CAREERS

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Scientists who have disabilities use a growing array of specialized equipment to enable them to carry out research.

DISABILITY AWARENESS

The fight for accessibility

An aisle too narrow, a lab bench too high: the scientific world is a complex place for researchers with disabilities. But many of them find ingenious ways to make it work.

BY ERYN BROWN

Henry "Hoby" Wedler caught the chemistry bug as a high-school student in Sonoma County, California. He loved to think about atoms and how they fit together to make molecules. Although he wanted to enrol in his school's advanced chemistry course, he faced a frustrating problem: he has been completely blind since birth, and his teacher thought that he might find it too hard. The field was too visual, she told him.

Nonsense, Wedler thought. "I said, 'No one can see atoms; it's completely cerebral.'" Now 28, he is studying for a PhD in organic chemistry at the University of California, Davis, and is considering teaching offers. His once-doubting school instructor has become one of his greatest allies.

It's not an easy road, but early-career scientists who face physical challenges such as blindness, deafness or paralysis are building varied and rewarding careers. They work in academic, government and industrial research as teachers, consultants and other occupations.

Success requires desire, grit and ingenuity. Researchers who have trouble seeing, hearing or with mobility need creative workarounds in the lab and field. They may have to design their own equipment. They need a crew of friends, peers and mentors who can provide support. And they must seek work that capitalizes on their strengths, accepting that some assignments may be beyond their reach — at least for now.

"You have to really want to be a scientist a lot, or it won't happen," says Richard Mankin, a research entomologist for the US Department of Agriculture (USDA) in Gainesville, Florida, who wears braces on his legs and ▶

relies on crutches to walk.

Despite a patchwork quilt of policies and guidelines that are meant to broaden employment opportunities, disabled people still have trouble finding work. A 2014 analysis by the Campaign for Science and Engineering, which promotes science in the United Kingdom, reported[1] that fewer than half of the nation's 5.2 million people of working age with disabilities had jobs between 2010 and 2011. They were more than twice as likely as peers without disabilities to report working part-time, and about half as likely to have jobs in science, technology, engineering and mathematics.

Similarly, in 2015, the US National Science Foundation reported[2] that about one in nine scientists aged 75 or younger in the United States had a disability. They, too, were more than twice as likely to be out of the labour force than their peers without disabilities.

As Wedler found, accessibility issues crop up long before a scientist enters the workforce. German-born climatologist Imke Durre, blind since early childhood, says that her father, a computer scientist, created a Braille word-processing program in the early 1980s to help her to do school work. Such technology is widespread today, says Durre, who works for the US National Oceanic and Atmospheric Administration.

But she says that there are still practical hurdles to using assistive tools, particularly for students. Even when Braille versions of textbooks are available, teachers may not know about them or be able to order them in time for a class. Figures, tables and graphs typically aren't translated into Braille, so a student with a visual impairment often needs to collaborate with a sighted colleague to interpret visual data — a process that may not go smoothly, says Durre. On occasion, she says with a laugh, she has shown up to a meeting carrying blank pages instead of the hard copies of graphs and tables that she thought she had prepared.

A FLEXIBLE SPACE

Mundane tasks pose barriers, too. James McNutt, who uses a wheelchair and studies the history of science at Queen's University in Kingston, Canada, set out last year to record some of the difficulties that he faces as he travels around the university (see go.nature.com/oaablb). With a video camera attached to his wheelchair, he attempted to open doors, operate lifts and visit washrooms. Buttons, switches and knobs were often out of reach. Doors wouldn't open. Passageways were too narrow or too winding to accommodate a wheelchair easily.

"Quite often, the planning people don't have an idea of what is and is not accessible," says McNutt, who has cerebral palsy. "They don't know how big the wheelchair is. They don't have any idea what it's like."

Audrey Kobayashi, a geographer at Queen's University and a member of the school's committee on campus accessibility, says that the situation has improved greatly over the past two decades. There are now clear lines of responsibility to ensure that students with disabilities get any help they need, and the movement is garnering attention (see 'A worldwide wave of awareness'). But Kobayashi, who uses a wheelchair at work because of a neurological disorder called transverse myelitis, says that a lot of challenges remain. "We're trying to make a barrier-free campus, but it's slow," she says.

The difficulties don't end after receiving a degree. Researchers who have a disability and want to work in a scientific field must first ensure that physical adjustments are made to labs and other workplaces to facilitate access. These can include redesigning lab sinks to accommodate a wheelchair, posting emergency instructions in Braille and checking that doorways to halls with lifts or ramps don't lock automatically and block exits.

In the United States, the Americans with Disabilities Act, enacted in 1990, requires accommodations in public spaces. The UK Disability Discrimination Act (1995) and Canada's Accessibility for Ontarians with Disabilities Act (2005) impose similar requirements for their regions. But the laws often do not require retrofitting, and thus many labs that were built before the legislation took effect remain difficult or impossible to navigate for scientists who have mobility issues: aisles are too narrow, tables are too tall and eyewash stations are tucked into inconvenient corners.

> ***"Quite often, the planning people don't have an idea of what is and is not accessible."***

Some scientists are attacking the problems on their own. Neuroscientist Bradley Duerstock, who has been quadriplegic for more than 25 years, developed a disability-friendly lab space at Purdue University's Center for Paralysis Research in West Lafayette, Indiana, where he researches assistive technologies. With grants from the US National Institutes of Health and other sources, he adapted the 'kitchen work triangle' — a home-design layout concept that imagines the stove, sink and refrigerator as the shape's corners — into a 'wet-laboratory work triangle' defined by the lab sink, lab bench and fume hood. Years ago, he designed a microscope that lets the user control illumination, focus and exposure through a computer interface, rather than tricky-to-operate knobs (now, such microscopes are commercially available).

Scientists with disabilities are also installing light switches that are positioned at an accessible height and that are labelled for people who rely on Braille, and they use adjustable-height lab benches and other accommodations.

Back in California, Wedler gives credit to his adviser, chemist Dean Tantillo, for hiring him as an undergraduate and for making the lab an easier place to work. With the help of US$30,000 in supplemental funding attached to his US National Science Foundation graduate fellowship, Wedler and other members of Tantillo's team developed a 3D-printing solution that produces tactile models of molecular structures. Different shapes and textures in the models represent different atoms and bonds, and Braille notations describe bond angles and bond lengths. It takes a couple of days to generate each printed model, but Wedler doesn't mind: the homegrown technology allows him to 'feel' the outcomes of his calculations so that he can verify his work on his own.

When Duerstock and Susan Mendrysa, then a colleague at Purdue's Institute for Accessible Science, polled coworkers to learn what qualities make a lab most accommodating, they found that working with an established, well-funded principal investigator was key: such scientists were more likely to give staff with disabilities the extra time they might need to complete their studies or to publish papers.

Colleagues can also help on a smaller scale. Born with muscles missing in his legs and

GROUP ACCOMMODATION

A worldwide wave of awareness

- The STEMM Disability Advisory Committee, a partnership between the Royal Society and other scientific groups in the United Kingdom, pushes to improve funding for scientists with disabilities, and hosted a conference in March focusing on the transition from study to the workplace.
- The American Association for the Advancement of Science led early on in making conferences accessible, and sponsors Entry Point!, a programme that places young scientists with disabilities at internships with university, government and industry labs.
- Sang-Mook Lee's Quality of Life Technology initiative at Seoul National University, funded by the South Korean government, promotes adaptive technologies for disabled students.
- Analytical chemist Karl Booksh at the University of Delaware in Newark runs a programme for disabled undergraduates that prepares them for graduate work.
- The American Chemical Society's Chemists With Disabilities committee has published a guide to teaching disabled chemistry high-school, college and graduate students[3].
- The International Association for Geoscience Diversity, in Cincinnati, Ohio, seeks to improve accessibility for students and scientists with disabilities in the Earth sciences. E.B.

Entomologist Richard Mankin (right) does work for the US Department of Agriculture in Guam.

AUBREY MOORE

arms, Mankin has conducted field research internationally since the 1970s, walking with crutches or crawling along the ground to study the sounds and vibrations that insects make in various locations. He seldom works in the field alone, and he keeps his trips short. He asks those who accompany him to manage tasks that he cannot perform, such as carrying equipment and climbing trees.

Physical barriers are not the only obstacles: bias can also be an issue. Jae-Hyeon Parq, a postdoctoral researcher at Seoul National University, who has used a wheelchair since sustaining a spinal injury as an undergraduate, worries that his disability will make it hard for him to find a job. Trained as a physicist, Parq now works in the lab of marine geologist Sang-Mook Lee, who has been trying to improve conditions for scientists with disabilities since 2006, when he was paralysed in a car accident.

"Most people, especially in Korea, don't understand the diversity of disabled people," Parq says. "They judge what I can and what I can't do from my appearance." If Parq can't get a permanent job, he says, he will continue to work for Lee.

PUBLIC SECRETS

Those whose disabilities aren't as immediately obvious face a different, yet related problem: whether to tell potential employers. "One of the most common questions I get is, should I say on my CV that I'm deaf?" says biochemist Annemarie Ross of the Rochester Institute of Technology's National Technical Institute for the Deaf in New York. Ross, who is hearing-impaired, tells students that it is their choice — there is no clear advantage for applicants who do or don't reveal a disability.

But it's a challenge that must be resolved, she says. "A big barrier in general for our students are the employers. They think, 'If a worker can't hear a fire alarm, how do we make sure they're safe? If they stay behind in a burning lab, we could be liable.'" Often, job candidates must persuade employers to reframe their assumptions in interviews, Ross says. Those with hearing disorders, for example, can see the strobe lights on many modern fire-alarm systems. By the same token, scientists in a lab don't spend much time doing physical tasks.

"I was always having to persuade people I could do things from a wheelchair," says Karl Booksh, an analytical chemist at the University of Delaware in Newark who experienced a spinal cord injury in university. "The way I convinced most of them was pointing out that the most successful faculty members didn't know where the pipettes were to begin with — that the key to success was writing papers and proposals."

Some scientists with disabilities have reframed their impairment as a positive attribute: they say that coping with the challenges of everyday life has helped them to develop unusual skills and expertise. Wedler, for instance, says that navigating town trained his brain to make spot-on mental maps. A similar sort of spatial thinking helps him with organic chemistry. "I was thinking in terms of feet and miles, but there's no reason you can't shrink that down to ångströms," he says. "In terms of doing the problems, I might have an advantage over my sighted peers."

Mankin is dubious that the stigma against those with disabilities will ever fade completely. He is president of the Foundation for Science and Disability, which sponsors a grant programme that supports the research of graduate students with disabilities. But, he says, he doesn't think of himself as disabled.

He is an enthusiast whose voice crackles with excitement when he talks about his work. He is studying psyllids, insects that cause a tree-damaging disease that threatens Florida's $10-billion citrus industry, and he has been developing systems that use vibrations to lure and trap male psyllids to prevent them from mating with females nearby. The approach could offer an alternative to pesticides, and has attracted the attention of federal legislators.

"Being a scientist has been lots of fun," Mankin says. "I've done things that I hope have benefitted humanity. This is what I always wanted to do." ■

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1. *Improving diversity in STEM* (Campaign for Science and Engineering & King's College London, 2014).
2. *Women, minorities, and persons with disabilities in science and engineering* (National Science Foundation, 2015).
3. Miner, D. L., Nieman, R., Swanson, A. B. & Woods, M. (eds) *Teaching Chemistry to Students with Disabilities* 4th edn (American Chemical Society, 2001).

CHARACTER TRAITS

Scientific virtue

Honesty and curiosity are the most important traits underlying excellent science, according to a survey of around 400 members of elite US scientific societies, such as the National Academy of Sciences. A pilot study led by survey co-organizer Robert Pennock, a philosopher at Michigan State University in East Lansing, had previously identified the ten most widely held values among scientists who have been honoured by their peers for being exemplary. Although honesty and curiosity dominated, these virtues also included perseverance, objectivity and the willingness to abandon a preferred hypothesis in the face of conflicting evidence (see 'Core values').

Little empirical research has been done to learn what traits scientists value most in one another, says Pennock, and this work indicates a high level of consensus among elite US researchers about what is important for the practice of science. He thinks that training programmes that emphasize such shared scientific values are likely to be more effective than are those that focus on compliance with official rules of behaviour; 94% of the scientists surveyed felt that scientific virtues can be learned.

About four in five of those surveyed feel that today's trainees share the scientific values that they themselves held when training, and 88% take candidates' scientific character traits into account when recruiting lab members. The team members presented their preliminary results at a meeting of the American Association for the Advancement of Science in February (see go.nature.com/o4urjl), and they plan to publish full results from a sampling of 500 established scientists, in addition to a similar-sized group of early-career scientists, in upcoming months.

CORE VALUES

Elite scientists were asked which three values they consider to be the most important.

*Willingness to abandon a preferred hypothesis when faced with conflicting results.

SOURCE: AAAS 2016 ANNUAL MEETING