vaccination rather than infection, donations will be discarded before a definite answer is at hand. Certificates of vaccination, safeguarded against falsification, would help, but only if donors make the effort to carry them.

What happens if vaccination is not completely protective against infection with HIV, as in the case of chimpanzees[4]? In this case even the introduction of certificates would not guarantee that a vaccinated donor was uninfected.

In our opinion the maintenance of an adequate blood supply will be jeopardized by large-scale vaccination against HIV. How are we to avoid this problem?

DIETMAR FUCHS
ARNO HAUSEN
GILBERT REIBNEGGER
DIETHER SCHOENITZER
ERNST R. WERNER
MANFRED P. DIERICH
HELMUT WACHTER

*Institute of Medical Chemistry and Biochemistry,*
*Blood Transfusion Centre, and Ludwig Boltzmann Institute of AIDS Research,*
*University of Innsbruck,*
*A-6020 Innsbruck, Austria*

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## Lead and children

SIR—In their article[1] "Lead and child development", Davis and Svendsgaard refer to evidence that postnatal mental development of children may be adversely affected at (umbilical cord) blood-lead levels as low as 6–7 μg dl$^{-1}$. The work to which they allude has now been published in full[2]. In the course of our research on placental element levels in relation to human fetal development[3] we have measured umbilical cord blood-lead levels for 100 obstetrically normal births in Barnsley in the United Kingdom. The range was 6–39 μg dl$^{-1}$, and the arithmetic mean 14 μg dl$^{-1}$. It therefore appears reasonable to infer that most if not all of these 'normal' neonates had been exposed *in utero* to levels of lead sufficient to be associated with some postnatal mental maldevelopment.

We scarcely need to labour the social and educational implications of this.

In general, we find that placental lead levels relate highly significantly to birthweight and other indices of prenatal development in a negative and dose-dependent manner, whereas lead levels in maternal and cord blood and maternal and neonate hair do not. We have, however, found that the levels of cadmium and zinc in placenta also correlate significantly with prenatal development, negatively and positively respectively[3]. So it may be that fetal exposure to these further two elements also needs to be considered in the aetiology of human postnatal maldevelopment, and that placenta is a better indicator tissue than blood.

D. BRYCE-SMITH

*Department of Chemistry,*
*University of Reading,*
*Whiteknights, PO Box 224,*
*Reading, Berkshire RG6 2AD, UK*

N.I. WARD

*Department of Chemistry,*
*University of Surrey,*
*Guildford GU2 5XH, UK*

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## Galactic chronology of thorium/neodymium

SIR — Butcher[1] has used his observations of thorium and neodymium lines in stars of different relative ages to determine the duration of nucleosynthesis over the lifetime of the Galaxy. He concludes that the age of the Galaxy is ≤ 9.6 Gyr for synthesis at a constant rate throughout the lifetime of the Galaxy. Here I compare Butcher's data with the galactic chronology I discussed in ref. 2. I conclude that my cosmochronological model based on $^{232}$Th, $^{235}$U and $^{238}$U as chronometers is in agreement with Butcher's observations when the ages of the stars in his observations are scaled to my galactic age equal to 10.0 ± 1.5(1$\sigma$) Gyr. My calculation is made using equation (1) (equation 38 in ref. 2).

This equation gives the ratio of abundance $N$ divided by relative production rate $P$ for any isotope $A$ to any standard $S$. The mean lifetimes are designated by $\tau_A$ and $\tau_S$ respectively. I have generalized equation (38) by replacing $\Delta$, the duration of nucleosynthesis before the Solar System formed, where necessary, with $t$, the duration for a star formed at time $t$ after the start of nucleosynthesis in the Galaxy taken as $t = 0$. The right hand side of equation (1) is based on a chronological model for nucleosynthesis in the Galaxy with an early spike, $S_E$, followed by uniform nucleosynthesis, $1-S_E$, as discussed by Meish and me[3] in connection with the rapid neutron capture process (r-process).

In ref. 2 the calculation of r-process production for the isotopes of U and Th were updated and used in combination with abundances at $t = \Delta$ inferred from meteorite data corrected to the origin of the Solar System 4.6±0.1(1$\sigma$) Gyr ago. Two ratios were available, $^{232}$Th/$^{238}$U and $^{235}$U/$^{238}$U, so two free parameters were determined, namely $S_E$ and $\Delta$. The values found were $S_E = 0.17 \pm 0.02(1\sigma)$ and $\Delta = 5.4 \pm 1.5(1\sigma)$ Gyr. Consequently the age of the Galaxy was given as $t_0 = 4.6 \pm 0.1 + 5.4 \pm 1.5 = 10.0 \pm 1.5(1\sigma)$ Gyr. This value agrees within the quoted errors with the value I obtained[4], $t_0 = 12.4 \pm 2(1\sigma)$ Gyr, using the nuclear cosmochronology I originally developed with Burbidge, Burbidge and Hoyle[5] and later perfected with Hoyle[6].

Butcher's observations involve radioactive $^{232}$Th ($\tau$ = 20.27 Gyr) and the seven stable isotopes of Nd ($A$ = 142–146, 148, 150). Butcher determined the relative abundances of Th and Nd in stars at the present time $t_0$, as a function of the time, $t$, of formation of the star. He designated this ratio as Th/Nd, in my notation equation (2).

If all of the isotopes of Nd had been produced in the r-process it would only be necessary to set $\tau_S = \infty$ in equations (1) and (2) taking Nd as the 'standard'. However Howard *et al.*[7] have analysed the production of the isotopes of Nd and have shown that the total element was produced 50 per cent in the r-process and 50 per cent in the s-process, the slow neutron capture process of ref. 5. In addition Sneden and Pilachowski[8] have reported observations on old metal-poor stars which can be interpreted by omitting an early spike in s-process nucleosynthesis. Only uniform synthesis over the lifetime of the Galaxy is necessary. Thus in applying equation (1) to Th and Nd the value for $S_E$ in the denominator is 0.17/2 = 0.085 and $(1-S_E)$ becomes 0.915. Equations (1) and (2) then yield equation (3).

In addition an overall normalization factor, $f$, is required in comparing Butcher's Th/Nd data with calculations using equations (1), (2) and (3) as $P$(Th)/(Nd) cannot be accurately calcuated. This comparison is shown in Fig. 1.

In Fig. 1 the ordinate shows the abundance ratios, Th/Nd, observed by Butcher[1] in 19 stars including the Sun with the uncertainties in the ratios quoted by him. The abscissa is the age, $t_0-t$ in my notation, of the 19 stars assigned by Butcher on the basis of values he was able to ascertain from recent literature. I have divided Butcher's age scale by a factor of 2 to agree with my value, $t_0$ = 10 Gyr, with one exception. The point for the Sun is plotted

$$\frac{N_A(t)/N_S(t)}{P_A/P_S} = \frac{S_E\exp(-t/\tau_A) + (1-S_E)(\tau_A/\Delta)[1-\exp(-t/\tau_A)]}{S_E\exp(-t/\tau_S) + (1-S_E)(\tau_S/\Delta)[1-\exp(-t/\tau_S)]} \quad (1)$$

$$N_A(t_0)/N_S(t_0) = \exp(t/\tau_A - t_0/\tau_A - t/\tau_S + t_0/\tau_S)N_A(t)/N_S(t) \quad (2)$$

$$\frac{\text{Th}}{\text{Nd}} = \frac{0.170 + 3.1156 \times [1-\exp(-t/20.27)]}{0.085 + 0.1694 \times t} \times f\exp[(t-10)/20.27] \quad (3)$$