

CAREERS

GENDER GAP Women still earn fewer US PhDs than men in most disciplines **p.517**

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NATURE

EDUCATION

Combine and conquer

Completing two graduate degrees can offer great flexibility.

BY AMBER DANCE

In 2009, veterinary ophthalmologist Ron Ofri took a call about a flock of sheep in northern Israel. Some of the lambs were day-blind: they wandered easily at night, but stood motionless when the Sun rose.

Ofri, a researcher at the Hebrew University of Jerusalem who has a PhD and a doctorate in veterinary medicine (DVM), examined the sheep. Then he swapped his clinician's hat for his research one, assessing the sheep's retinal function and genome using techniques that he had learnt in graduate school. He and his colleagues then determined that some sheep carry

a mutation in the same gene that causes human day-blindness. They successfully tested a gene therapy in sheep, and expect to soon launch human trials.

The combination of a clinical and a research focus has been enormously beneficial, Ofri says. "One enriches the other."

Ofri is one of a small group of PhD scientists who have augmented their research training with a professional degree or a master's in another topic — public health, for example, or physical therapy (see 'Mix and match'). Data from the US National Science Foundation show that fewer than 1% of the 261,581 people who were awarded a PhD between 2011 and

2015 also earned a Doctor of Medicine (MD) degree. Even fewer combined a PhD with a dental degree.

Obtaining multiple advanced degrees can open career doors and position scientists to act as a bridge between two fields of expertise. A downside, however, is that they can take a long time to complete — seven years or more, in some cases. The degrees are usually done sequentially, but some programmes make it possible to do them concurrently. The costs vary: during a PhD, tuition and stipends are usually covered by an adviser's grant or other sources.

But for professional degrees, students tend to pay their own way or have to apply for partial or full fellowships. Combination programmes can help to lower the costs, because they may fully or partially subsidize the clinical training. Furthermore, government schemes will often waive the repayment of loans for those who go on to perform clinical research.

Whatever the route, people who successfully complete multiple advanced degrees tend to have clear goals for how they will apply the skills from each, and have the ability to rapidly switch back and forth between the two roles, as Ofri did in his sheep project.

But it's not the right course for everyone, says Tim Church, chief medical officer at ACAP Health, a consultancy firm in Dallas, Texas, who has an MD and a PhD. Those mulling over this route, he says, should carefully consider their interest in research and whether the dual degree will lead to a better job. The degrees ended up being a great choice for him, but the cost may not be worth the sacrifices for everyone.

BRIDGE BUILDERS

For many, the clinical component comes first. In Europe, for example, people wanting to become dentists generally spend five or six years in training directly after finishing secondary school, says Paulo Melo, a PhD dentist at the University of Porto in Portugal and chair of the working group on education and professional qualifications at the Council of European Dentists. They can then train in a speciality such as oral surgery, or pursue a research master's or PhD. The number of people who go on to do the research component varies widely by nation and research field, he says.

Liz Kay, founding dean of the Peninsula Dental School at Plymouth University, UK, has earned a clinical degree in dentistry, a Master of Public Health (MPH) and a PhD in clinical decision-making. Now, she runs a master's ►

► of business administration programme for health-care workers. She spends one day a week in the clinic and teaches, researches and writes. “I’ve always tried to wedge open all my options,” Kay says.

In the United States, dentistry students typically cannot enrol for a clinical degree, such as a Doctor of Dental Surgery (DDS), until they have done an undergraduate degree. And some universities offer the professional degrees together with a PhD.

Professors who train students in such dual-degree programmes say that there’s a need for graduates who can change gear with ease. Michael Atchison, director of the veterinary-PhD programme at the University of Pennsylvania School of Veterinary Medicine in Philadelphia, says that his graduates are particularly desirable to pharmaceutical companies, which often struggle to find people who can adapt molecular and cellular data for use in an entire organism, he says.

According to a 2013 report by the US National Academy of Sciences (NAS), about one-quarter of the veterinary surgeons in contract research organizations hold PhDs, and they work mostly in safety research. In animal-health companies, about one-third hold PhDs, and they work mainly in clinical research and development. According to a 2007 NAS questionnaire, 24 of 170, or 37%, of company job adverts for full-time vets sought candidates with a PhD and a veterinary degree.

The NAS report estimated that an average of 83 North American vets enrolled in a PhD programme each year between 2007 and 2011. Further education is a popular option for vets

in Europe. A 2015 survey by the Federation of Veterinarians of Europe found that 21% of veterinary-degree recipients earn a PhD or master’s as well.

The dual degree may be a requirement for some jobs. Daisuke Ito says that applicants for his job as a medical-science liaison at Bristol-Myers Squibb in Fukuoka, Japan, were required to have both a PhD and an MD or veterinary-medicine degree. Liaisons use their scientific expertise throughout the drug-development process, and maintain relationships between the company and academic physicians.

“You have to be able to manage these two very different things you’re doing at the same time.”

In 2014, Emory School of Medicine partnered up with the Georgia Institute of Technology in Atlanta to offer a combined PhD and doctor of physical therapy (DPT) scheme. They, too, expect that the graduates will fill a niche, not least because one-fifth of the US population has a disability, according to the US Centers for Disease Control and Prevention. “There’s a growing recognition about the need for robust rehabilitation science and researchers,” says programme director Edelle Field-Fote.

Hiring committees may feel that having a PhD shows that a candidate has proven their ability to complete a complex project, says veterinary microbiologist Patrick Butaye of Ross University in Basseterre, West Indies. Butaye earned his veterinary degree at the University of Ghent in Belgium, where the six-year programme includes both undergraduate

and graduate course work. He then got a PhD from the university, and now holds an associate appointment there.

The system is similar in South Korea, says Jong Hyuk Kim, a cancer researcher at the University of Minnesota in Minneapolis. Kim wanted to know more about the diseases he’d been trained to treat during his six-year veterinary programme at Konkuk University in Seoul. So, in his final semester, he took some pathology courses that would count for credit in a PhD programme, and enrolled in that PhD course immediately after completing his veterinary degree. He estimates that about 10% of his classmates did so, too. Both Butaye and Kim note that their PhDs made it easier for them to find work abroad.

Most countries allow people to work for two advanced degrees sequentially, but truly dual programmes seem to be concentrated in the United States. Yet even there, they are rare. About 120 US universities offer MD-PhD programmes, 15 have vet-PhD courses and around a dozen have PhD-DDS combinations.

Dual programmes appeal most to students with a strong educational drive and clear goals. Osefame Ewaleifoh, for instance, was interested in combining tightly focused neurovirology questions with a wide view of public health. That brought him to the PhD-MPH programme at the Driskill Graduate Program in the Life Sciences at Northwestern University Feinberg School of Medicine in Chicago, Illinois. In his PhD lab, he studies the brain’s protections against viral invasion; in his public-health work, he’s implementing education for refugees to improve long-term health outcomes.

Of course, joint programmes can be costly. At the University of Buffalo in New York, Erik Hefti is the first student to embark on a combined PhD-doctor of pharmacy course. He took out loans for his pharmacy degree. Now doing the PhD component, he works nights in a hospital pharmacy so that he can pay off those loans before they accumulate too much interest.

For those who pay their own way through a professional course, the addition of a PhD can help to cut down on the debt. Church says that he owed nearly US\$300,000 — mostly from the MD — by the time he’d finished medical school, a PhD and an MPH course. But because he went on to perform clinical research, government programmes helped Church to pay it off within ten years.

CHOOSE YOUR ADVENTURE

Even if a university doesn’t offer a specific dual programme, students may be able to design their own, says Steven Anderson, associate director for the Driskill programme, which now allows PhD students to pursue an MPH or a Master of Science in Clinical Investigation (MSCI), after a few students did so on their own.

Eric Skaar was the first PhD student to do this. He was interested in molecular

MIX AND MATCH

Education top-ups

Degrees that can enhance a PhD include, but are not limited to, these programmes.

- **MD** A Doctor of Medicine often leads to work in academia, with most hours devoted to research, and some to clinical care.
- **MBA** A Master of Business Administration can help scientists to turn their research into start-up companies or to ascend in industry (see *Nature* **533**, 569–570; 2016).
- **JD** A Juris Doctor degree allows scientists to apply their technical expertise in patent law (see *Nature* **423**, 666–667; 2003).
- **DVM** Graduates with a Doctor of Veterinary Medicine can perform translational research in academia and are highly sought after by pharmaceutical companies.
- **DDS** Many PhD graduates who have a Doctor of Dental Surgery stay in academia, teaching and performing research.
- **MPH** A Master of Public Health teaches

rigorous statistics that enable researchers to work in areas such as epidemiology.

- **DPT** A Doctor of Physical Therapy helps PhD graduates to work in an academic post and to do research that informs clinical practice.
- **PharmD** A Doctor of Pharmacy with a PhD could work at a university or contribute to research or drug development in industry.
- **DNP** A Doctor of Nursing Practice prepares PhD graduates to perform research in nursing science and to teach in nursing schools.
- **MSCI** A Master of Science in Clinical Investigation produces a greater understanding of clinical research and opens up careers in clinical trials.
- **MPP** A Master of Public Policy sets graduates up to work in academia, government or research firms, analysing and developing child, family and educational policies. **A.D.**



Ron Ofri is often called on to assess eye infections at the Tisch Family Zoological Gardens in Jerusalem.

RON OFRI

epidemiology, and hoped that the master's would position him for jobs investigating disease outbreaks. At first, the university wasn't eager to let him enrol in the MPH, which at the time was meant only for medical students. But by promising that it would enhance his PhD, not distract from it, he found faculty support.

Skaar set rules with himself and his PhD adviser — that he'd be a research student until evening, when he attended his public-health classes. He aligned his two courses with a PhD dissertation on how the bacterium that causes gonorrhoea evades the immune system, and a public-health thesis on the epidemiology of the sexually transmitted infection. He never did become an outbreak investigator, but is now director of the division of molecular pathogenesis at Vanderbilt University School of Medicine in Nashville, Tennessee. Thanks to the MPH, he can approach his work on hospital infections with an epidemiological background.

Students who want to create an ad hoc joint degree should be prepared to hack through plenty of bureaucratic red tape, warns Anderson. Particularly if the degrees are administered by different schools within an institution, basic issues such as tuition and class registration can be tricky. In fact, he's not sure what form Driskill's MPH option will take in the future, because he's working out how to manage the tuition.

BALANCING ACT

The multiple-degree path is mentally tricky, too. Ofri notes that people in his clinic don't understand why he spends so much time in

the lab, and his students wonder why he's always in the clinic. It's near-impossible to maintain a perfect 50–50 split, says Jaime Modiano, a graduate of the Penn vet–PhD course and now director of the Animal Cancer Care and Research Program at the University of Minnesota in Minneapolis and in St Paul. He decided to forego taking the veterinary board exam, opting for a research postdoc instead.

Butaye made a similar decision: he researches antibiotic resistance in microbes. But he appreciates the veterinary degree for giving him the flexibility to work in multiple species.

The balancing act is especially challenging for students during dual-degree programmes. “You have to be able to manage these two very different things you're doing at the same time,” says Modiano.

In veterinary classes, he had to memorize and integrate masses of information, then apply it immediately to treat animals. In research, he had to find the information himself and integrate it to spur future discoveries. “People who are successful are highly adaptable,” he says. ■

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CORRECTION

The Careers Feature ‘Science on camera’ (*Nature* **545**, 123–125; 2017) accidentally claimed that sea ice is sinking. It is, of course, shrinking.

DOCTORATES

PhD gender gap

The proportion of women getting PhDs in science, technology, engineering and maths (STEM) in the United States has remained stagnant in the past decade, despite a 50% increase in the number of STEM doctorates awarded in the same period. The figures, released last month by the National Student Clearinghouse Research Center in Herndon, Virginia, in its report *Snapshot 27: Science and Engineering Degree Completion by Gender*, showed that although the number of STEM PhDs rose from about 18,000 in 2006 to more than 27,000 in 2016, the proportion of doctorates awarded to women remained at around 40%.

“So much attention has been paid to making hard-science disciplines more inviting to women, and a lot of institutions can claim progress,” says Douglas Shapiro, the centre's executive research director. “But when you look at the big picture, you don't see it.”

The report offers the first national-level snapshot of science and engineering degrees awarded in 2015–16, which the centre compared with those earned in 2006. It breaks STEM degrees into seven fields: engineering; computer science; Earth/atmospheric/ocean sciences; physical sciences; maths; biological and agricultural sciences; and social sciences and psychology.

The proportion of PhD degrees earned by women increased by no more than a few percentage points over the decade — except in maths, where it fell slightly from 29.2% to 28.4%, and in social sciences and psychology, where it fell from 56% to 55%.

The share of bachelor's degrees earned by women also fell during the decade in four disciplines: in maths (from 44.6% to 42.3%), in computer science (from 20.2% to 18.6%), in Earth sciences (from 40.3% to 38.2%) and in physical sciences (from 41.8% to 38.8%). Fewer bachelors degrees translates into fewer advanced degrees later on. “It's disheartening,” says Shapiro.

Since 2009, the only field in which women studying STEM subjects have earned a higher proportion of doctoral degrees is biological and agricultural sciences, according to the report. In 2006 they received 47.9% of PhD degrees in the discipline but that shifted to 51.6% by 2009. The trend continued through to 2016 when women earned 51.8% of PhDs in biological and agricultural sciences.

Shapiro says that the imbalance reflects the need for closer tracking of degree-earners.