using the PET method, scientists are identifying and measuring many of the processes by which the normal and abnormal brain works.

In a nuclear medicine imaging procedure, a radiotracer enters the subject's circulatory system either through an intravenous injection or by inhalation. PET, as does other nuclear medicine techniques, generates images of the spatial distribution of the radiotracer within an organ. But unlike most other nuclear medicine imaging methods, PET quantitates the distribution of the positron-emitting radiotracer. PET produces maps of the brain, for example, that depict the regional concentration of the radiotracer in units of nano curies per gram of tissue, not merely relative densities as a Gamma Camera or SPECT produce.

A radiopharmaceutical becomes a positron-emitting radiotracer by having one of its natural atoms replaced by a radionuclide. The most common of the radionuclides used in PET are ^{15}O, ^{13}N, ^{11}C and ^{18}F whose half-lives are 2.03, 10.3, 20.4 and 109.8 minutes, respectively (2). The short half-lives of these radionuclides offer a great advantage over those of typical radionuclides used in nuclear medicine for studying physiological function because even an initially very active tracer decays away quickly. This characteristic makes it possible to administer a high activity tracer, and then to measure the compound's distribution within the subject's brain tissue using a PET camera, while the counting rates are still high to obtain images of good statistical quality. The exposure to the subject is limited since the radioactivity of the tracer decays away rapidly. In other words, little radioactivity is retained in the tissue after the images have been measured.

In addition to having shorter half lives, the commonly used positron emitting radionuclide labels offer other advantages over the more commonly used isotopes in nuclear medicine. As has been noted, the radionuclides most commonly used as tracers are isotopes of oxygen, nitrogen, carbon and fluorine. Except for fluorine, these can be considered as the elements of life: atoms that are found in living tissue and most nutrients. Compounds including these atoms in their molecules can often participate in biochemical processes. Since living tissue can't distinguish between the normal atom and its isotope a chemist can synthesize a tracer in which the carbon, oxygen, nitrogen or a hydrogen atom is replaced by its positron-emitting isotope. Except for iodine, most radionuclides commonly used in nuclear medicine imaging don't actually participate in the usual metabolic pathways. Technitium and indium are not elements that are accepted by living systems.