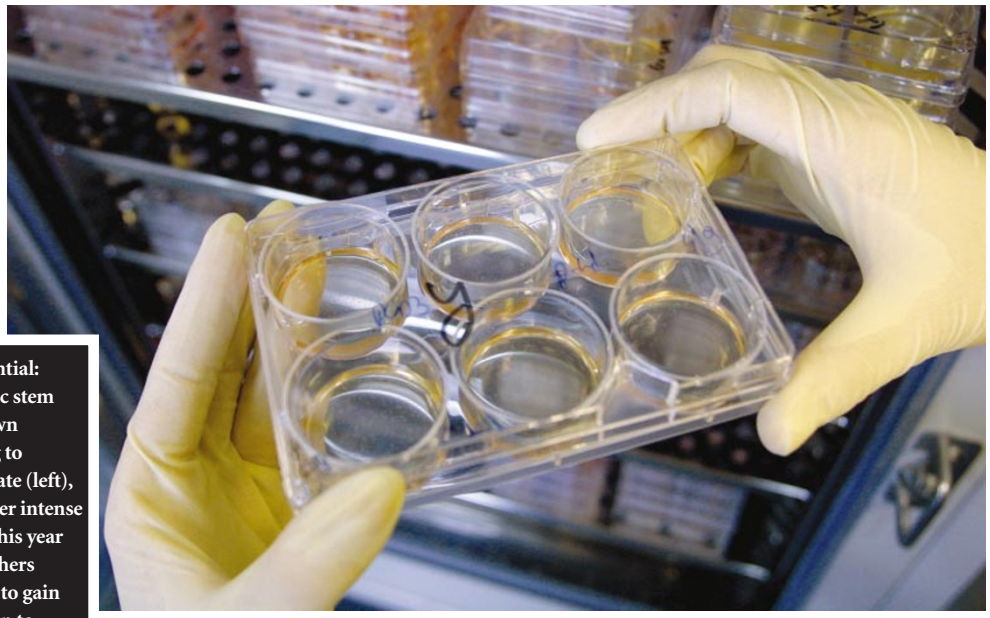

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Raw potential: embryonic stem cells, shown preparing to differentiate (left), came under intense scrutiny this year as researchers struggled to gain permission to investigate their therapeutic power.

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infrequently, he argues. So Nguyen and Lundgren may have been the unlucky victims of low-level anthrax contamination of the mail by the tainted letters.

Although anthrax and smallpox are worrying, a well-funded bioweapons programme could engineer pathogens to be even more deadly. In the long term, Block forecasts a "molecular arms race" between bioweapons developers and biodefence specialists.

To many experts, this prospect underlines the need for an effective mechanism to enforce the 1972 Biological Weapons Convention, the international agreement that is supposed to outlaw bioweapons production. But attempts to give the treaty teeth foundered this year, after the United States rejected the proposed monitoring scheme as ineffective and likely to compromise the commercial secrets of its biotechnology industry. Subsequent events have not changed the Bush administration's mind. ■

Jonathan Knight

Regenerative medicine

A world of difference

Location, location, location — for researchers exploring the therapeutic potential of human embryonic stem (ES) cells, the mantra of real-estate sales has acquired a fresh significance. ES cells hold the prospect of growing replacement tissues for those lost to disease, injury or ageing. But in this field, what you can do depends on where in the world your lab is based.

Among the major scientific nations, Britain emerged in 2001 as an enthusiastic supporter of ES-cell research, amending its law to allow ES cells to be isolated from human blastocysts — the hollow ball of cells that forms after some five days of embryological development — for research into regenerative medicine. Japan has also prepared guidelines that will give its researchers similar freedom. Sweden, Israel and Australia are also supportive of work on human ES cells.

But in several other countries, such work remains banned, or at least restricted. In France, for example, stem-cell researchers have been campaigning for more than two years to amend the law to allow research on human ES cells, and their isolation from blastocysts. This is not now expected to happen until early next year, and the revised law may not come into effect until 2003.

In Germany, meanwhile, hostility to the field in some quarters is so great that scientists wanting to import human ES cells have received death threats. Deriving human ES-cell lines is prohibited by Germany's strict embryo-protection law, but a loophole means that importing the cells has not yet been banned. Although the DFG, Germany's main research granting body, has approved funding for human ES-cell projects in principle, it is currently sitting on its hands, waiting for the parliamentary and public debate to reach a conclusion.

In the powerhouse of biomedical research — the United States — confusion reigns. In August, President George W. Bush announced that federal funds would be released for research on human ES cells. But there was an important caveat: the cell lines involved must have been derived before the date of his announcement.

Biologists don't know whether access to these lines will be sufficient to reap the potential of ES cells. Many of the 60 or so approved cell lines have not been fully characterized, and it could be that lines that have yet to be isolated will emerge as the preferred materials for researchers in the field.

More generally, proponents of regenerative medicine are unsure whether ES cells will remain the field's brightest stars. Alternatively, it might eventually become possible to coax the 'adult' stem cells that reside in many of our tissues to achieve similar results.

But the idea of 'therapeutic cloning' seems to be on the wane. By creating cloned human blastocysts, some experts have argued that it should be possible to derive ES cells perfectly matched to individual patients. But most now believe this will be too expensive and cumbersome for regular clinical use.

Advanced Cell Technology (ACT), a biotech company in Worcester, Massachusetts, begs to differ, and gained publicity in November by announcing that it had created cloned human embryos. It claimed to have passed a milestone on the road to therapeutic cloning. But in fact, the best ACT had achieved was a six-cell embryo — far from a blastocyst. If anything, the results confirmed just how difficult therapeutic cloning will be.

In any case, research into therapeutic cloning may be legislated into abeyance in many countries. The US Senate is poised to pass a bill that would ban all forms of human cloning, both reproductive and therapeutic. And the practice is already effectively prohibited by the Council of Europe's bioethics convention — to which many European countries have signed up — which bans the creation of embryos for research. ■

Peter Aldhous