

matics." But he adds: "We need more courses at all levels." The only course dedicated to bioinformatics in Spain is postdoctoral. Valencia is seeking formal relationships with the EBI as he believes that bioinformatics is not really promoted as a separate discipline in Spain. As in Italy, the money goes to molecular biology or protein chemistry groups that include a person with bioinformatics skills.

Away from academic institutions, the picture is equally vibrant and varied. Europe's pharmaceutical giants latched on to the significance of bioinformatic skills early on, and have indulged in aggressive poaching from the lower-paid public sector. The pharmaceutical industry's competition when recruiting high-quality staff, says Chris Rawlings, UK director for bioinformatics at SmithKline Beecham, is not from academic institutions, but from smaller genomics companies that can offer stock options and a prominent, leadership role in a small group.

Rawlings is less concerned by the competition for new recruits from the small bioinformatics companies that have recently begun the search for capital. The big pharmaceutical companies are building up a strong body of in-house expertise. "We go and talk to these people [in bioinformatics companies] and find out who they are. We are looking for niche technologies," he says. For the brave, the well informed and, above all, those with business acumen, there is nevertheless a whiff of money to be made from a start-up bioinformatics company.

"A lot of people see bioinformatics as the current technology frontier and believe, as they did eight years ago about the Internet, that there are a lot of opportunities out there," says Joseph Bergen of the venture-capital company 3i. But, says Bergen, it's all about timing, and bioinformatics has not broken cover yet. So far, he has seen interesting technology, but not the commercial sense that would convert an idea into hard cash. When the small companies do break cover, the SKBs and Glaxo Wellcomes of the world will be waiting. So far, says Lyall of Glaxo Wellcome, it is all smoke and mirrors.

For those contemplating a slightly less risky life in the commercial world, the big companies are still seeking people who will be effective from day one. "Bioinformatics is strategically important to us," says Rawlings. "The company's philosophy is that all new drug targets are expected to be discovered by genomics." SKB has two main informatics groups: in Philadelphia and Harlow (United Kingdom), whereas Glaxo Wellcome has three main centres for bioinformatics: Stevenage (United Kingdom), employing about 30 specialists; North Carolina, 25-30 specialists; and Geneva, between 5 and 10. There is also a small group in Madrid that collaborates with Valencia. Both Wellcome and SKB are not too far from Hinxton, where the EBI, the Sanger Centre (sequencing about a third

Useful Web sites for bioinformatics in Europe

The most useful site for those curious about bioinformatics in Europe is that of the EBI (<http://www.ebi.ac.uk>). The site is extensive, with a newsletter, job vacancies and a lot of educational material as well as further links, including one to its parent organization EMBL (<http://www.embl-heidelberg.de/>). It may just be my software, but I cannot always get through to this site.

A good starting point for a tour of European national centres is the

page of the European Science Foundation, which provides links to members. For example, (<http://www.esf-strasbourg.fr/members/map.htm>) will take you to French members, including the CNRS (<http://www.cnrs.fr/>). There is an English version of this site. One can also reach UK sites, including that for the BBSRC (<http://www.bbsrc.ac.uk/>). Finding information about bioinformatics on these sites requires some searching.

Also at European level is a page from the science directorate (<http://europa.eu.int/en/comm/dg12/biotech/biot-n.htm>). This provides links to biotechnology sites, including the European Federation of Biotechnology.

In the United Kingdom, the Wellcome centre provides a list of job vacancies at (<http://wisdom.wellcome.ac.uk/>). The page gives the option of searching for jobs in a given area, but I got no results. **Helen Gavaghan**

of the human genome) and the Medical Research Council's human genome mapping programme resource centre are sited.

SKB divides its bioinformatics activities into three areas: research; bioinformatics tool development and databases; and user support and services. This split accurately reflects the kind of jobs available to people interested in bioinformatics. The dream *curriculum vitae* for someone wanting to go into research in SKB or Glaxo Wellcome would show a bachelors' degree in a biological science, a masters' in computational science and a doctorate focusing on a problem in computational biology. Rawlings adds that he would like to see a stint or two as a postdoc. With this background, you are practically guaranteed to have Glaxo Wellcome and SmithKline Beecham fighting for your services. Says Brass: "You would probably earn in the mid to high thirties [£30,000+ a year], which compares with a salary in the mid thirties for a full professor in the UK."

The people working in bioinformatics tool development and user support and services will need a strong computing background. Of the support group, Rawlings says, "These people are not sitting on a help desk. They are performing sophisticated bioinformatics analyses for scientists without a Unix workstation." The pay scale, roughly — and both companies are a little coy about this — is low-to-mid £20,000 range for a person with a masters' degree, and high £20,000 to low £30,000 range for one with a masters' and a doctorate. "There is definitely a premium for having a masters' in bioinformatics compared with molecular biology," says Brass.

Given the boundaries that someone in bioinformatics must cross, perhaps the premium is justified. "It is not a field of science like genetics," says Michael Ashburner,

director of research at the EBI and a professor of genetics at the University of Cambridge, "it is a field in which nearly everyone comes from somewhere else." Slowly those people, in the United Kingdom at least, are being channelled through specialized masters' programmes. The universities of York, Manchester, Aberdeen and Birkbeck College (part of the University of London) offer masters' degrees in bioinformatics. There are more masters' courses in the pipeline, says Lyall, Edinburgh being one example.

Ashburner says: "We need to put more resources into training at the masters' level." The recent introduction of graduate schools into the United Kingdom on the US model (rather than having students attached to individuals in departments) makes the introduction of masters' degrees in interdisciplinary subjects like bioinformatics easier than it is in Europe, says Brass. The Manchester course takes up to 20 people each year; most come from a biology background, but Brass would like more from computer science, physics or mathematics.

The Manchester course concentrates on problem solving, being project- rather than lecture-based. The field is moving so fast that it would be difficult to construct a course otherwise. For example, when the EBI ran a workshop on 'common object request broker architecture' (CORBA — a way of transferring blocks of code between applications) earlier this year, it anticipated 40-50 attendees. In the event, 200 registered and a further 50 unregistered scientists turned up. Yet it is only this coming year that Manchester will teach CORBA. Even as they start their first job fresh from university, last year's graduates will find themselves running to catch up with the technology. □

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