secretion of recombinant proteins. Only then will generic 'super-secreting' strains become available for expressing a wide range of recombinant secretory proteins.

References

1 Hurtley, S. M. and Helenius, A. (1989) *Annu. Rev. Cell. Biol.* 5, 277–307
2 Klausner, R. D. and Sitia, R. (1990) *Cell* 62, 611–614
3 Romanos, M., Scorer, C. A and Clare, J. J. (1992) *Yeast* 8, 432–488
4 Freedman, R. B., Hirst, T. R. and Tuite, M. F. (1994) *Trends Biochem. Sci.* 19, 331–336
5 Knittler, M. R. and Haas, I. G. (1992) *EMBO J.* 11, 1573–1581
6 Mizunaga, T., Katakura, Y., Miura, T. and Maruyama, Y. (1990) *J. Biochem.* 108, 846–851
7 Quirk, A. V. *et al.* (1989) *Biotechnol. Appl. Biochem.* 11, 273–287
8 Schultz, L. D. *et al.* (1994) *Ann. NY Acad. Sci.* 721, 148–157
9 Robinson, A. S., Hines, V. and Wittrup, K. D. (1994) *Bio/Technology* 12, 381–385
10 Bibila, T. A. and Flickinger, M. C. (1992) *Biotechnol. Bioeng.* 39, 251–261
11 Bibila, T. A. and Flickinger, M. C. (1992) *Biotechnol. Bioeng.* 39, 262–272
12 Dorner, A., Krane, M. and Kaufman, R. (1988) *Mol. Cell. Biol.* 8, 4063–4070
13 Dorner, A., Wasley, L. and Kaufman, R. (1992) *EMBO J.* 11, 1563–1571
14 Shamu, C. E., Cox, J. S. and Walter, P. (1994) *Trends Cell Biol.* 4, 56–60
15 Dorner, A. J., Wasley, L. C., Raney, P., Haugejorden, S., Green, M. and Kaufman, R. J. (1990) *J. Biol. Chem.* 265, 22029–22034
16 Kohno, K., Normington, K., Sambrook, J., Gething, M-J. and Mori, K. (1993) *Mol. Cell. Biol.* 13, 877–890
17 Gallagher, P. J., Henneberry, J. M., Sambrook, J. F. and Gething, M-J. H. (1992) *J. Virol.* 66, 7136–7145
18 Helenius, A. (1994) *Mol. Biol. Cell* 5, 253–265
19 Rudolph, H. K. *et al.* (1989) *Cell* 58, 133–145
20 Chen, Y., Pioli, D. and Piper, P. W. (1994) *Bio/Technology* 12, 819–823

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Letter

The dogs that did not bark

Sometimes it is what an article does not say that may mislead readers as to the status of a scientific field. This is perhaps inevitable as authors of mini-reviews frequently have to restrict their selection of papers discussed to remain within the journal's specified limits. In a recent issue of *Trends in Biotechnology*, Montague and Morris[1] discuss a variety of applications of artificial neural networks (ANNs) in biotechnology, including a brief study from their own institution of the use of ANNs in the analysis of pyrolysis mass spectral (PyMS) data for microbial identification.

We think that *TIBTECH's* readers might also be interested to know that we have demonstrated that much greater power in the use of ANNs in analysing PyMS data may be obtained from exploiting them in effecting the quantitative (bio)chemical analysis of microbial (and indeed other) systems. Thus, we and our collaborators have shown that the combination of ANNs and PyMS may be used to quantify indole production in bacteria[2], biopolymers in binary[3,4] and tertiary mixtures[5], the production of recombinant proteins in whole cells of *Escherichia coli*[6], in mixed microbial cultures[5], and in the rapid and quantitative screening of cultures and fermenter broths for the overproduction of metabolites[7].

Inter alia, we have also been the first to apply PyMS and ANNs to the successful identification of the adulteration of extra-virgin olive oils[8,9], and in demonstrating that canine isolates of *Propionibacterium acnes* strains are the same as human wild-type strains[10,11]. Recent reviews of the general approach are available[12,13].

In another article in the same issue of *Trends in Biotechnology*, Konstantinov and co-workers[14] survey a number of approaches that have been taken for monitoring the biomass concentration of animal-cell cultures in real time, including the direct measurement of the electrical capacitance of animal-cell suspensions. They state, on the basis of an earlier study by the first author using a two-terminal device made available to him by the Kobe Steel Company (Kobe, Japan), that: 'practical applications of the method have not been very successful, chiefly due to the strong influence of the "resistance" component, which masks the capacitance', and that: 'as a result of the relatively low cell concentrations and high medium conductivity, it is unlikely that the capacitance method will find serious application in monitoring mammalian cell cultures'.

The influence of conductivity on dielectric measurements of this type is well known (and referred to as 'electrode polarization'), and is minimized by using a four-terminal configuration[15,16], as is in fact exploited in the other device that Konstantinov *et al.* cite in this context, the Aber Instruments (Aberystwyth, UK) Biomass Monitor. This (patented) approach and instrument[17,18] has been widely and successfully applied in media and in systems of substantial conductivity at laboratory and industrial scales, including bacterial and yeast cultures[17–22], bacterial biofilms[23], immobilized cells[24] and filamentous organisms in liquid and solid-substrate fermentations[25–28]. In particular, as existing instruments can accept conductivities up to 24 mS cm^{-1}, it has been very successfully exploited in both human blood[29], and in animal-cell cultures[30,31] in isotonic media.

The Biomass Monitor has a particularly high sensitivity for animal cells, as the dielectric increment (capacitance) per unit biomass scales linearly with the cell radius[32–34] and, interestingly, in the present context, we have also shown that multifrequency dielectric data can be analysed effectively using ANNs (Ref. 35). These and other facts would suggest to us not only that it is very likely indeed 'that the capacitance method will find serious application in monitoring mammalian cell cultures', but that it has, in fact, already done so.

References

1 Montague, G. and Morris, A. J. (1994) *Trends Biotechnol.* 12, 312–324
2 Goodacre, R. and Kell, D. B. (1993) *Anal. Chim. Acta* 279, 17–26
3 Goodacre, R., Edmonds, A. N. and Kell, D. B. (1993) *J. Anal. Appl. Pyrol.* 26, 93–114
4 Neal, M. J., Goodacre, R. and Kell, D. B. (1994) *Proc. World Congress Neural Networks*, San Diego, pp. I-318–I-323
5 Goodacre, R., Neal, M. J. and Kell, D. B. (1994) *Anal. Chem.* 66, 1070–1085
6 Goodacre, R., Karim, A., Kaderbhai, M. and Kell, D. B. (1994) *J. Biotechnol.* 34, 185–193
7 Goodacre, R., Trew, S., Wrigley-Jones, C., Neal, M. J., Porter, N. and Kell, D. B. *Biotechnol. Bioeng.* (in press)

8 Goodacre, R., Kell, D. B. and Bianchi, G. (1992) *Nature* 359, 594
9 Goodacre, R., Kell, D. B. and Bianchi, G. (1993) *J. Sci. Food Agric.* 63, 297–307
10 Goodacre, R., Neal, M. J., Kell, D. B., Greenham, L. W., Noble, W. C. and Harvey, R. G. (1993) *J. Appl. Bacteriol.* 76, 124–134
11 Goodacre, R., Howell, S. A., Noble, W. C. and Neal, M. J. *Zentralbl. Bakteriol.* (in press)
12 Goodacre, R. (1994) *Microbiol. Eur.* 2, 16–22
13 Goodacre, R., Neal, M. J. and Kell, D. B. *Zentralbl. Bakteriol.* (in press)
14 Konstantinov, K., Chuppa, S., Sajan, E., Tsai, Y., Yoon, S. and Golini, F. (1994) *Trends Biotechnol.* 12, 324–333
15 Kell, D. B. (1987) in: *Biosensors; Fundamentals and Applications* (Turner, A. P. F., Karube, I. and Wilson, G. S., eds), pp. 427–468, Oxford University Press
16 Kell, D. B. and Davey, C. L. (1990) in: *Biosensors: A Practical Approach* (Cass, A. E. G., ed.), pp. 125–154, IRL Press at Oxford University Press
17 Harris, C. M., Todd, R. W., Bungard, S. J., Lovitt, R. W., Morris, J. G. and Kell, D. B. (1987) *Enzyme Microb. Technol.* 9, 181–186
18 Kell, D. B., Markx, G. H., Davey, C. L. and Todd, R. W. (1990) *Trends Anal. Chem.* 9, 190–194
19 Boulton, C. A., Maryan P. S. and Loveridge, D. (1989) *Proc. 22nd European Brewing Convention*, Zürich, Switzerland, pp. 653–661, European Brewing Convention
20 Ferris, L. E., Davey, C. L. and Kell, D. B. (1990) *Eur. Biophys. J.* 18, 267–276
21 Markx, G. H., Davey, C. L. and Kell, D. B. (1991) *J. Gen. Microbiol.* 137, 735–743
22 Austin, G. D., Watson, R. W. J., D'Amore, T. (1994) *Biotechnol. Bioeng.* 43, 337–341
23 Markx, G. H. and Kell, D. B. (1990) *Biofouling* 2, 211–227
24 Salter, G. J., Kell, D. B., Ash, L. A., Adams, J. M., Brown, A. J. and James, R. (1990) *Enzyme Microb. Technol.* 12, 419–430
25 Davey, C. L., Peqaloza, W., Kell, D. B. and Hedger, J. N. (1991) *World J. Microbiol. Biotechnol.* 7, 248–259
26 Peqaloza, W., Davey, C. L., Hedger, J. N. and Kell, D. B. (1991) *World J. Microbiol. Biotechnol.* 7, 260–268
27 Peqaloza, W., Davey, C. L., Hedger, J. N. and Kell, D. B. (1992) *J. Sci. Food Agric.* 59, 227–235
28 Fehrenbach, R., Comberbach, M. and Pjtre, J. O. (1992) *J. Biotechnol.* 23, 303–314
29 Beving, H., Eriksson, L. E. G., Davey, C. L. and Kell, D. B. *Eur. Biophys. J.* (in press)
30 Cerckel, I., Garcia, A., Degouys, V., Dubois, D., Fabry, L. and Miller, A. O. A. (1993) *Cytotechnology* 13, 185–193
31 Degouys, V. *et al.* (1993) *Cytotechnology* 13, 195–202
32 Pethig, R. and Kell, D. B. (1987) *Phys. Med. Biol.* 32, 933–970
33 Davey, C. L., Davey, H. M. and Kell, D. B. (1992) *Bioelectrochem. Bioenerg.* 28, 319–340
34 Davey, C. L., Davey, H. M., Kell, D. B. and Todd, R. W. (1993) *Anal. Chim. Acta* 279, 155–161
35 Kell, D. B. and Davey, C. L. (1992) *Bioelectrochem. Bioenerg.* 28, 425–434

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biotopic

Biotechnology's issue of public credibility

The biotechnology industry continues to grow globally, with new products and new scientific achievements in its laboratories (and those of its affiliated scientists in academia) a regular occurrence. However, surveys of the general public in countries where the industry's products and services are to be produced or sold indicate that there is little trust in either the industry or in the governmental organizations responsible for regulating it.

This sweeping conclusion (which is subject to myriad qualifications inherent in reading public-opinion polls across national borders) can be drawn from the results of a poll[1] requested by the Commission of the European Union (EU) in its 12 member countries ('Eurobarometer 39.1'), and a series[2] of surveys in 10 other countries ('International Bioethics Survey'), predominantly in the Pacific Rim. In addition to India, Russia and Israel, the International Bioethics Survey included Australia, Hong Kong, Japan, New Zealand, The Philippines, Singapore and Thailand. The conclusion of these surveys was re-inforced by the findings of three North American surveys[3–5].

While the questions asked, and the responses received, on the topic of trustworthiness were not identical across the five sets of surveys, the message was surprisingly similar across national lines, with some notable exceptions.

European opinions

The question posed by the European Commission (EC) poll is shown in Box 1. In no EU country did more than 2% of those responding select 'Industry' as the one source in which they would have most confidence, and that percentage was only reached in Ireland, Spain and the UK. The other nine countries all showed percentages of 1% in that category. When asked about additional sources of information that they would trust, 'Industry' responses rose to an average of 6%.

As for confidence in 'Public Authorities' to tell people the truth about biotechnology, the percentages were relatively higher, with an average of 5% of individuals surveyed choosing this category as the most reliable source of information, and 17% including it among other sources that they would find credible. The greatest confidence in governmental authorities was found in Denmark (18% of respondents listed these as the most trusted source, and 45% considered them as another trusted source), and the least confidence was found in Italy (2% and 10%, respectively).

In whom did the Europeans surveyed have more trust on issues of biotechnology and genetic engineering, you ask? Environmental organizations (30% of individuals surveyed listed these as the most trusted source, while 61% would consider them as another trusted source), consumer organizations (26% and 55%, respectively), and schools/universities (16% and 39%, respectively) ranked first, second and third in order by significant margins in composite averages of the 12 countries (Ref. 1, Appendix 2, Table 4.2.2, p. 25).

Greater confidence in India, Israel and Thailand

The citizens of the primarily Pacific Rim countries surveyed using