



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 'troisième 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 FF72,000 (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 FF120,000 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.



King: favours early introduction.

the Karolinska Institute in Stockholm, is working on the use of microbes or microbial products to study cellular processes (see *Science* 271, 315–316; 1996). An example is how *Listeria* can move inside cells and polymerize actin. “The opportunities for cellular microbiology are enormous — it brings you to the heart of molecular pathogenesis,” says Normark.

Everyone concurs that the integration of molecular biology techniques into cognitive neurobiology is one exciting area, and that the integration of cell biology into a study of pathogenesis at the tissue level is another.

Daniel Louvard, director of the research division of the Institute Curie in Paris, produces an analogy that defines cell biology and captures the flavour of the excitement and opportunity: “Imagine you are a visitor from Mars and you come across a sixteenth-century timepiece, in bits. All those wheels and springs. You know what the concept of ‘time’ is, but you have all these wheels and things in front of you — it would take you a long time to put it together so it works.”

Jacopo Meldolesi is scientific director of DIBIT, the internationally acclaimed basic research branch of the San Raffaele Institute, which hosts the labs of various Milan University professors. He would not rule out a medical degree followed by specialization as a way in to cell biology. Solari, Geuze and Normark suggest starting with a good biological degree (covering molecular biology and genetics), and seek to encourage curiosity about the “culture of biology”.

Rod King, director of studies at the National Institute for Medical Research in London, agrees: “I think it’s important to introduce students to biology early on, and then they don’t get afraid of it, because I don’t think there’s any doubt that some chemists and physicists never cotton on to biology. They’re not attracted, or it remains a pile of nomenclature which is foreign. We have programmes here, for example, which are involved in using quite sophisticated chemistry to construct ‘caged’ molecules.”

Louvard goes further: “On top of molecular genetics, we need more graduates who understand quantitative biochemistry — we also need chemists and physicists to go into cell biology.” And Hopkins says: “If I were setting out on a career now, I’d want to have an understanding and a technology that was flexible enough to take me into nerve cells, or the immune system, or whatever. You need to be a card-carrying molecular biologist. You need to know how to manipulate DNA when you are an undergraduate.

“So, if you’re coming to university and you want to be a cell biologist, you should

make sure you have a sound education in biochemistry and a good education in molecular biology.” You will then need a PhD (see box) and, as King advises, “remember, you’re very much part of a team”.

As with other disciplines, the ‘postdoc run’ follows the PhD. Short-term postdoc contracts are reasonably easy to find (see box), but permanent jobs are another matter. European governments must give urgent thought to the creation of more permanent jobs for experienced postdocs. Molecular cell biology is the key to biomedical research



Louvard: captures the excitement.

in all the main health-care problems of the next millennium — including neurodegenerative disease, atherosclerosis and cancer. If the most talented of Europe’s young researchers are going to be attracted into, and kept in, academic science, governments need to plan for the future.

How much money will these governments have wasted in training people to the end of a second postdoc, only to see them dropping out of mainstream science because there is no career structure? □

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Opportunities open up in Dresden

Barbara Miller

Long after political reunification in 1990, Germany is still struggling to achieve economic and social uniformity. Scientific research in east Germany is developing frustratingly slowly, but will receive a welcome boost with the foundation in Dresden of a Max Planck institute for cell biology and genetics, due to open in mid-2000. The directors are Kai Simons, Anthony Hyman and Marino Zerial from the European Molecular Biology Laboratory (EMBL) in Heidelberg and Wieland Huttner of the University of Heidelberg.

One of the fundamental principles of the Max Planck Society, Germany’s main scientific research organization, is that its institutes are evenly distributed throughout the country. After reunification, institutes and departments were closed in the west to pay for 20 planned institutes in the east. But progress has not been straightforward. An institute needs a strong local scientific environment. Sadly, standards of research in east German universities are in general lower than in the west.

The fact that the new institute is in historic Dresden rather than in its rundown

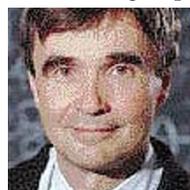
industrial neighbour Halle will help recruitment, according to Huttner. In Dresden there are relatively few research institutes, mainly concerned with physical sciences. But the small biology faculty at the local Technical University is expanding and will collaborate with the new institute.

East Germany does not have the western tradition of collaborative scientific research. “Combining molecular disciplines like cell biology and genetics in the east did not take place,” says Simons. “The most difficult problem will be to attract the best scientists.” West German scientists avoid the east because of this historical image. Jürgen Kirschner, director of the Max Planck institute for microstructure physics in Halle, says he has mainly recruited from other countries, particularly Asia. “The image problem will decrease with time,” says Kirschner, “but will last at least the next ten years.”

The Dresden institute will have a collaborative research programme aimed at elucidating the molecular mechanisms of tissue formation. The main individual projects will be on cell division, structure of cell organelles, membrane transport and cell polarity. The institute will also develop biochemical and microscope techniques in collaboration with the Technical University. Herwig Gutzeit, vice-dean of biology, says: “The university expects to get a large impetus to its own research from the collaboration.”

Dresden has always been an important bridge between east and west. “Unified Europe still needs this gateway,” says Simons, so the institute will train young scientists from eastern Europe using money from the European Union.

Simons plans to give young scientists a central role in the work of the institute: the relatively small directors’ research groups will interact with 19 scientifically independent junior groups. The concept of young scientists as group leaders is revolutionary in



Simons: not curbed by tradition.

Germany.

Simons has experienced the advantages of his proposed system while at EMBL, which, as a European rather than a German institution, is not constrained by national traditions.

“The young group leaders change because they are hired on fixed-term contracts [for a maximum of five years] and therefore the groups are always filled with innovative ideas and enthusiasm.” Recruitment of group leaders is due to start soon, and the institute will soon hold the first in a series of annual symposia. Further information can be obtained from: dresden@embl-heidelberg.de □

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