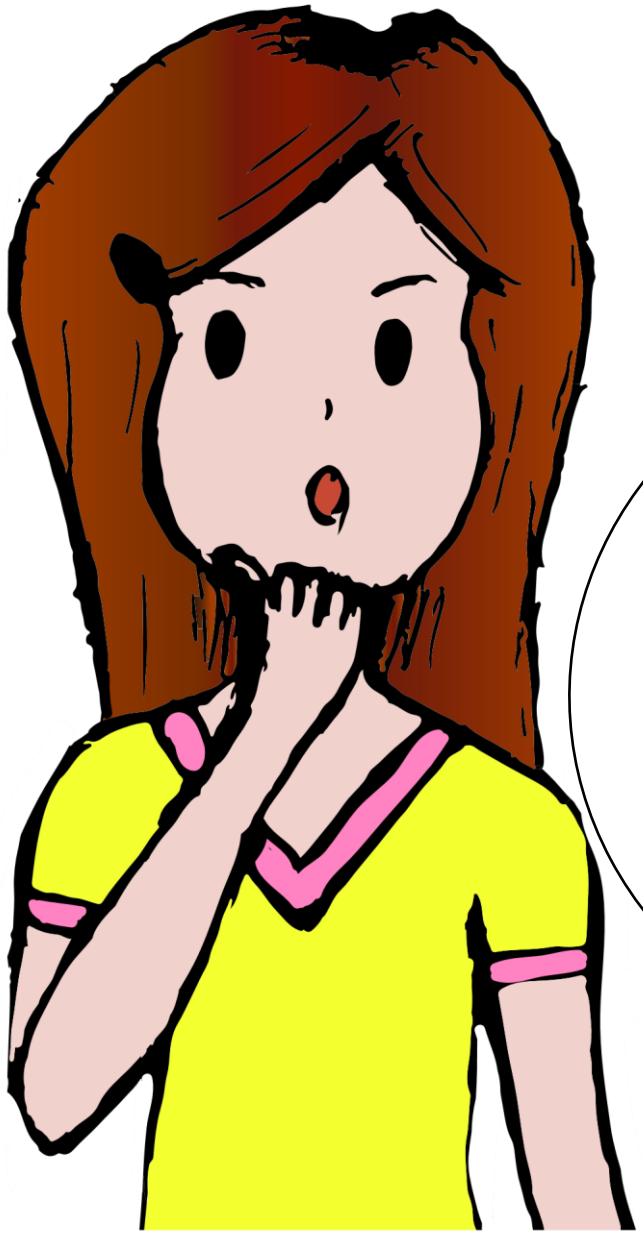

OK, I think I start to understand. Just like when we write a code in the computer and the program does the function, so bacteria are like computers!
Exactly! Except they are living organisms.
Got it but… How will these bacteria help my grandfather remember taking his medications and do his daily injections? Can they talk?

No need to talk!


These bacteria will be inside your grandfather's intestine and their code will take care of the rest.
How?



The code that we write in their DNA will contain an insulin sequence of our choice. And this insulin can be secreted only when we stimulate them with a certain signal. Think of it like a switch that can be opened or closed.

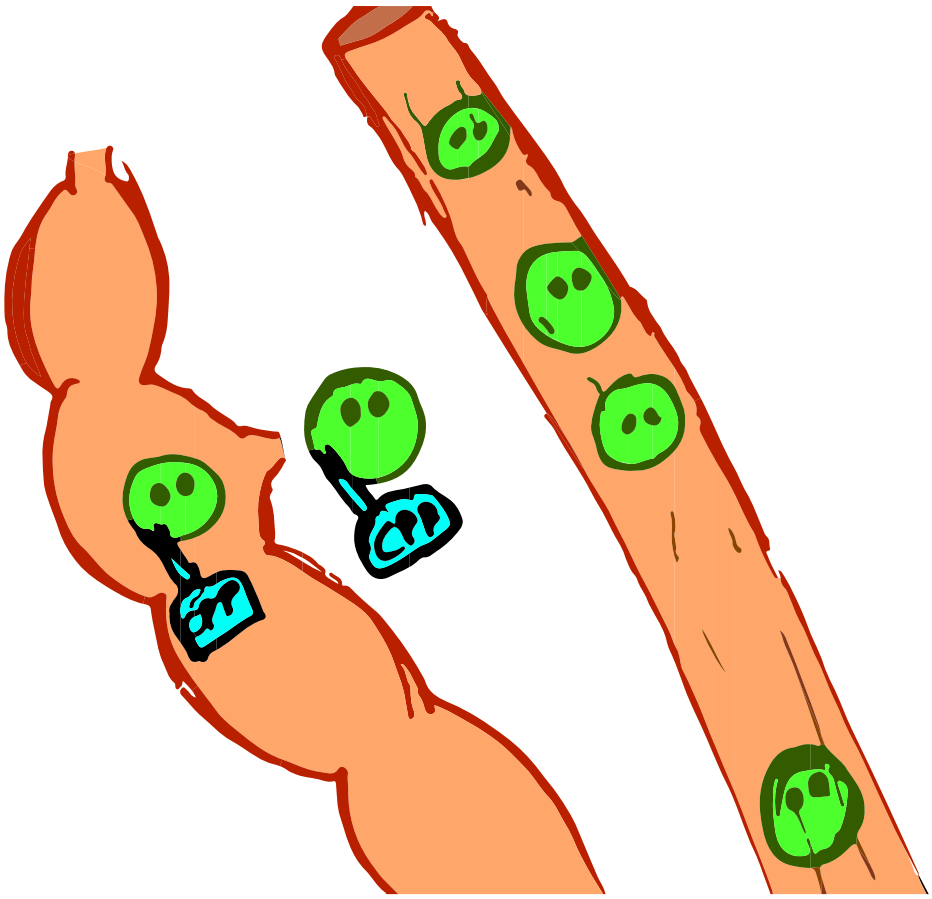


Hmm, interesting…
What is insulin?

Insulin is a hormone that regulates your blood sugar by transferring the glucose from the bloodstream into the cells. However, your grandfather is diabetic, so his insulin is not functioning well. That's why we send our own designed insulin to help him.

What do you mean by “designed”?

Well, in better terms, “engineered”.



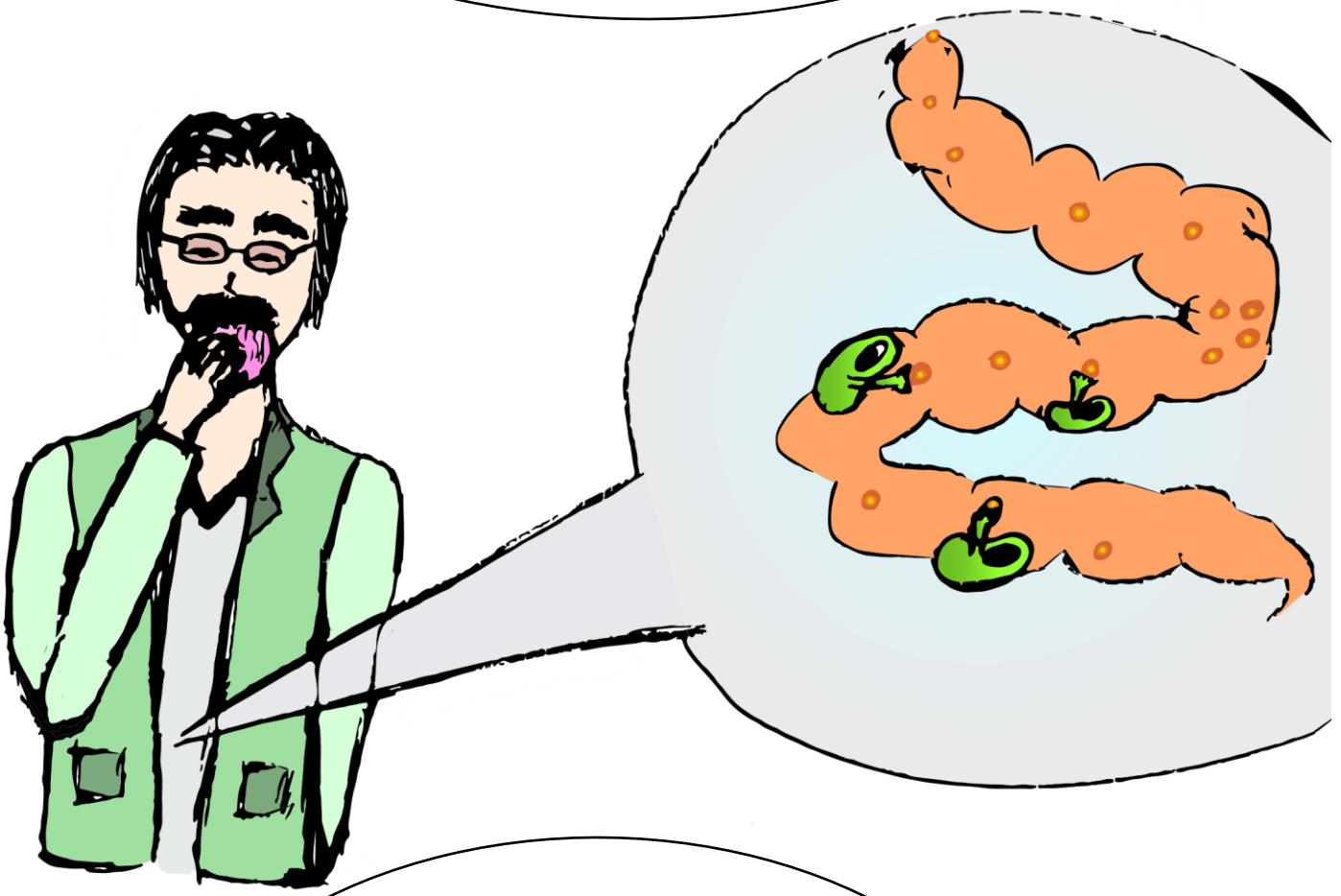
We have to change or “engineer” this insulin a little bit before sending because we have a barrier. This barrier is the intestine. This insulin needs to pass the intestine layer and should go into the bloodstream, where it can do its magic.

That's why we put a “penetrating code”, right after the “insulin code”, so our engineered insulin can go through the cells of the intestine right into the blood.

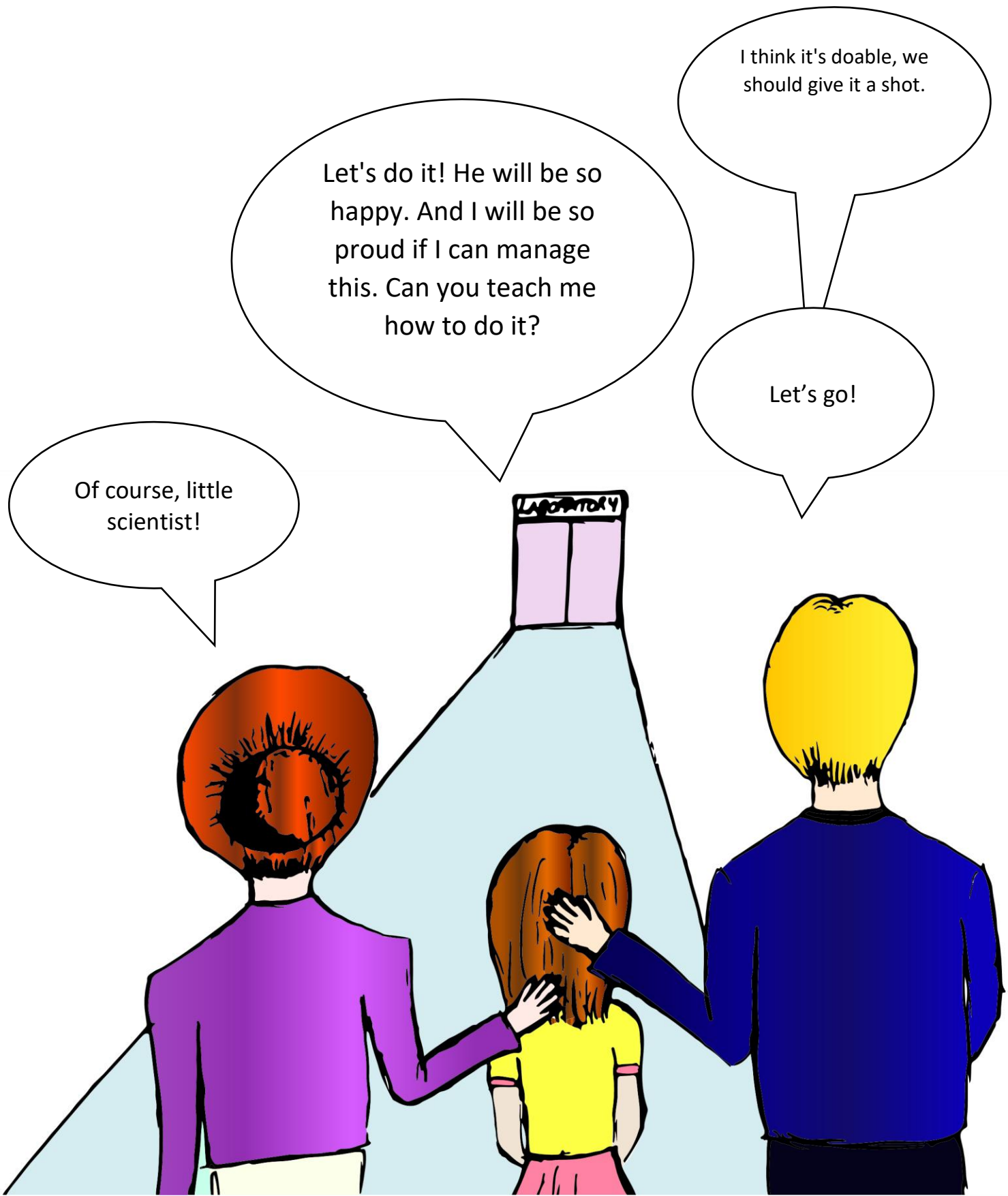
Cool!
In better terms, “cell penetrating peptide” will be attached to the “single-chain insulin analog” that we have selected.

Hmm, still cool! What about his injections and medications, how can these bacteria fix that?
How is it going to be automatic?
That's the best part! He does not have to do injections anymore because instead of injecting insulin into his blood, this insulin will be automatically provided to him when he needs it. So, he does not have to remember.

Hmm, it is still in test but… Basically, these bacteria can sense what's going on in your grandfather's body and detect his blood sugar levels. If it is too high, which is the case with your grandfather after he eats a huge sugary meal, our bacteria can sense it and secrete the insulin which can help your grandfather to lower his blood glucose.



These machines we call “sensors”. They can sense one parameter and can switch on and off their codes accordingly. But it is not as easy as it sounds. There are too many parameters.


I think it's doable, we should give it a shot.
Let's do it! He will be so happy. And I will be so proud if I can manage this. Can you teach me how to do it?
Let’s go!
Of course, little scientist!

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İhsan Doğramacı
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