Developing animals tolerate anoxia and asphyxia better than adults, and fetuses are more resistant than newborns (Glass et al., 1944; Dawes et al., 1959; Duffy et al., 1975). The greater resistance of the immature cardiovascular system partly accounts for this decreased vulnerability, but the resistance of the developing nervous system seems to be the major determinant of anoxic morbidity and mortality. The greater susceptibility of the nervous system, compared to the heart, is emphasized by the fact that when newborn dogs or rats are exposed to an atmosphere of nitrogen, the heart continues to beat long after respiratory movements cease (Fazekas et al., 1941; Swann et al., 1954; Adolph, 1974), implying loss of central respiratory control prior to circulatory failure.

Several factors have been suggested to account for the enhanced tolerance of the immature brain to anoxic insults. The developing brain, presumably owing to its poor synaptic organization (Aghajanian & Bloom, 1967), has a lower metabolic requirement than that of the adult (Thurston & McDougal, 1969; Duffy et al., 1975); it may also contain larger endogenous energy stores (Mayman & Tijerina, 1971). Young animals are relatively poikilothermic and lower body temperatures during anoxia would be expected to further reduce overall energy demands. Differences in regional cerebral blood flow may also play some role.

The survival times of fetal rats at term and of postnatal rats during exposure to nitrogen at 37°C are depicted in figure 1. The fetuses, aged 12-18 hours prior to expected delivery, were obtained following decapitation of the dam and rapid hysterotomy. Comparing the duration of anoxia required to kill 85% of the animals, fetuses lived 50 times longer than young adult rats, 5 times longer than 7-day-olds, and twice as long as 1-day-old neonates.

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Since anoxia blocks oxidative energy production by the brain, animals with greater endogenous cerebral energy stores should be more resistant to oxygen lack. Compared in Table I are the concentrations in whole brain (rat) and cerebral cortex (dog) of the major energy precursors measured in animals of different ages. In rats, glycogen was highest in fetuses and declined with age, whereas phosphocreatine was lowest in fetuses and highest in adults. ATP levels were found to be similar in all age groups. Compared to rats, lower concentrations of ATP were observed in dog brain, but the values for ATP were similar in newborn and adult dogs. Despite some variations in concentrations of individual substrates, however, total preformed and potential energy reserves were similar in newborn and adult rats, and only slightly higher in fetuses. It seems likely that total energy stores in the newborn and adult dog cerebral cortex are also comparable, although we can’t conclude this with certainty because values for glycogen in the newborn dog are not available.