temperature differences is easiest at around 35 °C, it will be easier for an organism functioning at that temperature to emit or detect signals that are encoded by such differences. 35 °C is the most economical value in terms of energy consumption for the maintenance of good discrimination between temperatures for signal detection purposes. Signals at these levels will also be relatively free from neural noise.

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SIR—I would like to challenge several of J. Paul's ideas in his proposal[1] that the body temperature of homoiotherms is close to 36°C because the specific heat of water is near a minimum at this temperature. First, not all homoiotherms have body temperatures near the 36°C of eutherian mammals. Monotremes average 31.7°C, while birds average 40°C (ref. 2). Furthermore, during aerobic exercise homoiotherms typically regulate their body temperature at 3–4°C higher than they do at rest[3].

Second, Paul states that by regulating at 36°C an animal minimizes the cost of changing temperature because the specific heat of water is minimal at 35°C. According to his graph, however, this claim is based on a very small quantitative effect; as a first approximation, an animal regulating at 28°C will expend only 0.02 per cent more energy to raise its temperature

1°C than will an animal regulating at 36°C (this assumes the animal can store all the heat).

Third, Paul ignores the significance of temperature differences between the body and its environment for the energy budget. These seem to represent a more important quantitative effect. Again as a first approximation, the cost of maintaining body temperature above ambient temperature is proportional to the difference between the two. The costs for changing temperature are probably much less important than the magnitude of the animal–environment temperature gradient for an animal's energy economy.

While I doubt the exact role that Paul has suggested for the specific heat of water in determining the body temperatures of homoiotherms, the significance of the physical properties of water should be remembered as a potentially important factor in the evolution of body temperature. Interested readers may consult Calloway[4], who has suggested that cells would function best at 40°C, Brock[5], Hamilton[6] and Heinrich[3] for further points related to this subject.

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Tunable noise

SIR—Nittmann and Stanley[1] have introduced the concept of tunable noise to the dielectric breakdown model (DBM) growth process of Niemeyer *et al.*[2]. Instead of adding to the growing structure at the first time a surface site is chosen, Nittman and Stanley introduce the additional condition that growth will only take place at a surface site after it has been chosen *s* times, where *s* = 1 corresponds to the classical DBM algorithm. They observed that in their modified DBM algorithm, simulations with the condition *s* >1 will grow thicker fingers as *s* increases and they call this phenomenon "tunable noise".

In the one-dimensional case, the DBM algorithm becomes identical to the Diffusion Limited Aggregation (DLA) algorithm of Witten and Sander[3] as the number of sites becomes large. Recently, we provided a connection between DLA simulations and the fingering phenomenon of two-fluid displacement in porous media[4,5]. In particular, we can identify the DLA algorithm with the displacement of a newtonian fluid by an inviscid fluid (in the

absence of surface tension effects) in a model porous medium which has a single chamber with fluid capacity ϕ at each grid node where one discretizes the solution of the Laplace equation. To characterize the random nature of porous medium, the fluid capacities of the chambers are taken as independently and identically distributed random variables. The classical DLA algorithm corresponds to the case in which the probability density function for the fluid capacities ϕ is exponential,

$$f(\phi) = (1/\langle\phi\rangle) \exp(-\phi/\langle\phi\rangle)$$

whereas other densities $f(\phi)$ will correspond to porous media having different random structures. The case of a delta function distribution of fluid capacities (ϕ = constant) is equivalent to a non-random medium in which fluid displacement is governed only by the solution of the Laplace equation — displacement in a perfectly uniform Hele-Shaw cell is a good realization of this limit.

Moreover, our unpublished data show that for a porous medium constrained to having a given mean fluid capacity $\langle\phi\rangle$, the exponential distribution is the most

random way in which the fluid capacity can be partitioned. In the language of Nittmann and Stanley, this exponential distribution (which corresponds to the classical DLA) has the highest possible noise level. The tunable noise condition of Nittmann and Stanley, parameterized by the value of *s* (>1), corresponds to the case of having *s* chambers at each node, where the fluid capacity of each of the *s* chambers is still exponential. This decoration can be viewed as each node having a different statistical distribution of fluid capacities. The resulting fluid capacity per node is

$$\Phi = \sum_{i=1}^{s} \phi_i$$

and this random variable is readily shown to have the gamma density

$$F(\Phi) = \left(\frac{s}{\langle\Phi\rangle}\right)^s \frac{\Phi^{s-1}}{(s-1)} \exp\left(-\frac{s\,\Phi}{\langle\Phi\rangle}\right)$$

with mean $\langle\Phi\rangle$. The case *s* = 1 reduces the exponential distribution as expected, whereas in the limit $s \to \infty$ the gamma distribution sharpens up towards the limit of a delta function. The concept of tunable noise in a DLA algorithm can be used to quantify porous media having different statistical properties.

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Estimating guild size

SIR—Not only do we agree with Perry's modification[1] of our model of estimating guild size[2] but we had already incorporated the suggested modification into our simulation model, as reported at the British Ecological Society symposium in April 1986. The text of our contribution is in press[3]. As Perry suggests, the modification in the mechanics of the model produce slightly larger guild sizes which fit the field data more closely.

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