Microbe

by Joan Slonczewski
biologist and science fiction author at Kenyon College

Microbe was first published in Analog, August 1995; reprinted in David G. Hartwell's Year's Best SF, published by HarperPrism in paperback in 1996.

"The rat didn't die." Andra walked around the holostage. Before her, projected down from the geodesic dome, shone the planet's image: Iota Pavonis Three, the first new world approved for settlement in over four centuries. As Andra walked around, the swirl of a mysterious continent peered out through a swathe of cloud. She stopped, leaning forward on her elbows to watch. What name of its own would the Free Fold Federation ultimately bestow on IP3, Andra wondered; such a lovely, terrifying world.

"Not the last time, the rat didn't." The eyespeaker was perched on her shoulder.

It belonged to Skyhook, the sentient shuttle craft that would soon carry Andra from the study station down to land on the new world. A reasonable arrangement:

The shuttle craft would carry the human xenobiologist through space for her field work, then she would carry his eye on the planet surface, as she did inside the station. "The rat only died down there the first eight times."

"Until we got its `skin' right." The "skin" was a suit of nanoplast, containing billions of microscopic computers, designed to filter out all the local toxins--arsenic, lanthanides, bizarre pseudoalkaloids. All were found in local flora and fauna; inhaling them would kill a human within hours. In the old days, planets had been terraformed for human life, like Andra's own home world Valedon. Today they would call that ecocide. Instead, millions of humans would be lifeshaped to live here on planet IP3, farming and building--the thought of it made her blood race.

"We got the skin right for the rat," Skyhook's eyespeaker pointed out. "But you're notexactly a rat."

From across the holostage, an amorphous blob of nanoplast raised a pseudopod.

"Not exactly a rat," came a voice from the nanoplast. It was the voice of Pelt, the skinsuit that would protect Andra on the alien planet surface. "Not exactly a rat--just about nine-tenths, I'd say. Your cell physiology is practically the same as a rat; why, you could even take organ grafts. Only a few developmental genes make the difference."

Andra smiled. "Thank the Spirit for a few genes. Life would be so much less interesting."

Pelt's pseudopod wiggled. "The rat lived, and so will you. But our nanoservos completely jammed." The microscopic nanoservos had swarmed into sample life forms from IP3 to test their

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interesting."

Pelt's pseudopod wiggled. "The rat lived, and so will you. But our nanoservos completely jammed." The microscopic nanoservos had swarmed into sample life forms from IP3 to test their chemical structure. But for some reason they could barely begin to send back data before they broke down. "Nobody cares about them."

"Of course we care," Andra said quickly. Pelt never let anyone value human life above that of sentient machines. "That's why we cut short the analysis, until we can bring samples back to the station. That's why we're sending me."

"Us," he corrected.

"All right, enough already," said Skyhook. "Why don't we review our data one last time?"

"Very well." A third sentient voice boomed out of the hexagonal panel in the dome directly overhead. It was the explorer station herself, Quantum. Quantum was considered female, the others male; Andra could never tell why, although sentients would laugh at any human who could not tell the difference. "Here are some microbial cells extracted from the soil by the last probe," said Quantum.

The planet's image dissolved. In its place appeared the highly magnified shapes of the microbes. The cells were round and somewhat flattened, rather

like red blood cells. But if one looked closer, one could see that each flattened cell was actually pinched in straight through like a bagel.

"The toroid cell shape has never been observed on other planets," said Quantum.

"Otherwise, the cell's structure is simple. No nuclear membranes surround the chromosomes; so, these cells are like bacteria, prokaryotes." Skyhook said, "The chromosome might be circular, too, as in bacteria."

"Who knows?" said Pelt. "On Urulan, all the chromosomes are branched. It took us decades to do genetics there."

"We just don't know yet," said Quantum. "All we know is, the cells

contain DNA."

"The usual double helix?" asked Skyhook. The double helix is a ladder of DNA nucleotide pairs, always adenine with thymine or guanine with cytosine, for the four different "letters" of the DNA code. When a cell divides to make two cells, the entire helix unzips, then fills in a complementary strand for each daughter cell.

"The nanoservos failed before they could tell for sure. But it does have all four nucleotides."

Andra watched the magnified microbes as their images grew, their ring shapes filling out like bagel dough rising. "I'll bet their chromosomes run right around the hole."

At her shoulder Skyhook's eyespeaker laughed. "That would be a neat trick." Quantum added, "We identified fifteen amino acids in its proteins, including the usual six." All living things have evolved to use six amino acids in common, the ones that form during the birth of planets. "But three of the others are toxic--"

"Look," exclaimed Andra. "The cell is starting to divide." One of the bulging toroids had begun to pucker in, all along its circumference. The puckered line deepened into a furrow all the way around the cell. Along the inside of the "hole," a second furrow deepened, eventually to meet the furrow from the outer rim.

"So that's how the cell divides," said Skyhook. "Not by pinching in across the hole; instead it slices through."

"The better to toast it."

At that Pelt's pseudopod made a rude gesture. "Pinching the hole in wouldn't make sense, if your chromosome encircles the hole; you'd pinch off half of it."

Andra squinted and leaned forward on her elbows. "I say--that cell has three division furrows."

"The daughter cells are dividing again already?" Skyhook suggested.

"No, it's a third furrow in the same generation. All three furrows are meeting up in the middle."

"That's right," boomed Quantum's

voice. "These cells divide in three, not two," she explained. "Three daughter cells in each generation." Sure enough, the three daughter cells appeared, filling themselves out as they separated. Other cells too had puckered in by now, at various stages of division, and all made their daughters in triplets. "How would they divide their chromosomes to make three?" Andra wondered. "They must copy each DNA helix twice before dividing. Why would that have evolved?"

"Never mind the DNA," said Pelt. "It's those toxic amino acids you should worry about."

"Not with you protecting me. The rat survived." Quantum said, "We've

discussed every relevant point. We've established, based on all available data, that Andra's chance of survival approaches one hundred percent."

"Uncertainties remain," Skyhook cautioned.

Andra stood back and spread her hands. "Of course we need more data--that's why we're going down."

"All right," said Skyhook. "Let's go."

"I'm ready." Pelt's pseudopod dissolved, and the nanoplast formed a perfect hemisphere.

Andra unhooked Skyhook's eyespeaker from her shoulder. Then she walked back around the holostage to lift the hemisphere of Pelt onto her head. Pelt's nanoplast began to melt slowly

down over her black curls, leaving a thin transparent film of nanoprocessors covering her hair, her dark skin, and her black eyes. It formed a special breather over her nose and mouth. Everywhere the nanoplast would filter the air that reached her skin, keeping planetary dust out while letting oxygen through. The film covered the necklace of pink andradites around her neck, spreading down her shirt and trousers. She lifted each foot in turn to allow the complete enclosure. Now she would be safe from any chemical hazard she might encounter.

#

In Skyhook's viewport, the surface of planet IP3 expanded and rose to meet

them.

Numerous tests had established its physical parameters as habitable--gravity of nine-tenths g, temperatures not too extreme, oxygen sufficient and carbon dioxide low enough, water plentiful. The ozone layer could have been denser, but human colonists would have their eyes and skin lifeshaped for extra enzymes to keep their retina and chromosomes repaired.

At a distance the planet did not look remarkably different from Andra's home world. A brilliant expanse of ocean met a mottled brown shore, rotating slowly down beneath the craft. Beyond, in the upper latitudes, rolled the blue-brown interior of a continent, broken

only by a circle of mountains. As Skyhook fell swiftly toward the land, curious patterns emerged. Long dark bands ran in parallel, in gently winding rows like a string picture. The lines were bands of blue vegetation; the probe had sent back footage of them, wide arching structures tall as trees. Each band alternated with a band of yellow, which gave way to the next band of blue. Over and over the same pattern repeated, ceasing only at the mountains.

"I've never seen patterns like that on uncolonized worlds," Andra mused.

"They do look like garden rows," Skyhook admitted. "Perhaps the native farmers will come out to greet us."

If there were intelligent life forms,

they had yet to invent radio. A year of monitoring the planet at every conceivable frequency had yielded nothing, not so much as a calculation of pi.

Skyhook landed gently in a field of dense vegetation. The wall of the cabin opened, the door pulling out into an arch of nanoplast. A shaft of brilliant light entered.

"All systems check," crackled Quantum's voice on the radio in her ear. "Go ahead."

Andra gathered her field equipment and set Skyhook's eye upon her shoulder again. Then she stepped outside.

The field was a riot of golden ringlets, like wedding bands strewn out.

Her gaze followed the cascade of gold down to the edge of the field, where taller dark trunks arose in shallow curves, arching overhead. From the taller growth came a keening sound, perhaps some living thing singing, or perhaps the wind vibrating somehow through its foliage. "It's beautiful," she exclaimed at last. Beneath the golden ringlets grew dense blue-brown vegetation, reaching to Andra's waist. She bent closer for a look. "These look like plants, `phycoids.'

The ringlets might be flowers."

"They could just as well be snakes ready to snap," warned Skyhook. "Watch your step."

She looked back at the shuttlecraft,

planted in the field like a four-legged insect. Then she lifted her leg through the foliage, Pelt's nanoplastic "skin" flexing easily. Immediately her foot snagged. She tried to pull out some of the growth, but found it surprisingly tough and had to cut it with a knife. "The leaves and stems are all looped," she observed in surprise. "All looped, just like the `flowers;' I'll never get through this stuff." Pelt said, "They are phycoid. I detect products of photosynthesis."

"They could be carnivorous plants," Skyhook insisted. Andra collected some more cuttings into her backpack. "I wish I could smell them," she said wistfully. Pelt's skin filtered out all volatile organics. She

aimed her laser pen to dig one out by the roots. The phycoid came up, but nearby stems sparked and smoldered.

"Watch out!" squeaked the eyespeaker.

She winced. "Don't deafen me; I'll put it out." She stamped the spot with her boots and sprinkled some water from her drinking jet. "This planet's a fire trap." The phycoid roots, she noted, were long twisted loops, tightly pressed together, but loops nonetheless. All the living structures seemed to be bagels squashed and stretched.

"Great Spirit, we've got company," Skyhook exclaimed. Andra looked up. She blinked her eyes. A herd of brown-striped truck tires wererolling slowly

across the field. To get a closer look, she pressed through the phycoids, stopping every so often to extricate her feet from the looped foliage.

She made about ten meters progress before stopping to catch her breath.

"No need to get too close," Skyhook reminded her. His eye had telephoto.

"Yes, but I might pick up droppings, or some fallen hair or scales." Some of the rolling "tires" were heading toward her. Each one had several round cranberry-colored spots set in its "tread." The "tread" was composed of suckers that stretched and extended to push in back, or pull in front. "They must be animal-like, `zoöids,'" suggested Andra. "Those red things--could they be

eyes?"

She counted them, two, three, four in all, before the first came up again. Those eyes must be tough, not to mind getting squashed down.

"If these creatures are zoöids," Pelt wanted to know, "how do they feed?" Skyhook said, "Their suckers ingest the phycoids." Andra stopped again to pull out her foot. "They sure know how to travel," she wryly observed.

"No wonder they never evolved legs." One four-eyed zoöid got excited, and took off with remarkable speed; then it suddenly reversed, heading backwards just as fast. These zoöids had no "backwards" or "forwards," she thought.

Quantum radioed again. "Andra, how

are you holding up? Is your breathing okay?"

She took a deep breath. "I think so." Most of the rats had died from inhaling toxic dust. She resumed her attempt to make headway through the phycoids, and searched the ground for anything that looked like droppings. Overhead, she heard a strange whirring sound. A flock of little things were flying, their movements too fast for her to make out.

"Their wings are turning full around, like propellers," Skyhook exclaimed in amazement. "Why, all these creatures are built of wheels, one way or another."

"Sh," said Andra. "A zoöid is coming up close." The creature rolled slowly over the phycoids, squashing the golden

ringlets beneath it. Andra took a closer look. "There's a smaller ring structure, just sitting inside the bagel hole. I'll bet it's a baby zoöid." The clinging little one rolled over and over inside as its parent traveled. The parent did not seem to notice Andra at all; neither her shape nor her smell would resemble a native predator, she guessed.

The radio crackled again. "We must attempt contact," Quantum reminded her. Any zoöid might be intelligent.

Andra held out her communicator, a box that sent out flashing lights and sound bursts in various mathematical patterns, strings of primes and various representations of pi and other constants. It even emitted puffs of volatile

chemicals, to alert any chemosensing creature with a hint of intelligence. Not that she expected much; their probes had broadcast such information over the past year.

Then she saw it: A giant zoöid was approaching, five times taller than the others and perhaps a hundred times their weight. As it barreled along, picking up speed, the small striped ones took off, zigzagging crazily before it. The ground rumbled beneath her feet.

"Get back to my cabin!" urged Skyhook. "We'll all get run over."

"Wait," said Pelt. "Do you think it heard us? What if it wants to talk?"

"I don't think so," said Andra, prudently backing off. "I think the

smaller zoöids attracted it, not us."

A small zoöid went down under the giant one, then another. That seemed to be the giant's strategy, to run down as many little ones as it could. At last it slowed and turned back, coming to rest upon one of the squashed carcasses.

"It's extending its suckers to feed," observed Skyhook. "Let's get back before it gets hungry again."

"I think that will be a while," said Andra. "It's got several prey to feed on."

The rest of the smaller zoöids seemed to have calmed down, as if they knew the predator was satisfied and would not attack again soon. Definitely a herd mentality; no sign of higher intelligence here.

Andra resumed collecting phycoids and soil samples, recording the location of each. Deeper into the field, she saw something thrashing about in the phycoids.

She made her way toward it through the tangle of looped foliage.

"It's a baby zoöid," she exclaimed. The poor little bagel must have fallen out when its parent ran off. Or perhaps the parent had expelled it, as a mother kangaroo sometimes did. At any rate, there it was, squirming and stretching its little suckers ineffectually, only tangling itself in the phycoids.

"Watch out; it might bite," said Skyhook.

"Nonsense. I have to collect it."

Andra stuffed her hands into a pair of gloves, then approached warily. With one hand she held out an open collecting bag; with the other, she grabbed the little zoöid. It hung limply, twisting a bit. Suddenly it squirted something. An orange spray landed on the phycoids, some of it reaching her leg. Andra frowned. She plunged the creature into her bag, which sealed itself tight. "Sorry about that, Pelt."

"You're the one who would have been sorry," Pelt replied. "That stuff is caustic, as strong as lye. No problem for me, but your skin would not have liked it."

"Thanks a lot. I guess we should head back now; I've got more than I can hold."

She turned back toward Skyhook, some hundred meters off, his spidery landing gear splayed out into the phycoids. Methodically she made her way back, with more difficulty now that she had so much to carry. She was sweating now, but Pelt handled it beautifully, keeping her skin cool and refreshed. The distant forest of tall blue phycoids sang in her ears. The Singing Planet, they should call it, she thought.

"Andra . . . something's not right," Pelt said suddenly.

"What is it?" She was having more trouble plowing through the foliage; her legs were getting stiff.

"Something that baby zoöid sprayed is blocking my nanoprocessors. Not the

chemicals; I can screen out anything. I'm not sure what it is."

"What else could it be?"

Skyhook said, "Just get back to my cabin. We'll wash you down."

"I'm trying," said Andra, breathing hard. "My legs are so stiff." The shuttle craft stood hopefully ahead of her. Only about ten meters to go, she thought.

"It's not your legs," Pelt's voice said dully. "It's my nanoplast. I'm losing control over the lower part, where the spray hit. I can't flex at your joints any more."

Her scalp went cold, then hot again. "What about your air filter?"

"So far it's okay. The disruption has not reached your face yet."

"Just get back here," Skyhook urged again. "You're almost here." Obligingly the doorway appeared on the craft's surface, molding itself open in a rim of nanoplast.

"I'm trying, but my legs just won't bend." She pushed as hard as she could.

"Drop your backpack," Skyhook added.

"I won't give up my samples. How else will we learn what's going on here?" She fell onto her stomach and tried to drag herself through.

"It's microbes," Pelt exclaimed suddenly. "Some kind of microbes--they're cross-linking my processors."

"What? How?" she demanded. "Microbes infecting nanoplast--I've

never heard of it."

"They messed up the probe before."

"Quantum?" called Andra. "What do you think?"

"It could be," the radio voice replied. "The nanoprocessors store data in organic polymers--which might be edible to a truly omnivorous microbe. There's always a first time."

"Microbes eating nanoplast!" Skyhook exclaimed. "What about other sentients?

Are the microbes contagious?"

"You'll have to put us in isolation," said Andra.

"Andra," said Pelt, "the cross-linking is starting to disrupt my entire system."

His voice came lower and fainter. "I don't know how long I can keep my

filters open."

Andra stared desperately at the door of the shuttle, so near and yet so far.

"Quantum, how long could I last breathing unfiltered air?"

"That's hard to say. An hour should be okay; we'll clean your lungs out later."

She tried to recall how long the first rat had lived. Half a day?

"I'm shutting down," Pelt warned her. "I'm sorry, Andra . . . . " Skyhook said, "Pelt, you'll last longer in rest mode. We'll save you yet--there's got to be an antibiotic that will work. They've got DNA--we'll throw every DNA analogue we've got at them."

The nanoplastic skin opened around Andra's mouth, shrinking back around

her head and neck. An otherworldly scent filled her lungs, a taste of ginger and other unnameable things, as beautiful as the vision of golden ringlets. Planet Ginger, she thought, smelled as lovely as it looked. She was the first human to smell it; but would these breaths be her last?

Pelt's skin shriveled down her arms, getting stuck at her waist near the spot that got sprayed. She tried again to pull herself through the phycoids, grabbing their tough loops. Suddenly she had another idea. Pulling in her arms, she sank down and rolled herself over and over, just like the zoöids. This worked much better, for the phycoid foliage proved surprisingly elastic,

bending easily beneath her and bouncing back again. Perhaps those zoöids were not quite so silly after all.

At the door, Skyhook had already extruded sheets of quarantine material, to isolate her and protect his own nanoplast from whatever deadly infection Pelt harbored. The doorway extended and scooped her up into the cabin. As the doorway constricted, at last closing out the treacherous planet, Andra let out a quick sigh of relief. "Skyhook, we've got to save Pelt. Have you got anything to help him?"

Two long tendrils were already poking into the quarantine chamber, to probe the hapless skinsuit. "I'm spreading what antibiotics we have on

board," said Skyhook, from the cabin speaker now. "Nucleotide analogues, anything likely to block DNA synthesis and stop the microbes growing. It's bizarre, treating a sentient for infection."

Andra carefully peeled off the remaining nanoplast, trying to keep as much of it together as possible, although she had no idea whether it was beyond repair.

"Pelt," she whispered. "You did your best for me." By the time they returned to the station, there was still no sign that any of the antibiotics had curbed the microbes. Quantum was puzzled. "I have a few more to try," she said, "but really, if the chromosomes are regular DNA, something should have worked."

"Maybe the microbes' DNA is shielded by proteins."

"That wouldn't help during replication, remember? The double helix has to open and unzip down the middle, to let the new nucleotides pair. There's no way around it."

Andra frowned. Something was missing; there was still something wrong, about the growing microbes with their three daughter cells. How could they unzip their DNA, fill in each complementary strand, and end up with three helices? She thought she had figured it out before, but now it did not add up. She coughed once, then again harder. Her lungs were starting to react to the dust--she had to start treatment

now.

"We've got some data on your samples," Quantum added. "The microbial cells concentrate acid inside, instead of excreting it, like most of our cells do. I still find only fifteen amino acids, but some of them--"

"I've got it!" Andra leapt to her feet. "Don't you see? The chromosome is a triple helix. That's why each cell divides in three--each daughter strand synthesizes two complements, and you end up with three new triple helices, one for each cell." A fit of coughing caught up with her.

"It could be," Quantum said slowly. "There are many ways to make a DNA triple helix. One found in human

regulatory genes alternates A-T-T triplets with G-C-C."

"Then it has a two-letter code, not four." Double-helical DNA has four possible pairs, since A-T is distinguished from T-A; likewise G-C differs from C-G. Quantum added, "The triple helix is most stable in acid, just what we found in these cells."

"Just hurry up and design some triplet analogues." Quantum's sentient brain could do this far faster than any human. "Triple helix," Andra repeated. "It would resist ultraviolet damage much better, with the planet's thin ozone layer.

But how to encode proteins, with only two `letters'?" The triple helix had only two possible triplets; its three-letter

"words" could only specify eight amino acids to build protein. "Maybe it uses words of four letters. With two possible triplets at each position, that would encode two to the fourth power, that is, sixteen possible amino acids."

"Fifteen," corrected Quantum, "if one is a stop signal."

#

The next day, after an exhaustive medical workout, Andra felt as if a vacuum cleaner had gone through her lungs. Pelt still had a long way to recover, but at least the pesky microbes were cleaned out.

"It's hopeless," complained Skyhook's eyespeaker. "If even sentients aren't safe, we'll never explore that planet."

"Don't worry," said Quantum's voice above the holostage. "Pelt's nanoplast has an exceptionally high organic content. A slight redesign will eliminate the problem. Machines have that advantage."

Still, Pelt had nearly died, thought Andra.

"Your phycoid and zoöid samples all have toroid cells, too," Quantum added.

"They have circular chromosomes, with no nuclear membranes: They're all prokaryotes. Just wait till the Free Fold hears about this," Quantum added excitedly. "I've got the perfect name for the planet." Andra looked up. "Planet of the Bagels?"

"Planet Prokaryon."

Prokaryon--yes, thought Andra, it sounded just pompous enough that the Fold would buy it.

Still, she thought uneasily about those regular garden rows of phycoid forest and fields, with all kinds of creatures yet to be discovered. "I wonder," she mused. "Some one else just might have named it first."

--The End--The planet Prokaryon is featured in my forthcoming novel,

THE CHILDREN STAR!

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