



NEAL'S ADVENTURES

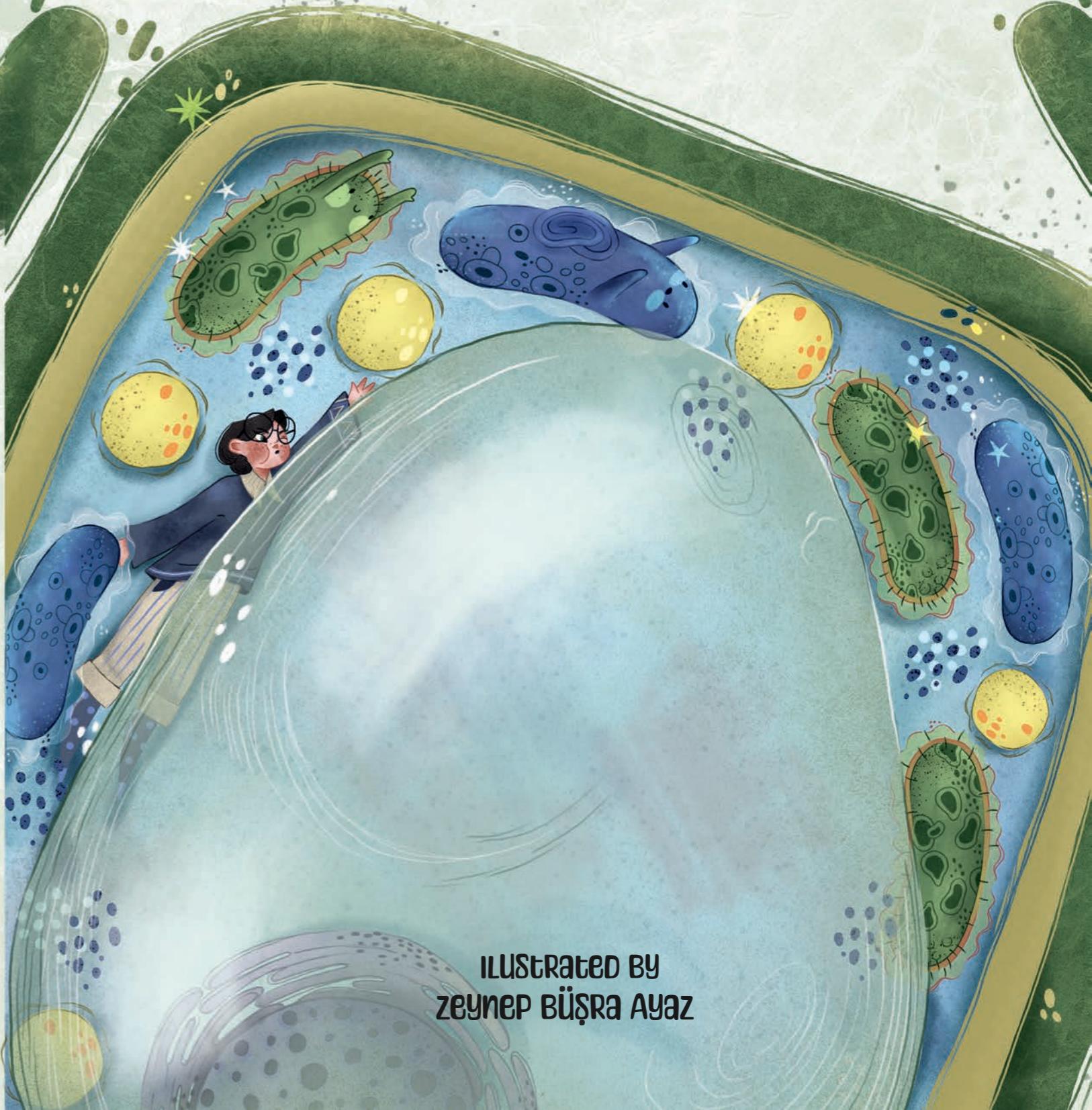
THE MYSTERY INSIDE THE PLANTS

WRITTEN BY

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Neal has a new friend -- a plant! But one day, it looks sick. To learn more about his plant, Neal dives into a big book about plants -- and then into the plant itself.

He journeys through the roots and stem to the leaves, encountering unexpected challenges and some frightening obstacles along the way. But he surprises even himself when his curiosity wins out over fear every time.



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Dear Children,

We live in a world with other organisms that you can see with your eyes; like animals, plants, and fungi and microscopic organisms.

Plants provide us with food, medicine, and clean air. They make our world a more beautiful place to live.

As a sign of our gratitude, this work is dedicated to plants. It offers an adventure in the world of plants. In this adventure, everything might sound new for you. Don't give up reading; be courageous enough to explore this new world. You might read this whole work or the certain parts of it again and again to get familiar with the heroes of this world. In the end, you'll feel part of it.

Seckin & Esra

"Take the **seeds**; these will become your **plants**!" said Ms. Explorer, the science teacher, before ending the class.

Students were excited to take responsibility for the seeds they had gathered on the field trip. Neal was always curious about plants. Now, it was the time to have his own plant. With all these thoughts, he hardly followed the closing words of Ms. Explorer.

However, he heard her say that students would plant the seeds into pots with their parents. He remembered the nested old pots his mother had stashed on the balcony. Did she have unused soil, too? What if he couldn't sow the seeds properly? What if he couldn't make them grow?

As soon as Neal arrived home after school, he did exactly what his teacher had asked. Neal looked for a pot and some soil. Luckily, the nested pots were still on the balcony. He placed a serving table next to the window. This was the lightest place in the house.

Oh! There was one vital thing lacking!
Bringing some water, Neal's mom said:
"This will be the lifeblood for your plant."
Now, everything was ready to plant his seeds.



After that day, Neal frequently checked the moisture of the soil and replenished the water if he felt the soil was dry.

One morning, as soon as he woke up, he visited his pot as usual and saw something green coming from the soil.

"Hey, Mom, look!" he shouted. "What happened to my seed? One of my seeds has grown! Now it is green!"

His mother came over and hugged Neal, "Look, your seed has **germinated!** Well done, my boy!"

After that day, Neal checked the plant, replenished the water, and observed his plant growing quickly. It was a healthy dark green color. Everything went well for the plant until now... till that day...

One morning, his plant seemed different. Its leaves had turned yellowish. Neal called his mom.

"What has happened to my plant? Look at its leaves. They look yellow and weakened. Is it sick?"

Mom said with a soothing voice, "It is okay, sweetheart. We, people, also sometimes get sick and get well again if treated properly. I am sure you'll figure it out and do your best to solve its problem."

Neal had a lot of questions. His mother decided to bring a book so that he could learn more about plants for himself.

Neal started reading the book, hoping to understand plants better and find the solution to his plant's problem.



Neal read the book for the whole day, as if he was left thirsty and he had finally found a fountain of water. He found a clue about why his plant had turned yellow: "Plants produce their own food, but to do this, they must take minerals from the soil. If the soil doesn't have enough minerals, the leaves of the plants may turn yellow. Plants with yellow leaves may be rescued by adding the missing **minerals** in the form of fertilizer."

Aha! That could be the answer! He decided to add fertilizer to the soil. He planned to do this the next day.

Neal added to his "to-do list,"

"Buy some fertilizers for your plant."

To buy some fertilizer, Neal went shopping with his father the next day. He explained his plant's problem to the shopkeeper and learned how to apply the **fertilizer**.

As soon as he returned home, he added the fertilizer to the plant's soil. He hoped he had solved the problem. "I love my plant," he said. "I need to know how to take care of it."

Neal decided to go on reading the book. He learned not only about caring about plants but also many other things about plants: the organs of the plant, plant **cells**, and even **organelles**. The book said that the functioning of the whole plant often only make sense when we know what is going on in individual plant cells. "I wish I could see the cells. But they are too tiny," Neal murmured hopelessly. He fell asleep with the book in his hands, no clue what is waiting for him when he wakes up.





When Neal woke up, he felt cold. His pillow and blanket were gone.

He opened his eyes wide. "Where am I?"



Everything was huge. He was lying on a huge stone and looking at a plant similar to a skyscraper's size.
"It's not the world around me that got bigger," he gasped.
"It's me who is small!"

Hold on! This was the place on the cover page of the plant book he had been reading. How was it possible? Neal thought he was in a dream, but everything looked very real. Could he use this dream to explore his plant? He liked this idea very much.

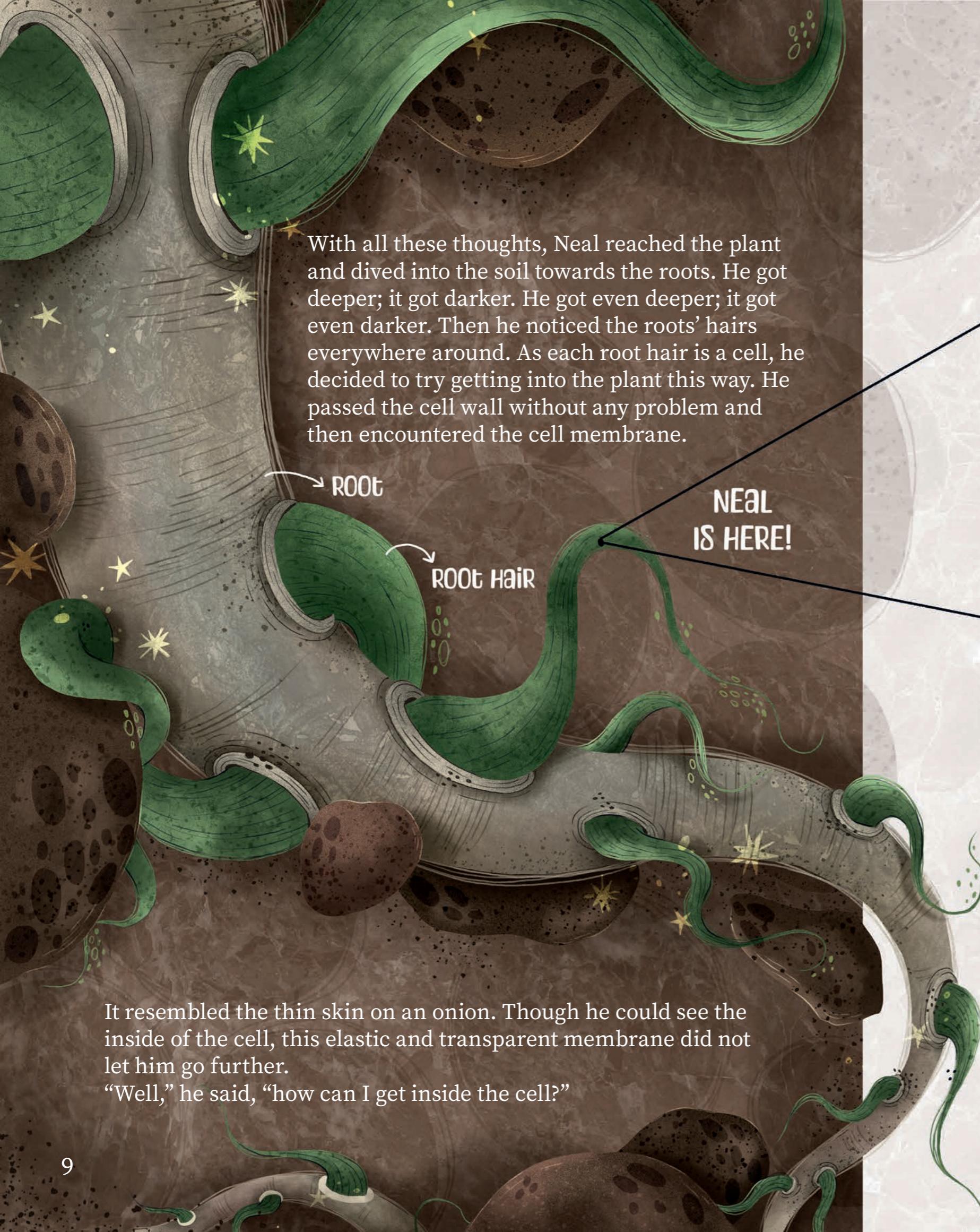
"A plant gets nutrients and water from its roots," he said
"Maybe I can follow the **roots** to sneak into the plant. Then I might see what is inside a plant with my own eyes!"
Neal jumped off the rock to the wet soil and swam to the plant. His adventure began!

As Neal was going towards the plant, he was trying to recall all the parts of a plant. This information would soon become handy to navigate inside the plant.

"Under the microscope, a plant seems not like a plant anymore but like tiny balloons stashed next to each other," he had read in the book. "These balloon-like structures are called cells. Each plant cell is covered with a thin sheet called the **cell membrane** and a thicker layer called the **cell wall**."

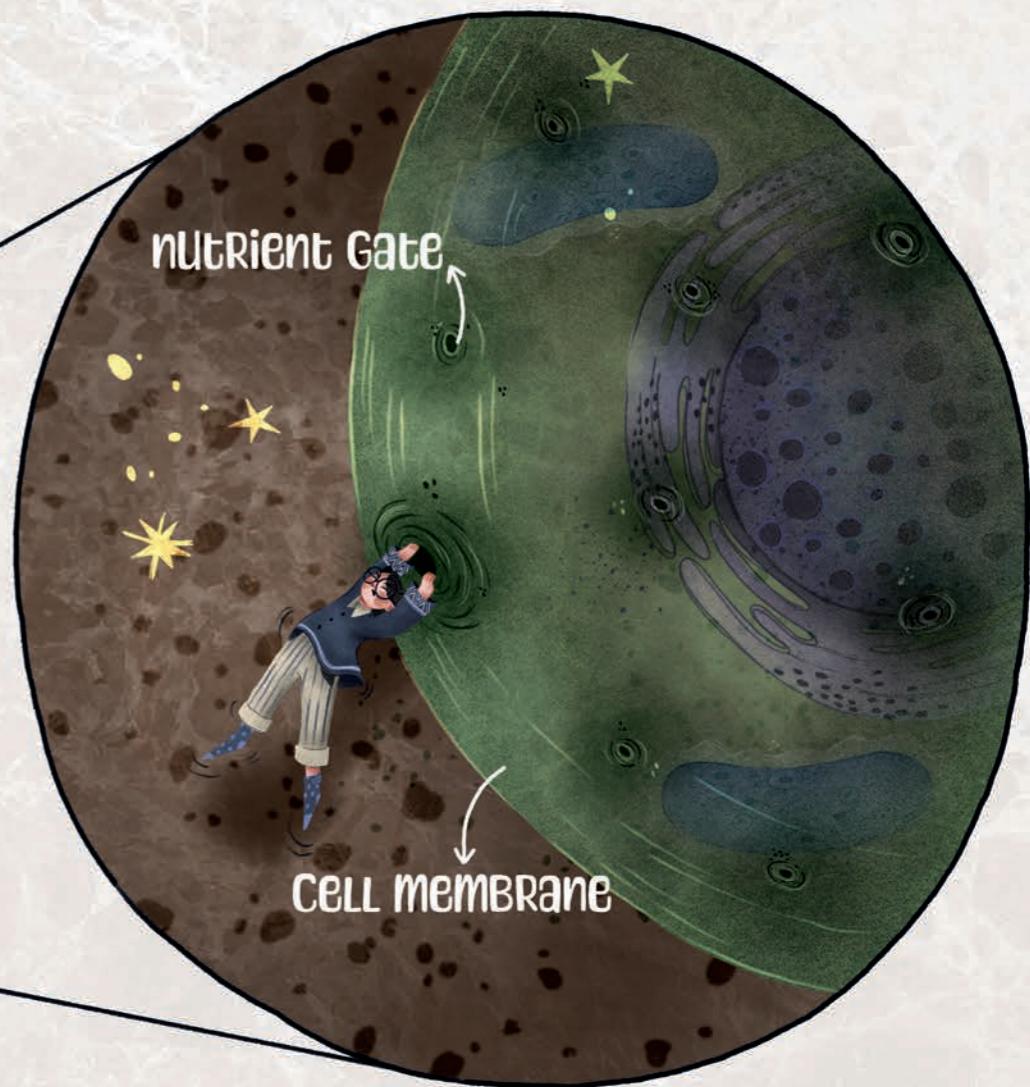
He remembered that nutrients and water could freely pass through the cell wall but could not move across the membrane. Instead, they had to find special gates in the membrane and pass through them.

What about Neal? Would he be able to pass through cell walls and find one of these membrane gates for himself?



It resembled the thin skin on an onion. Though he could see the inside of the cell, this elastic and transparent membrane did not let him go further.

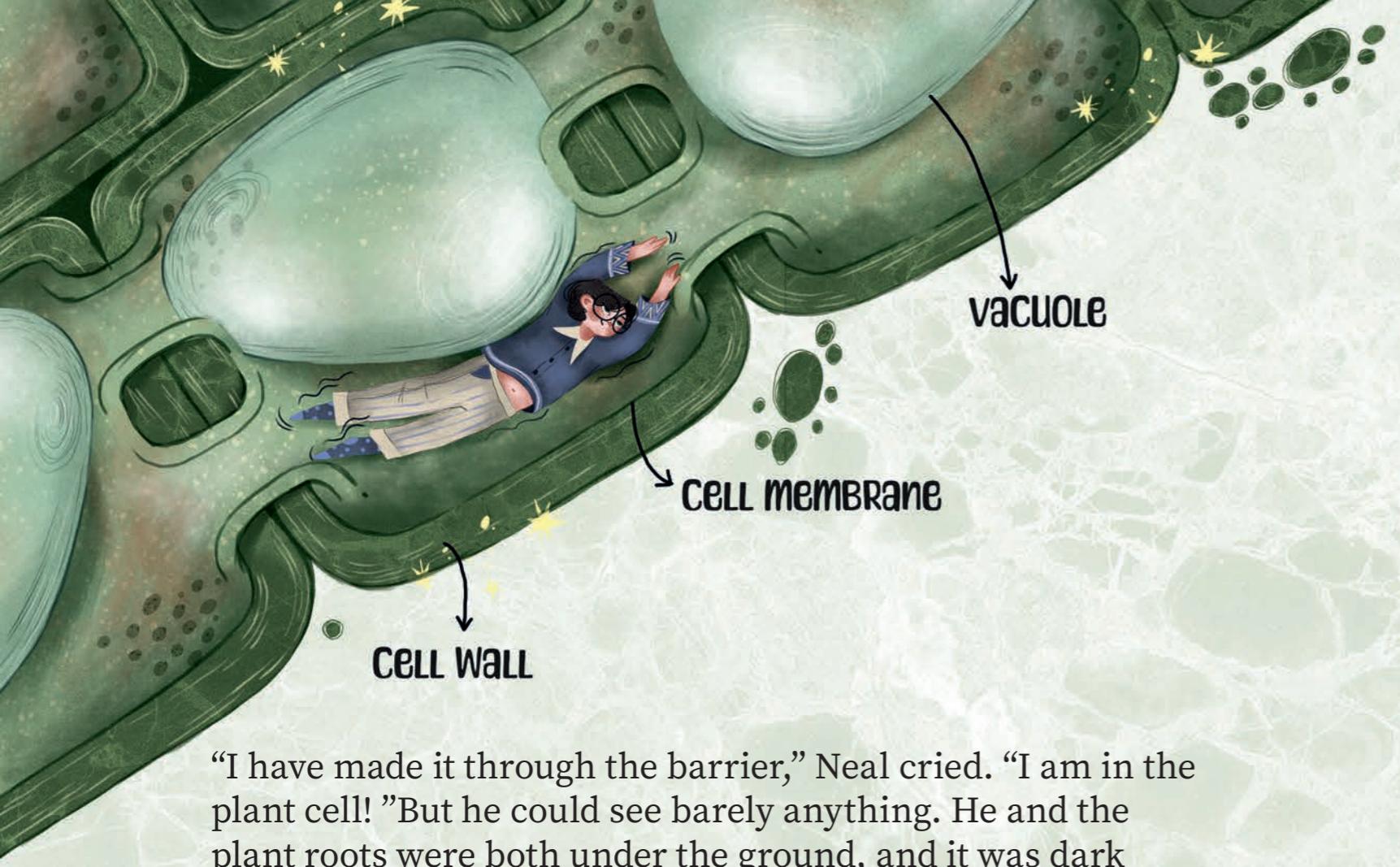
"Well," he said, "how can I get inside the cell?"



Neal remembered again from the book, "Whatever enters the cell has to pass through the cell membrane first." He couldn't be an exception.

He started swimming around the cell membrane, looking for an opening that enables the uptake of nutrients from the soil. There were many gates for nutrients to enter, but all were much smaller than he was. He chose one of the gates and tried to force himself through it.

"Iiihhh!" Neal held the gate and tried to tear it apart. A "crack-crack" sound echoed, and the opening started to enlarge.



"I have made it through the barrier," Neal cried. "I am in the plant cell!" But he could see barely anything. He and the plant roots were both under the ground, and it was dark down there. Had he made a mistake in crossing the cell membrane? What if he was wasting his time? And what if he couldn't get out?

But his curiosity overcame his fear, and he wondered again what was inside a plant. Maybe he could find a way to get to the upper part of the plant, where he would have more light to explore.

Neal thought about the journey of water and nutrients that he had learned about during his day of reading. After entering the root, these substances go all the way through the cells to the center of the plant to enter the **xylem** stream, which goes upwards to the plant's leaves. Maybe this stream could act like an elevator and take him to the aboveground part of the plant! But first he had to head towards the center of the root to find the xylem.

Neal started to swim. He discovered that once inside one plant cell, you could easily pass to other cells. They were all connected. No need to look for the membrane gates anymore. He felt so lucky!

While swimming, in most cells he passed, his body brushed up against something slimy. It was dark, so he couldn't see what it was, and that felt creepy. He speeded up, "I should find the xylem as soon as possible and leave the underground."

Soon Neal heard the sound of moving water. He followed the sound. Finally he found himself near the xylem. But he needed to pass through two membranes to get inside. One membrane to leave the current cell and another to enter the xylem cell.

"I dislike passing through the membranes." Desperately, he pushed through the nutrient gate to fit in and passed to the other side. "I came here to learn about plants," he complained, "but so far all I have achieved is to build my muscles." Inside the xylem, he found himself on the edge of an abyss. "This is too much for a simple dream," Neal thought. "Can it be real?"

He looked down and noticed a shimmering light at the bottom of the abyss. Was that water rising toward him? Suddenly he lost his balance and fell into the abyss.



SPLASH!

"Oh, that was the most fantastic jump ever, so much fun!" he cried. "This is like an aquapark. I wish my friends were here too." As he ascended, just as he had hoped, his surroundings got brighter and brighter. Looking up, he saw an even brighter light.

"This should be sunlight!" he cried. "This tunnel I'm in, might open directly to the outside." But just as the words left his mouth, the water pushed him down into the plant cell again. Inside the cell, he stood up. His eyes were dazzled by the light. He looked around.

"I did it! I am in the stem," he said. "It is not dark anymore, so I can clearly see now what a plant cell looks like!" Neal saw that he was in a rectangular cell. He could see the **plasma membrane** that was covering it. The insides of the cell were pushing this membrane to the cell wall. The cell wall seemed thin in this cell, not very much different than the thickness of the membrane.

"I guess cells can be different depending on their location in the plant," he thought. He also noticed it was more difficult to swim in these cells. Previously, it had felt like swimming in sea water, but now it felt like swimming in a more honeyish liquid. "Honeyish?" This idea brought a smile to his face. "Maybe it also tastes like honey?" Neal swallowed a little bit of the liquid. "It really is sweet!"

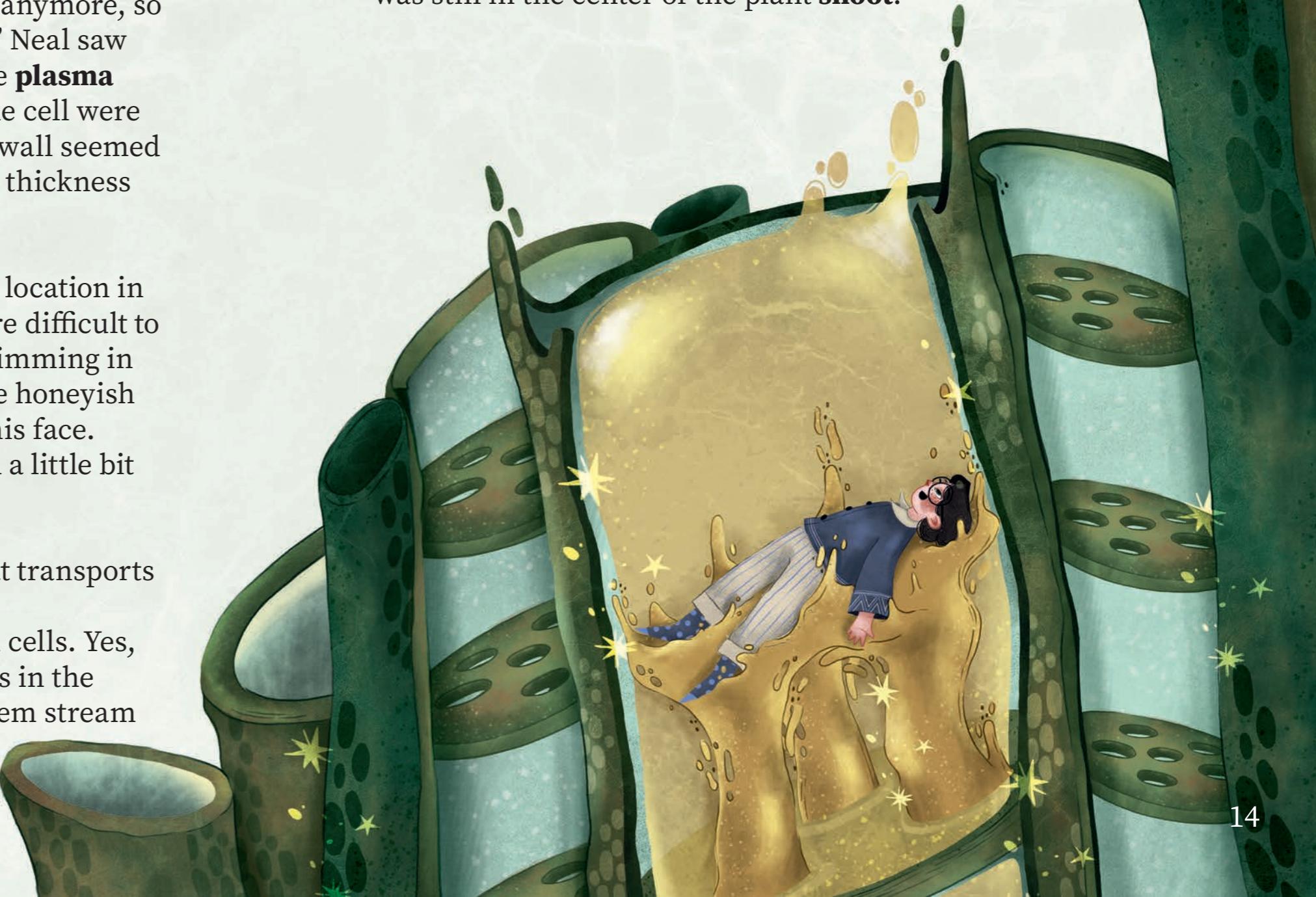
Could it be the phloem, the highway of plants that transports sugar?

Neal enjoyed looking around. He passed between cells. Yes, these must be special cells. Most probably, he was in the phloem. He recalled what he read about the phloem stream in the book his mother had given him.

Phloem carries the food, mainly sugar, made during the **photosynthesis** in the leaves to every part of the plant.

Right now, the liquid he was swimming in was more or less stable. Soon, though, he heard a sound and prepared himself for movement. It felt great to know the basic structures of plants and to be able to anticipate what would come next. Suddenly he heard a loud "Wooo!" and was hit strongly from the back. He spread his arms while the flow was pushing him very fast. The flow disappeared, and the "wooo" sound weakened as the wave of sugar water moved farther away.

It was time to see more typical cells, but where to go? He was still in the center of the plant **shoot**.





Sugar transported through phloem is produced in the cells of the leaves. If he follows the phloem he should be able to reach the leaf cells. To do this he needs to swim against the current. As he swam through the phloem against the current, he noticed that the phloem was getting sweeter.

"To the source!" he shouted, imagining himself as a shark following the blood of his prey in the sea.

The phloem stream ended up at cell membrane. Now an expert at finding the nutrient gateways, he pushed through hard to leave the cell he was in. He passed some cell walls, and entered the next cell through the plasma membrane. He lost his balance and fell down. As his bottom hit the ground, he heard laughter. He was not alone here.

Neal saw two structures walking away. They were moving quickly.
He stood up and moved toward them. "Hey, wait! Who are you?"

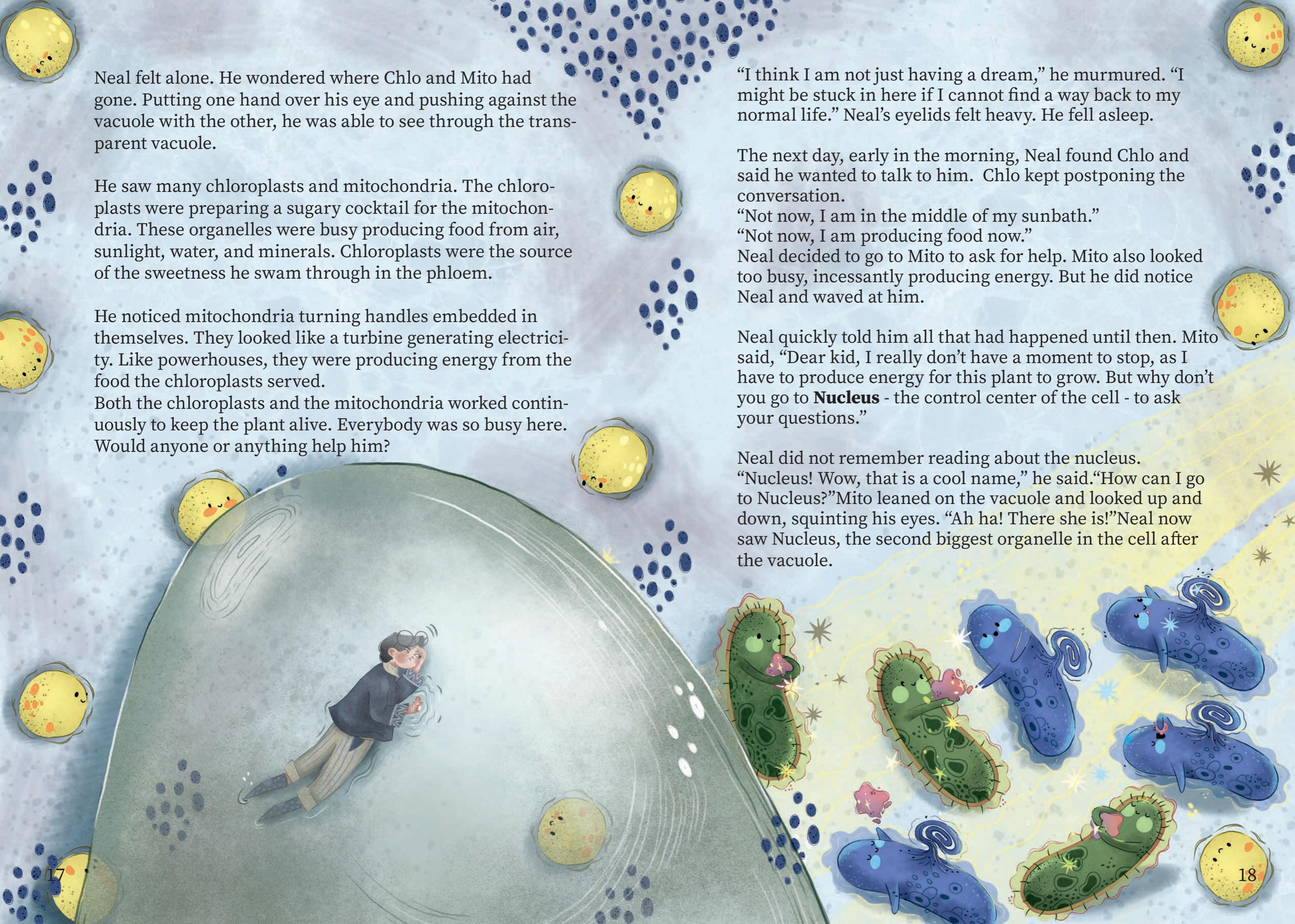
He and the structures were in a leaf cell. This cell was almost completely filled with a big **vacuole**. He realized this was the slimy thing he had encountered while swimming through the root cells. The vacuole was taking up so much space and pushing against them so much that Neal and the laughing structures had to walk as if they were crawling on glass.

"Hello, kiddo," said one. "I am Chloroplast; this is Mitochondrion. Call us Chlo and Mito."

"I am Neal. I..."

He tried to explain how he had woken up small, came here to explore the plant, and did not know how to return to his everyday life. They said they were unfortunately very busy now. Chloroplast told him to come back later, and the two walked faster, as if someone was chasing them.

"Wait, when will you be free?" Neal asked. "It is important!" No answer came.



Neal felt alone. He wondered where Chlo and Mito had gone. Putting one hand over his eye and pushing against the vacuole with the other, he was able to see through the transparent vacuole.

He saw many chloroplasts and mitochondria. The chloroplasts were preparing a sugary cocktail for the mitochondria. These organelles were busy producing food from air, sunlight, water, and minerals. Chloroplasts were the source of the sweetness he swam through in the phloem.

He noticed mitochondria turning handles embedded in themselves. They looked like a turbine generating electricity. Like powerhouses, they were producing energy from the food the chloroplasts served.

Both the chloroplasts and the mitochondria worked continuously to keep the plant alive. Everybody was so busy here. Would anyone or anything help him?

"I think I am not just having a dream," he murmured. "I might be stuck in here if I cannot find a way back to my normal life." Neal's eyelids felt heavy. He fell asleep.

The next day, early in the morning, Neal found Chlo and said he wanted to talk to him. Chlo kept postponing the conversation.

"Not now, I am in the middle of my sunbath."

"Not now, I am producing food now."

Neal decided to go to Mito to ask for help. Mito also looked too busy, incessantly producing energy. But he did notice Neal and waved at him.

Neal quickly told him all that had happened until then. Mito said, "Dear kid, I really don't have a moment to stop, as I have to produce energy for this plant to grow. But why don't you go to **Nucleus** - the control center of the cell - to ask your questions."

Neal did not remember reading about the nucleus.

"Nucleus! Wow, that is a cool name," he said. "How can I go to Nucleus?" Mito leaned on the vacuole and looked up and down, squinting his eyes. "Ah ha! There she is!" Neal now saw Nucleus, the second biggest organelle in the cell after the vacuole.

Neal swam around the vacuole to arrive at the nucleus. This place was much calmer than where the organelles were. Nucleus looked calm and wise, as if she had all the keys to every problem that ever existed.

"Who are you, little boy?"

Neal introduced himself and told her what happened to him. "I see, boy, I see," she said, thinking for a while. Then she said, "Take the dandelion, boy. Take the dandelion."

"Dandelion?" asked Neal in amazement.

"This region has many dandelions, and their seeds are carried by the wind like hot air balloons. When the wind comes, climb up the plant, exit through a **stomata**, jump to a piece of dandelion fluff, and use it to search for your home. However," she raised her finger as a warning sign, "using dandelions is very risky because they can time travel if not ridden properly."

Nucleus wished him good luck. Neal returned to Mito and Chlo and spent a few more days here and there in the plant, waiting for some wind to come.

A few days later, Neal woke to an unusual tremble.

"An earthquake!" he cried.

A moment later, "Ah, this must be the wind, and the plant is shaking!"

He quickly swam through phloem cells, swallowing some of the sweet stream.

"Chloroplasts sure know how to make cocktails," he thought. This reminded him of Chlo, and he felt down for a moment.

He heard the sound of water and knew the xylem was next to him. He passed into the xylem. It felt like an elevator. The xylem flow carried him upward to the light.

The plant was shaking like crazy, but after all his other adventures, Neal did not feel scared of this shaking. Indeed, he felt very happy as he was getting closer to the bright light that appeared and disappeared like a ship in a stormy ocean.





He could see the stomata and the open **guard** cells. The water bringing him up was now in contact with air spaces and water molecules floating off into the air. Neal climbed up the cells and passed through the stomata. Finally, he was outside, and he was amazed by the scene he saw.

Hundreds of dandelion fluffs were coming, and he saw them behind continuously rising water vapor, making it a magical scene.

“Now is the time!” he shouted, catching one of the dandelions passing next to him. But he couldn’t lift his feet; guard cells were closed enough to hold his foot. He looked down and smiled with joy, the guard cell released his foot.

“See you, Neal; thanks for your visit! Do not forget us!” cried Chlo and Mito, waving their hands from inside the guard cell. He waved back to them but could not say “Good-bye” because of the lump in his throat.

Dandelion took off from the plant, the plant that had served him as a home, school, and playground. Now, it was shrinking and disappearing entirely before his eyes.

He turned from the plant to look ahead. His eyes shone with pride.

“It will not be easy to return to my normal life after this adventure,” he thought, but he was surprised that this thought did not scare him much. Still, he missed his home and family.

He took a moment to enjoy watching the sunset. All the dandelion seeds became red as they reflected the sun.



The wind picked up. As it became more powerful, it scattered the dandelion seeds. Neal found that it was becoming very difficult to ride the dandelion seed. He tried to keep it going straight, but the dandelion seed started to turn very, very fast. Was this what Nucleus had warned him about? Neal started to feel dizzy and to see flashes before his eyes and then he fainted.



NEAL
IS HERE!

Glossary

Cell: A cell is the basic building block of all living things. It's like a tiny, microscopic unit that makes up every plant, animal, and even you.

Cell Membrane: A cell membrane is like the outer skin of a cell. Imagine it as the cell's protective barrier or the cell's "border control." Just like our skin protects us from things outside our bodies, the cell membrane protects the inside of the cell. It's very picky about what it lets in and out. It allows in important stuff like food and oxygen that the cell needs to stay alive, and it also allows waste products out.

Cell Wall: Imagine a cell wall like a tough, outer shell that surrounds the cell, kind of like a suit of armor for a knight. It protects the cell from outside forces and gives it strength. It's different from the cell membrane, which is more like a flexible skin.

Chloroplasts: They capture sunlight to make food for the plant. This process is called photosynthesis. Think of chloroplasts as the chefs of the plant cell, using sunlight as their secret ingredient to cook up some tasty food for the plant.

Fertilizer: Fertilizer contains things like nitrogen, phosphorus, and many others. These nutrients help the plants grow bigger, produce more flowers or fruits, and stay healthy.

Germination: This is when the seed starts to sprout and grow into a tiny plant. It's a bit like a plant's birthday or the moment it wakes up from a long nap in the ground.

Guard cells/stomata: Plants have small openings on their leaves, called stomata, which are like little doors for the plant to breathe through. These openings allow the plant to lose water and exchange gases. Guard cells are the special cells that control these stomata. They act like guards that open and close the doors (stomata) to help the plant. When it's sunny and the plant needs to take in carbon dioxide, the guard cells open the stomata. But when it's too dry and the plant needs to conserve water, the guard cells close the stomata to prevent water loss.

Mineral: We use the word mineral as simple elemental nutrients (See nutrient) that plants take up from the soil. They include nitrogen, phosphorus, potassium, calcium, iron and others. Each of these nutrients plays a specific role in helping the plant stay strong and healthy. For example, iron helps plants synthesize chlorophyll.

Mitochondria: They take in food and oxygen, then use a special process to turn it into energy that the cell can use to do all its jobs.

Nucleus: It contains important instructions in the form of genetic material, like DNA, which tells the cell what to produce and how to grow. So, the nucleus is like the brain of the cell, helping it carry out all its tasks and stay organized.

Nutrient: We use nutrients in the text to refer necessary material for healthy plant growth but not necessarily minerals. Sugars for example are non-mineral nutrients.

Organelle: Just as the bodies contain organs that have various roles; such as nose for smelling and hand for grasping, cells also have parts that do various tasks; such as mitochondria for producing energy and chloroplast for producing food. We call these organelles.

Phloem: Plant veins have phloem and xylem. Phloem consists of live cells specialized for nutrients to flow, for example unlike other plant cells they do not possess a large vacuole not to interrupt the flow. Phloem carries sugar produced in the leaves to wherever it is needed. Phloem can flow in any direction, unlike xylem.

Photosynthesis: Plants use sunlight, carbon dioxide (a gas in the air), water and minerals (absorbed through the roots) to produce sugar. Photosynthesis takes place in the chloroplast, the sugar produced then can turn into energy by mitochondria.

Plant: Most plants live both in under and above ground at the same time and do photosynthesis. Their cells usually possess cell walls and a large vacuole.
Plasma membrane: Same as cell membrane

Root: The root is the part that grows underground. Roots have special parts called root hairs that gather water and nutrients from the soil.

Root hairs: When you look at the roots of a plant, you might notice these tiny hair-like structures that stick out from the main roots.. Root hairs help the plant take in water and nutrients from the soil. They have a large surface area that makes it easier for the plant to absorb what it needs.

Seed: A seed is what plants use to make new plants. It's like a baby plant that's all wrapped up in a little protecting package. This package contains the nutrients the plant needs until it establishes its root.

Shoot: The shoot is the part of a plant that grows above ground. It contains leaves and flowers.

Stomata: Look up for "guard cells"

Transpiration: Plants release water from the stomata by evaporation to cool down and to receive nutrients and water from the root continuously.

Vacuole: Vacuole is like a storage closet for a plant cell. Excess nutrients or metabolic byproducts can be sent to the vacuole. Vacuoles can be very large and can press the organelles to the plasma membrane, helping to keep the cell and eventually plant rigid.

Xylem: Xylem carries water from root hair all the way to the leaf. Xylem must lose water from the stomata to replenish the lost water from the root. This continuous loss and gain creates the xylem stream which is always only one direction from root to the shoot. Xylem is made of dead empty cells unlike phloem.