



Nutrition and Reproduction : Physiological Mechanisms

David T Baird

Centre for Reproductive Biology, University of Edinburgh

The reproductive system is extremely sensitive to influences from the external environment (Martin, Rodger&Blanche2004). Most animals adjust their pattern of reproduction so that the chances of their offspring surviving are maximal. Reproduction involves much greater energy expenditure in the female than in the male. The nourishing of offspring during pregnancy and lactation and their subsequent rearing to adulthood are the biggest expenditure of energy that a female mammal will make in her lifetime. Hence the female reproductive system is much more sensitive to disruption than the male.

Because reproduction involves energy expenditure it is not surprising that the physiological control mechanisms are linked to those involved with appetite and nutrition (Wade&Jones2004). Food is used as a source of energy for a variety of essential and non-essential functions. In times of deprivation it is necessary to ration available oxidizable substrate in favour of those essential functions involved in staying alive e.g. keeping warm(Bronson 1989). Reproduction is expendable at least in the short term and can be deferred until times are more favourable.

Reproductive function, like appetite, is responsive to short term changes in metabolic food oxidation. For example approximately 1-5% of women suffer from "weight related amenorrhoea"(Laughlin, Dominguez &Yen1998). Because many girls with delayed puberty are relatively thin during adolescence it has been suggested that a certain critical body weight (47 kg) or body fat content is required for onset of cyclical ovarian activity (Frisch&McArthur1974). However, although ovarian activity and fat content are correlated they are not causally linked. It is relatively easy to dissociate fatness and reproductive function. Thus for example menstrual cycles return in some female athletes when energy expenditure is reduced such as after an injury long before there is any change in body weight or an increase in body fat (Loucks 2003).

The mechanisms involved in this adjustment of reproductive function involves the availability of calories. Experiments in rats and sheep point to an area in the hind brain(postrema PA) which detects glucose,insulin and probably leptin and transmits signals to the forebrain and hypothalamus to modulate the activity of GnRH neurones (Wade&Jones 2004). Recent observations in women with "hypothalamic amenorrhoea" have suggested that these experimental studies are relevant to clinical disorders. Women with anovulation associated with strenuous exercise or who are underweight, have low levels of leptin, LH and oestradiol(Welt et al 2004). The frequency of LH pulses is too low to sustain development of antral follicles to the point of ovulation. When leptin was injected to restore levels to normal, there was an intermediate increase in the frequency of LH pulses within 2 weeks, followed by growth of large ovarian follicles. Whether leptin acts directly on the hypothalamus or increases the availability of oxidizable metabolic substrates or both is unknown. It is likely that leptin plays a significant role in mediating this event although it should be noted that when nutritionally starved animals are re-fed the frequency of LH pulses increases long before there is an increase in circulating leptin.(Schneider 2004).