Table Sites of internet interest for cell biology	
Organizations and societies	
Federation of American Societies for Experimental Biology	www.faseb.org/
American Society for Cell Biology (placement)	www.faseb.org/ascb/place/place.htm
FASEB Consensus Coference on Graduate Education report	www.faseb.org/opar/educrpt.html
Commission on Professionals in Science and Technology (CPST)	www.aaas.org/opst/
Academic laboratories	
Institute for Chemistry and Cell Biology	www.hms.harvard.edu/iccb/
UC Berkeley Department of Molecular Cell Biology	mcb.berkeley.edu/
Corporations employment	
Hoercst Marion Roussel	www.hmri.com
Eli Lilly	www.lilly.com
Incyte Pharmaceuticals	www.incyte.com
Grants and funding (private)	
The Pew Charitable Trust	www.pewtrusts.com/
Packard	www.packfound.org/packhome.htm
Burroughs Wellcome	www.bwfund.org/index.html
Howard Hughes Medical Institute	www.hhmi.org
American Cancer Society	www.cancer.org/grants/index.html
Vanderbilt Medical Center	www.mc.vanderbilt.edu/vumc/biosci/fundag.htm
Tram Research Funding Opportunities	tram.rice.edu/TRAM/fund/index.html
The Foundation Center	www.fdncenter.org

end of his graduate work at the University of California, San Francisco when he started to investigate the various options for using his degree. His scouting produced a collaboration in neurobiology with Regeneron of Tarrytown, New York. After several months of work in California, Bowen volunteered to continue the work at Regeneron for three or four months. The success of the project resulted in him doing a two-year postdoc at the company with George Yancopoulos.

Bowen warns that a postdoc in industry can vary considerably from one company to the next, and even within a company. "Through good planning and good fortune," he ended up doing projects that gave him creative control as well as experience in research. He advises people looking at postdocs in industrial research to establish whether the position will allow them to make decisions or whether they will be executing someone else's plan.

The FASEB report says: "If faculty retire soon after they reach 65, a significant number of jobs in academia is predicted for the next 10 years." However, as retirement is no longer mandatory at 70, the University of California at Berkeley offered an early retirement incentive scheme more than five years ago. This resulted in 30% of the faculty in molecular and cell biology retiring early. "Fortunately, we've been able to recycle most of those positions," says Schekman. Some universities are implementing similar schemes, including Cornell, North Carolina, Pittsburgh and Southern California.

Reasons for maintaining, or even expanding, faculty numbers include the projected increase in college enrolment from 14.2 million in 1995 to 16 million in 2005, and increased interest in the life sciences. According to Schekman, there is a nationwide trend showing that more students are interested in medicine and biotechnology. At Berkeley, molecular and cell biology is the most popular undergraduate course, accounting for nearly ten per cent of students. □

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Favouring the brave

Potter Wickware

With US university science departments saturated and postdocs vigorously competing for the scanty number of faculty openings, does the discouraging proverb "Many are called but few are chosen" describe the lot of job-seekers in cell biology? "Not at all!", asserts Mina Bissell, director of the life sciences division at Lawrence Berkeley Laboratory in California and past president of the American Society for Cell Biology.

But many cell biology jobs are now in new areas: information management, computer science and engineering are becoming integral components of the discipline. High-resolution microscopy, for example, relies heavily on computational biology, a dynamic new subdiscipline rich with opportunity, yet the traditionally trained biologist may not have these skills.

Research problems are becoming so complex that collaborative projects are inevitable, Bissell observes. She believes that agencies such as the National Science Foundation, the space agency NASA and the Department of Energy should significantly complement the National Institutes of Health (NIH) by supporting interdisciplinary research. And universities' criteria for granting tenure must also change to reflect the newly collaborative nature of cell biology.

Are we training too many biologists? "We need all the talent we can get," Bissell emphasizes. She does not believe the gloomy prediction originating in the physics community that the end is nigh for growth in science ventures. "We have only scratched the surface. The Human Genome Project will be completed in 2005 and that will be just the beginning. Looking ahead we see magnificent problems that will keep us busy for decades."

But it must be acknowledged that certain opportunities are limited. The traditional route of academic tenure track at a research institution is a diminishing option. The path chosen by Michael Goldman is an example of the changing career landscape in cell biology. He works on X-chromosome inactivation and trains cell and molecular biologists at San Francisco State University. "When I left the ivory tower in 1988, one of my mentors said 'You're leaving the priesthood'. Not many people would put it that baldly," Goldman says, but it's undeniable that this mindset lingers on.

Goldman observes that in northern California, at least, the job market is strong. Masters and bachelors students are able to land technical jobs within four weeks as research assistants and scientists in the San Francisco Bay area's three main research universities, two large government labs or more than 500 biotechnology companies. The problem is not in placing students, but in ensuring that they complete their university courses, says Goldman. "We're not near the point of saturation in cell biology as a whole, although the academic faculty paid with hard money is at its limit." There are plenty of 'soft' money jobs, a trend that is likely to continue, particularly if the NIH fulfils its promise of increased funding in future.

Gerard Manning did research at Stanford and now develops genome analysis software at Molecular Applications Group, a bioinformatics company in Palo Alto, California. He agrees that the west coast job market is healthy: "There's lots of technician mobility. I've heard of good people getting multiple offers from the first few resumés. Personal contact always helps. In some fields there is an acute shortage — bioinformatics, people with gene-array chip experience." But he notes that cell biology is increasingly being defined by the ability to access, manipulate and interpret huge amounts of data.

How should cell biologists train in information management? It's easier said than done, says Joel Bellenson, who used his Stanford BA in biology and programming skills to co-found Pangea Systems, a bioinformatics company in Oakland, California. "Formalized training is hard because things are changing so fast." Nevertheless, the problems are fairly straightforward. "The DNA and protein patterns and the signalling pathways will always be there, as will the strategy of reasoning from observations derived from

Bissell: 'magnificent problems' ahead.

model organisms."

How should the individual contemplating a career in cell biology proceed? Concentrate on the present, Bissell advises. "Be flexible. If something comes up that you need to learn, learn it. But be excited about science, not about employment. If you're truly excited, the job will follow. Your degree can prepare you for all sorts of eventualities that it's impossible to foresee. Start by doing research as an undergraduate, to see if it's what you enjoy." Goldman concurs. "If all you want is a job, maybe a BA or MA is good enough. But don't get a PhD unless you are sure. Then carefully reflect on whether you like the principal investigator, whether you are inspired by the research."

Manning warns that, for up to 12 years, someone doing a PhD followed by postdocs will make up to $20,000 a year less than someone who takes a technical job straight after an undergraduate degree. As Bissell says, "The moment of discovery when you develop a gel, see the excitement in a pupil's eye — these are the reasons we do science. It has never been easy to do science well and have security and recognition from the start." □

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Not enough places to go in Europe

Owen Goldring

How should an undergraduate starting a degree in biological sciences find out about a research career in cell biology? Imagine a seminar, "Starting to put the cell biology timepiece together", at which the speakers explain their concept of cell biology, describe what training is best, and what salaries can be expected.

The main difference between cell biology and other areas of biology is that the cell biologist is not confined to particular cells, says Colin Hopkins, head of the Medical Research Council Unit of Molecular Cell Biology at University College London. Hopkins defines molecular cell biology as the study of how molecules combine to create macromolecular assemblies within cells, and how those assemblies — ribosome, nuclear pore, and so on — are kept working in concert.

Hopkins believes that the molecular mechanisms in all cells will turn out to be similar, and therefore would not be surprised to find a cell biologist working on T cells one day and on nerve cells the next. Or they might use their skills in research on gene-knockout functional analysis (reverse genetics) in yeast, nematode, *Drosophila* or transgenic mouse models, working out the fate map of a protein.

Apoptosis, a process at the other end of the spectrum in which the cell's machinery unravels in an ordered, programmed death, is discussed by Roberto Solari, head of cell biology at Glaxo Wellcome in Stevenage, southern England. Solari describes how adenoviral E1B protein inhibits apoptosis. Researchers in Solari's group, after doing yeast two-hybrid experiments, found that E1B bound to the human protein Bak. In this instance, Bak — an 'executor' of apoptosis — has been inhibited by this viral E1B product (see *Nature* **374,** 731–733; 1995).

Hans Geuze, of the department of cell biology in the medical faculty of Utrecht University in the Netherlands, has been localizing MHC class II molecules to various intracellular organelles during the cellular processes of antigen presentation. This research, soon to be reviewed in *Immunology Today*, is a classic example of how immunoelectron microscopy, biochemistry and molecular biology have all come together at the level of the cell. "Cell biology is an integrating discipline," says Geuze.

Staffan Normark, vice-dean of research at

Salaries and qualifications across Europe

To see what general advice on cell biology is available in Europe, access **http://www.ukplus.co.uk/dynamic/index.html,** which leads to the search engine UK Plus. Type in "cell biology", and select "in all of the Web". On its next page, UK Plus offers various countries. Type in "cell biology" again, with a country.

The Netherlands
Four-year degree, followed by four- to six-year PhD (salary 27,000 to 48,000Gld (US$13,170 to $23,420)). Grants are for four years. Postdoc salary is 49,000 to 59,000Gld over four years. Most Dutch PhDs do their postdocs in Holland. About 5% of postdocs get permanent academic positions. Geuze estimates that over the past 30 years more than 70% of the postdocs from his lab have gone into the pharmaceutical industry and the rest into teaching or scientific publishing.

France
Four-year degree, followed by the 'troisieme cycle' (PhD programme). The first year is a seminar- and project-based introductory programme with an examination, followed by a 'state fellowship' for the next three years (salary FFr72,000 (US$11,810) net of tax). Competition is intense. After this, most French postdocs go abroad because the government does not fund PhD graduates to do postdocs in France. Initially, fewer than 10% of returning postdocs will find permanent jobs in academic research (salaries start at about FFr120,000 net of tax). The government is talking about creating state-funded postdoc positions for returning postdocs. Louvard says that, without drastic action, many of the best students will opt for other professions.

Sweden
Three-year degree, followed by a master's programme (non-taxable stipend of Kr8,000 (US$985) a month) and a PhD, possibly funded via the supervisor's grant. The Karolinska Institute in Stockholm has 1,600 registered graduate students, of whom 500 are engaged in biomedical research. Sweden is creating 'graduate schools in biomedical research' for 450 students at various universities. Many Swedes do postdocs elsewhere in Europe on European Molecular Biology Laboratory (EMBO) fellowships or in the United States. Some private Swedish grant foundations give funds for two years abroad and then three at home. Swedish postdoc salaries are around Kr20,000 a month (taxable). There are few permanent jobs. Staffan Normark says: "The Karolinska plans to start its own postdoctoral programme."

Italy
Five-year degree; four-year PhD. Annual salary 18 million to 24 million Lira (US$10,020 to $13,370). Meldolesi, of DIBIT in Milan, has taken the unusual step of registering many of the institution's PhD students with the UK Open University. "Unfortunately, in Italy, there are PhD courses given by people who are not qualified to do so, and there's sometimes little quality control," he says. Italian postdocs are encouraged to go abroad via the EC or EMBO fellowships. In Italy, postdocs get about 30 million Lira a year. Returning postdocs face the familiar problem of few permanent jobs.

United Kingdom
Three- or four-year degree and three-year PhD (salary about £9,000 (US$14,690)). A few PhDs are funded for four years (salary £10,000–12,000). Such courses are competitive. The 'lead year' is spent rotating through various labs, or with a short spell in industry, followed by a three-year programme of research. Hopkins would like this four-year programme to become the norm. Postdocs are well-placed for short-term positions (salary about £18,000 for a new postdoc) because of charity funding, but not for permanent jobs in academic or government research institutions, which eventually pay £30,000–£40,000. Hopes that industry will help may not be realized because the major pharmaceutical companies are reducing their workforces following mergers. **O.G.**