

TEENY TINY: WE ARE MICROBES! WELCOME TO THE WONDERFUL WORLD OF BACTERIA, VIRUSES, AND FUNGI

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All around us are little things that are too tiny to see. They grow, divide, mutate, and evolve, without us even noticing. They may be small, but they affect all life on Earth and every movement we make!

Fuzz is a microbe. He's so tiny that the human eye can't see him! There are countless little things all around us that are too tiny to see. Where do they come from? How did humans discover them? How many different kinds are there? How are they relevant to our lives? Let Fuzz introduce you to the world of microbes!

Although microbes are tiny, they affect all life on earth. This beautifully illustrated book is packed with information. Lively and vivid, it makes reading and learning about microbes fun!

Text by Miki Lee

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Hidden away in an old apartment in Hsinchu county, the Fun Art Studio focuses on children's art education, illustration and graphic design – including the popular science picture book *Grandpa's Book of Magic: Protecting Water and Soil*, and the board game *Magic Wonderland: Secrets of Water and Soil Conservation*.



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Translated by Helen Wang

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This is Fuzz.

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Fuzz is a microbe.

Fuzz is tiny, very tiny, incredibly tiny.

No matter how good your eyesight is, or how hard you try,

You will never see him with just your eyes.

He's on this tiny dot right now,

Can you shake his hand?

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Fuzz's story starts like this:

A long, long time ago, a tiny microbe was born!

That was before dinosaurs, cockroaches, flowers and trees,
when the world was still a vast sea.

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The tiny microbes lived on Earth,

and as each day passed, more and more creatures appeared,

and the microbe family grew bigger and bigger.

After billions of years, humans appeared.

The tiny microbes lived alongside

humans and many other animals and plants.

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Millions more years passed. One day, a businessman called Antonie Philips van Leeuwenhoek started looking at everything around him through a special microscope he had invented himself. He suddenly saw lots of tiny things wriggling about.

That was when humans discovered microbes!

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They were Fuzz's ancestors, the predecessors of his great-great-great-great-great grandparents.

Now, could you do me a favor?

Fuzz speaks very softly, could you please make your ears as big as you can and listen carefully?

Fuzz just landed on the dot. He's waving and saying Hello!

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Hello! I'm Fuzz!

Just now I was playing on your fingertip.

What? You didn't notice?

Oh dear! I'm just too tiny. If you want to see me you'll have to use an amazing instrument called a microscope.

This is Staphy. She's a microbe too.

She usually lives on your fingertip, but she just landed on this book with Fuzz.

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A microscope is a super-powerful magnifying glass.

Through a microscope you can see something hundreds or thousands of times larger than it really is.

That's how you can see microbes.

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Now you can see me, let me introduce my family and friends!

I have loads of brothers and sisters, and lots of relatives.

Look! There are so many different types of microbes in our family!

#We are Protists! (single-cell creatures)

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#We are Algae!

#We are Fungi!

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We are Bacteria!

Fuzz (Escherichia coli) lives in the gut.
He looks like a little sausage with wriggly tails, and covered in fuzz.
He's a superstar in the world of microbes.
E. coli grow fast and are easy to culture,
That's why scientists love to use them in experiments.
Every day, Fuzz's friends work hard in laboratories,
helping humans answer all kinds of questions.

Staphy (Staphylococcus aureus) is round and likes to stick with her friends - they look like bunches of grapes.

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#We're Archaea! #We're Viruses!

Have you noticed? We tiny microbes aren't like you: we have no arms or legs, no eyes or noses. We're not like plants either: we don't have roots or leaves. Some microbes look pretty much the same, but some couldn't be more different!

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We may be tiny, but we're not all the same size. Just like the animal world with its gigantic elephants and mini little mice, the world of microbes has creatures great and small.

#Hey, this one looks like me! #It IS you!

Fuzz and Staphy are in the bacteria family. Bacteria are several times bigger than viruses, but much smaller than fungi, algae and protists!

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What's more amazing is that we tiny microbes are part of a family that's so big we don't even know how many of us are on earth!

#Let me down! #Let me down! #Let me down!

Seesaws are fun!

Go! Go! Come on! Come on!

If you weighed all the microbes on earth at the same time, they would be 1000 times heavier than all the humans put together. That's right! 1000 times! There are more of us than there are...

...leaves on the trees! # ...fish in the sea! # ...stars in the universe!

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#You'll be astonished at how many
of us are there, even in a tiny place!

For example, in a little clump of soil
there might be 1,000,000,000 microbes!

Uh, what's that?! Let's count together:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10...

Er, I'll have to stop now, because even if you went without sleep,
it would take over 30 years to count 1,000,000,000 microbes!

Wow! 30 years! You'll be a grown-up by then!
Maybe have children of your own!

#On your mum's phone
there are about 250,000
microbes!

I want to count too: 1, 6, 3, 8, 5, 10...
Err, what am I counting?

#It's actually like a whole page typed with microbes and for the entire book like this one!

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It sounds incredible, doesn't it! But we tiny
microbes live in lots of other places too.
Look around, can you find us?

We live in forests, deserts, snowfields, volcanoes, streams and the deepest sea.

What about me? Where am I?

This is Plano (*Planococcus halocryophilus*). She likes to live in freezing places, like the snow or
ice at the North Pole!

This is Pyro (*Pyrococcus furiosus*). She prefers super hot places, like deep-sea vents or boiling hot springs!

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You can find us everywhere, on land, in the ocean, in the air - every corner on earth. We are in places you might expect, and places you wouldn't expect, like ... in your home!

Let me guess...you're sitting down, right? maybe you are on a chair? A couch? The floor? A bed? Your mommy's lap?

No! you can't be sitting in a bathtub?! Wherever you're sitting, your little bumbum will be squashing a lot of my friends! AHHHH~::~

#Could you please stand up and take a deep breath with me?
Follow me, INHALE...

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#Hey! Staphy, is that you?

Although you can't see them, there are lots of tiny microbes floating in the air around you. When you breathe, they go in and out of your nose. It seems that you breathed in too hard, and accidentally sucked in Fuzz, Staphy and a new friend!

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Hey! It's Clado!

Mold spores are like seeds. If they land on your bread or your fruit, they'll start growing a greeny-black mycelium forest on your food!

Sometimes you can find the black dots on the bathroom wall, and that's Clado's work too.

This is Clado (*Cladosporium cladosporioides*)! He's a mold spore, a microbe of the fungi family. Fungi are much bigger than bacteria.

#Fun Guy! Fun Guy! I am a Fun Guy!

#No, no, no – he's not a Fun Guy! He's a kind of mold!
It's dark in here, could you please take us back to the book?
Now, please EXHALE... whhhhh!

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Ah, we're finally back. Thank you!

Actually, fungi don't just do bad things. They do good things too. For example, Mr. Yeast (*Saccharomyces cerevisiae*) loves to make bread! And Miss Koji-Mold (*Aspergillus oryzae*) makes soya sauce!

We have some fantastic chefs in the bacteria family too!

My friend Lacto (*Lactobacillus*) is a great master at making cheese and yoghurt! And Aceto (*Acetobacter*) can turn fruit juice into vinegar!

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Rumble rumble – all this talking about food is making me hungry!

We tiny microbes eat all kinds of food – plants, animals, soil, rocks, oil, plastics, as well as stinky smelly rubbish!

The truth is, without we microbes eating all the time to break things down, planet Earth would be completely filled with nasty rubbish!

#This is Ideo (*Ideonella sakainensis*). He munches on plastics.

Yes! Yummy rubbish tastes the best!

Rubbish! Rubbish! I want to eat rubbish!

This is Alcani (*Alcanivorax borkumensis*). Greasy petrol is her favourite drink.

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More than that! I have lots of amazing friends, who like to live on, and sometimes inside, animals and plants. They can do lots of different things!

We can digest food!

Miss Pyromyces (*Pyromyces* sp.), a fungus, and Fibro (*Fibrobacter succinogenes*), a bacterium, both live in cow's guts. They help cows to digest the cellulose in grass.

We can make nutrients!

This is Azoto (*Azotobacter*), a bacterium that lives in the root cells of plants. He turns nitrogen in the air into nutritious food that the plants can absorb.

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#We can fight off disease!

This is Wolba (*Wolbachia* sp.), a bacterium that lives inside the bodies of insects. They protect insects from virus attacks.

#Air! Air! I want to eat air!

#We glow!

This is Ali (*Aliivibrio fischeri*), a light-emitting bacterium. It and its siblings live inside this sweet squid, and every evening they make it glow!

#Some of my friends can turn into bright torches!

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There are so many strange and wonderful things that tiny microbes can do! It's time to reveal this year's Marvellous Microbes!

THE MARVELLOUS MICROBE AWARDS

Most Resistant to Acid

Granny Picro (*Picrophilus torridus*)

This archaeon only likes hot and acidic places.

Most Comfortable in Salt

Grandpa Halo (*Halobacterium salinarum*)

This bacterium soaks all day in saltwater lakes and doesn't go anywhere else.

Most Resistant to Radiation

Deino (*Deinococcus radiodurans*)

This bacterium has a super-strong regeneration function, he doesn't care about damage from radiation.

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Best at Making Oxygen

Prochloro (*Prochlorococcus marinus*)

This bluey-green bacterium sunbathes all day, and constantly puffs out oxygen.

Stickiest Microbe

Caulo (Caulobacter crescentus)

This bacterium makes sugary glue that is three times stickier than superglue!

Most Magnetic Microbe

Magneto (Magnetotactic bacterium)

This bacterium has a long string of tiny magnetic balls inside his belly.

Most Electrogenetic Microorganism

Geo (Geobacter sulfurreducens)

This bacterium is famous for their ability to create electric currents and produce electricity.

Best at Attacking Bad Bacteria

Miss Penny (Penicillium chrysogenum)

This fungus produces antibiotic that attacks those annoying bacteria that make us ill. She's a good friend to humans!

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#Water, water, everywhere!

#Aargh! You just spat all over us!

#Hey, who's that little guy?

Little guy?! Are you talking about yourself?

Huh! I can't believe that no one in the virus family

won a Marvellous Microbe Award! That can't

be right! Let me introduce myself! I'm Rhinie (Rhinovirus).

Viruses are the smallest microbes. We're too tiny

to live independently, so we have to live inside other creatures.

p.33

#Fuzz, there's a bug on you!

#What? Go away, go away! Don't come near me!

Ah, that's Phagie (Bacteriophage lambda), another virus. We viruses aren't just parasites for animals and plants. Some viruses actually live inside bacteria, and they make more of themselves whenever they can. By doing that, they sometimes unknowingly make people sick. Oops, sorry!

#Go away! Get lost! I've got important things to do!

p.34

Phew, luckily I am ok... Now, I have to tell you a big secret!
Shh... can you come a bit closer?

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And the biggest secret ever was...
I LOVE YOU!

#Oh, come on! Give me a hug!
#We love hugs! right? Rhinie?
#I like kissing too! Smooch...
#hug! hug! I want a hug!

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I'm not the only one who loves you. My aunts and uncles, and all my cousins and distant relatives... all of us tiny microbes adore you! We live in your hair, your eyelashes, in your nose and mouth, on your fingers and toes... we're all over your body! But our favourite place is your tummy!

#It's real! We're having a party on your body! Right now!
#It's so lovely and warm on your body...
#Party! Party! I wan a Party!
#Oh no, please, no screaming!

p.37

Your body is like a planet, and we microbes make our homes all over it!

E. coli like Fuzz that live in the warm guts of animals often help make rare nutrients, and help you fight off harmful bacteria.

I love staying in your warm poo poo!

p.38

#Hey, Staphy, what's wrong?
#I think I'm growing!

Most members of the bacteria family, like Fuzz and Staphy, reproduce by growing and dividing. Microbes divide at different speeds. Fuzz and Staphy can divide about every half an hour. Some Bacteria divide much more slowly.

Staphy's dividing right now! When we microbes are happy we get bigger and bigger.

#Yay! I'm getting bigger! I'm not the little guy anymore!

Suddenly, there was a POP! Staphy split into two! It's so easy to go from one to two!

#NOOOO~~ I'm little again. Boo hoo."

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Who are you? Why do you look exactly like me?

Then 2 became 4

And 4 became 8

And 8 became 16

And 16 became 32

And 32 became 64

And in no time, there were lots and lots of tiny microbe babies!

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Aagh! Watch out!

Things are getting out of control! Staphy is dividing way too fast! Once she gets inside your body, she will drop little toxin bombs. It will make you sick! Quick, summon all the superheroes on your body to the rescue!

#Usually, your skin is like armour and will block bacteria like Staphy so they can't harm you or make you ill. She must have sneaked in through a cut in your skin!

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Mayday! Mayday! Calling all the immune warriors!

There are lots of immune warriors in your body, and their job is to help you fight off those tiny troublemakers!

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That was close!

No wonder before you eat, grown-ups are always telling you "There are germs! Go and wash your hands!"

#You know, it's not fair just calling us bacteria germs. Viruses (like Rhinie), and fungi (like Clado), and many other kinds of microbes can make you sick too!

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These tiny troublemakers can easily get into your body through your mouth, nose, eyes and any cuts on your skin! We particularly like travelling on your hands, and take the opportunity when you are talking, sneezing, coughing or kissing to jump onto someone else! We travel by boat, by car, by metro and by airplane – we are always on the go!

Some naughty tiny microbes live on other bugs, or in dirty food or water. They can also sneak into your body through mosquito bites or contaminated food and cause havoc!

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Although we microbes are usually good friends to humans, sometimes you really need to be careful! If microbes start attacking your body, things can get very bad!

So, next time when your mom says “Wash your hands”, you should totally go to **WASH YOUR HANDS.**

And next time she tells you to “Brush your teeth”, you should definitely **GO to BRUSH YOUR TEETH.**

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But... before you wash your hands, please don't forget to put me back on this book. It's really scary down in the drain, I absolutely don't want to be there!

Bye for now! See you next time!