tion of ^{15}O-labeled carbon dioxide, which is converted to ^{15}O-labeled H_2O by carbonic anhydrase in the lung, using a steady-state model (Jones et al. 1976; Frackowiak et al. 1980). During inhalation of ^{15}O-labeled O_2 in a second run, the local brain activity as measured by PET mainly represents ^{15}O-labeled H_2O produced by aerobic metabolism in the tissue, which is also freely diffusible. Since the distribution of water between tissue and blood is known from the first run, the production rate of ^{15}O-labeled H_2O and hence the rCMRO may be calculated. Correction for the amount of unmetabolized oxygen bound to hemoglobin is possible by measurement of local cerebral blood volume using ^{11}C-labeled CO or ^{15}O-labeled CO as a hemoglobin marker (Lammertsma and Jones 1983). The relation between rCMRO and rCBF gives the regional oxygen extraction rate (rOER).

Studies in Normal Human Subjects

In normal volunteers, the average rate of cerebral glucose utilization is 29–32 μmol/100 g/min (Mazziotta et al. 1981; Heiss et al. 1984), as determined by means of ^{18}FDG and PET. Under control conditions (darkened laboratory and low noise background during examination), the anatomy of the brain is reflected in the metabolic activity of the transaxial cross sections. Individual metabolic rates can be estimated by direct comparison with the shades of gray or with the corresponding colors on the reference scale: The highest values are found in the visual cortex (45–50 μmol/100 g/min) and in the striatum (42–46 μmol/100 g/min). Values in other areas of the cortex, in the thalamus (35–42 μmol/100 g/min), and in the gray matter structures of the posterior fossa (25–30 μmol/100 g/min), are much lower. The lowest LCMRGl is found in white matter (15–22 μmol/100 g/min).

Studies of oxygen consumption and regional blood flow have also demonstrated comparable differences between gray and white matter: The mean value of CMRO was determined to be 5.9 ml/100 g/min for gray and 1.8 ml/100 g/min for white matter, while the mean rCBF values were 65.3 and 21.4 ml/100 g/min respectively (Frackowiak et al. 1980). The rOER was 0.48–0.49 for both tissues. Differences among various gray structures, as described for CMRGl, were not observed with the ^{15}O method, but this might be due to its low spatial resolution.

Age-related decreases of glucose metabolism and oxygen consumption observed in preliminary studies (Frackowiak et al. 1980; Kuhl et al. 1982c) were not confirmed in recent investigations on larger groups of volunteers: In 40 selected healthy men, neither the CMRGl of the whole hemispheres nor that of individual brain regions correlated with age (Rapoport et al. 1983). Similar results were reported by Metter et al. (1983) and Leon et al. (1983), but interregional correlations of older volunteers differed from those observed in younger men (Metter et al. 1983). The previously observed age-dependent changes in oxygen consumption were not confirmed in a recent study by Frackowiak et al. (1981).