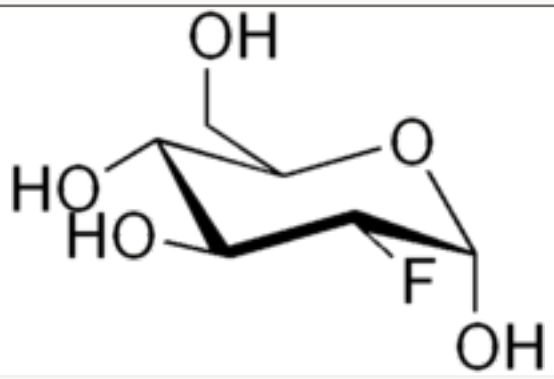
Fluorodeoxyglucose

From Wikipedia, the free encyclopedia

(Redirected from FDG)

Fluorodeoxyglucose is a glucose analog. Its full chemical name is **2-fluoro-2-deoxy-D-glucose**, commonly abbreviated to FDG.

FDG is most commonly used in the medical imaging modality positron emission tomography (PET): the fluorine in the FDG molecule is chosen to be the positron-emitting radioactive isotope fluorine-18, to produce ^{18}F-FDG. After FDG is injected into a patient, a PET scanner can form images of the distribution of FDG around the body. The images can be assessed by a nuclear medicine physician or radiologist to provide diagnoses of various medical conditions.

Fluorodeoxyglucose	
	
Chemical name	2-Deoxy-2-fluoro-D-glucose
Other names	2-Fluoro-2-deoxy-D-glucose FDG
Chemical formula	$C_6H_{11}FO_5$
Molecular mass	182.15 g/mol
CAS number	[29702-43-0] [63503-12-8] (^{18}F)
Density	? g/cm^3
Melting point	170-176 °C

SMILES	O[C@H](C(CO)O[C@H](O)[C@H]1F)[C@H]1O
Disclaimer and references	

Contents

Mechanism of action and metabolic fate

FDG, as a glucose analog, is taken up by high-glucose-using cells such as brain, kidney, and cancer cells, where phosphorylation prevents the glucose from being released intact. The 2-oxygen in glucose is needed for further glycolysis, so that (in common with 2-deoxy-D-glucose) FDG cannot be further metabolized in cells, and therefore the FDG-6-phosphate formed does not undergo glycolysis before radioactive decay. As a result, the distribution of ^{18}F-FDG is a good reflection of the distribution of glucose uptake and phosphorylation by cells in the body.

Before FDG decays, it is inhibited from metabolic degradation or use, because of the fluorine at the 2' position in the molecule. However, after FDG decays radioactively, its fluorine is converted to ^{18}O, and after picking up a H^+ from the environment, it becomes glucose-6-phosphate labeled with harmless nonradioactive "heavy oxygen" (oxygen-18) at the 2' position, and is thereafter metabolized normally in the same way as ordinary glucose.

Applications

In PET imaging, ^{18}F-FDG can be used for the assessment of glucose metabolism in the heart and the brain. It is also used for imaging tumours in oncology. ^{18}F-FDG is taken up by cells, phosphorylated by hexokinase (whose mitochondrial form is greatly elevated in rapidly-growing malignant tumours)[1], and retained by tissues with high metabolic activity, such as most types of malignant tumours. As a result FDG-PET can be used for diagnosis, staging, and monitoring treatment of cancers, particularly in Hodgkin's disease, non-Hodgkin's lymphoma, and lung cancer. It has also been approved for use in diagnosing Alzheimer's disease. Bro.

In body-scanning applications in searching for tumor or metastatic disease, a dose of FDG in solution (typically 5 to 10 millicuries or 200 to 400 MBq) is typically injected rapidly into a saline drip running into a vein, in a patient who has been fasting for at least 6 hours, and who has a suitably low blood sugar. (This is a problem for some diabetics; usually PET scanning centers will not administer the isotope to patients with blood glucose levels over about 180 mg/dL = 10 mmol/L, and such patients must be re-scheduled). The patient must then wait about an hour for the sugar to distribute and be taken up into organs which use glucose—a time during which physical activity must be kept to a minimum, in order to minimize uptake of the radioactive sugar in muscles (this causes unwanted artifacts when the organs of interest are inside the body). Then, the patient is placed in the PET scanner for a series of one or more scans which may take from 20 minutes to as long as an hour (often, only about quarter of the body length may be imaged at a time).

History

In the 1970s, Tatsuo Ido at the Brookhaven National Laboratory was the first to describe the synthesis of ^{18}F-FDG. The compound was first administered to two normal human volunteers by Abass Alavi in August, 1976 at the University of Pennsylvania. Brain images obtained with an ordinary (non-PET) nuclear scanner demonstrated the concentration of FDG in that organ (see history reference below).

Means of production and distribution

Because the high energy particle bombardment conditions in the medical cyclotron which is used to produce ^{18}F would destroy organic molecules like deoxyglucose or glucose, the radioactive ^{18}F must be made first as fluoride in the cyclotron. This may be accomplished by bombardment of neon-20 with deuterons, but usually is done by proton bombardment of ^{18}O-enriched water, causing a (p,n) reaction (neutron knockout, or spallation) in the ^{18}O to produce ^{18}F as labeled hydrofluoric acid, HF. The quickly-decaying $^{18}F^-$ (18-fluoride) is then collected and immediately attached to the deoxyglucose in an automated series of chemical reactions in a "hot room" (radioisotope chemistry preparation chamber). Following this, the labeled FDG compound (with half-life only 109.8 minutes set by the decay of the ^{18}F) is rapidly shipped to points of use by the fastest possible mode. This may include dedicated small commercial jet services, to extend the reach of PET scanning to centers hundreds of miles away from the cyclotron which produces the radioisotope-labeled compound.

References

- GE Health page on FDG.
- The Conception of FDG-PET Imaging. Abass Alavi and Martin Reivich.

1. ^ High Aerobic Glycolysis of Rat Hepatoma Cells in Culture: Role of Mitochondrial Hexokinase -- Bustamante and Pedersen 74 (9): 3735 -- Proceedings of the National Academy of Sciences. Retrieved on 2005 December 5.

External links

- Links to external chemical sources

Categories: Organofluorides | Monosaccharides | Radiopharmaceuticals | Neuroimaging