**Radiopharmaceutical Name**

- **2-deoxy-2-[^18]F-fluoro-D-glucose**
- Abbreviations: [^18]F-fluorodeoxyglucose, ^18F-FDG or FDG

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<th>Radiopharmaceutical Image</th>
<th>Normal Biodistribution Sample</th>
<th>Radiopharmaceutical Structure</th>
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**Radionuclide**

- ^18F
- Half-life 109.7 minutes
- Emission positron Emax 1.656 MeV

**Molecular Formula and Weight**

- C_{6}H_{11}^{18}FO_{5}
- 181.1 g atom mole^{-1}

**General Tracer Class**

- Diagnostic PET Radiopharmaceutical.

**Target**

- Cancer cells, infection, inflammation, viable myocardium, brain
- Of note: FDG PET/CT is commonly performed for cancer staging and follow-up, evaluation of myocardial viability or sarcoidosis and assessment of neurological conditions including epilepsy and dementia. FDG PET/CT can also be used to assess infection.

**Molecular Process Imaged**

- Increased glucose metabolism.

**Mechanism for in vivo retention**

- FDG is a glucose analog that is transported from the blood into cells by glucose transporters (predominantly GLUT1). Once in the cell, FDG is phosphorylated by hexokinase (mainly HK2) to form FDG-6-phosphate. Further metabolism of FDG-6-phosphate is limited and FDG-6-phosphate is essentially trapped in the cell. Although certain cells have phosphatases that dephosphorylate FDG-6-phosphate allowing washout (such as the liver), this is very limited over the imaging time period.

**Metabolism**

- FDG is phosphorylated in the cell to form FDG-6-phosphate, which is trapped within the cell. FDG is cleared via the kidneys and excreted in the urine.
**[18F]fluorodeoxyglucose, 18 F-FDG or FDG**

2-deoxy-2-[18F]-fluoro-D-glucose

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### Radiosynthesis

18F-labeled FDG was first synthesized by Wolf et al. using electrophilic fluorination at Brookhaven National Laboratory in 1976. The idea was to use 3,4,6-tri-O-acetyl-D-glucal as precursor with 18F-F2 to produce a 3:1 mixture of 18F labeled difluoro-glucose and difluoro-mannose derivatives that were then separated and hydrolysed with hydrochloric acid to form 2-fluoro-2-deoxyglucose with a yield of 8% and synthesis time of 2 hours (Ido T, Wan CN, Casella V, et al. "Labeled 2-deoxy-D-glucose analogs: 18F-labeled 2-deoxy-2-fluoro-D-glucose, 2-deoxy-2-fluoro-D-mannose and 14C-2-deoxy-2-fluoro-D-glucose". *J Labeled Compounds Radiopharm* 1978; **24**: 174–183.)

The major limitation of electrophilic fluorination was the low rate of radioactive fluorine incorporation into the precursor agents and production of 18F-F2 from a Neon gas target via a 20Ne(d,α)18F reaction. Considerable work has since been done to develop an improved method of radiosynthesis. In 1986, Hamacher *et al.* reported using Krytofix™ as a catalyst with a mannose triflate precursor and purification with a series of anion exchange column, C-18 reverse phase column and alumina column to produce 18F-FDG via nucleophilic fluorination with over 95% purity by a process resulting in yields over 50% and reaction time of approximately 50 minutes. (Hamacher K, Coenen HH, Stocklin G. “Efficient stereospecific synthesis of no-carrier-added 2-[18F]-fluoro-2-deoxy-D-glucose using aminopolyether supported nucleophilic substitution”. *J Nucl Med* 1986; **27**(2): 235-238.)


### Availability

18F-FDG has a half-life of under 2 hours, and must be rapidly shipped to its point of use. Many sites manufacture 18F-FDG using on-site cyclotrons and have developed shipping networks that supply the PET imaging centers in the United States, Canada, Europe and other countries.

### Status with USP / EuPh

USP and EuPh monographs have been prepared. USP compliance is described in: SOP 921.01 “Ensuring USP Compliance of 18F Fluorodeoxyglucose used in ACRIN studies” The implementation of cGMP for PET by FDA in June of 2012 has led the USP to no longer support monographs for PET radiopharmaceuticals and all FDG synthesis in the United States must be done under FDA through a New Drug Application (NDA), amended New Drug Application (ANDA), investigational new drug application (IND) or an institutional radioactive research drug application (RDRC). All use of FDG that is not clinical must fall under these same FDA rules but implementation for FDG has been delayed and researchers should contact the FDA to be aware of the state of enforcement of the regulations.

### Recommended Activity and Allowable mass


The dose for whole-body oncologic PET/CT is typically: 370-740 MBq (10-20 mCi) for adults and 3.7-5.2 MBq/kg (0.1-0.14 mCi/kg) for children.

For evaluation of neurologic FDG PET/CT please refer to the practice guidelines available through the Society of Nuclear Medicine and Molecular Imaging website: [http://interactive.snm.org/index.cfm?PageID=772](http://interactive.snm.org/index.cfm?PageID=772)

Additional guidelines are available at: [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2791475/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2791475/)

### Dosimetry

The radiation dose to the patient for 18F-FDG PET/CT is based on the combination of the radiation dose from the radiopharmaceutical and from the CT portion of the study. The effective dose from the administration of 18F-FDG for an oncologic PET/CT scan is estimated to be
**Pharmacology and Toxicology**

There is no definite toxic effect of $^{18}$F-FDG when used as described by the procedure guidelines given by the Society of Nuclear Medicine and Molecular Imaging.

**Current Clinical Trials**

The NIH clinical trials registry ([www.clinicaltrials.gov](http://www.clinicaltrials.gov)) should be consulted for a list of current trials using $^{18}$F-FDG. As of early 2013, it listed 772 active or completed clinical trials. Of these, 275 were recruiting subjects.

**Reference Site / Person**

The FDA describes the development of $^{18}$F-FDG PET on the following site:


The NCI reports on consensus recommendations for use of $^{18}$F-FDG PET:


**Imaging Protocol**

In general, patients are asked to fast for 4–6 hours prior to the administration of $^{18}$F-FDG. Normally, diabetic patients are asked to fast for 4 hours while non-diabetic patients are asked to fast for 6 hours. Oral hydration prior to and following the study is encouraged. Exercise should be avoided for 24 hours prior to the study. If intravenous contrast material is used, patients should be screened for a history of iodinated contrast material allergy, use of metformin for the treatment of diabetes mellitus and renal disease. Intravenous contrast material should not be administered if serum creatinine is above 2.0 mg/dL. An intraluminal gastrointestinal contrast agent may be used to provide improved imaging of the gastrointestinal tract unless medically contraindicated or unnecessary for the clinical indication. The blood glucose level should be checked before $^{18}$F-FDG administration. Most institutions reschedule the patient if the blood glucose level is greater than 150–200 mg/dL. For brain imaging, the patient should be in a quiet and dimly lit room from the time of radiopharmaceutical administration through the uptake time. For body imaging, a seated or recumbent position is suggested at the time of radiopharmaceutical administration and throughout the uptake phase. For details regarding image acquisition please refer to the Society of Nuclear Medicine and Molecular Imaging website: [http://interactive.snm.org/docs/jnm30551_online.pdf](http://interactive.snm.org/docs/jnm30551_online.pdf)

**Human Imaging Experience**

The first human administration of $^{18}$F-FDG occurred in 1976 in normal volunteers. Listed below are selected references on the use of $^{18}$F-FDG. Either MICAD or PubMed should be searched to find the most recent reports of human imaging studies.


Carr R, Barrington SF, Madan B, O’Doherty MJ, Saunders CAB, van der Walt J, Timothy AR. Detection of lymphoma in bone marrow by...
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