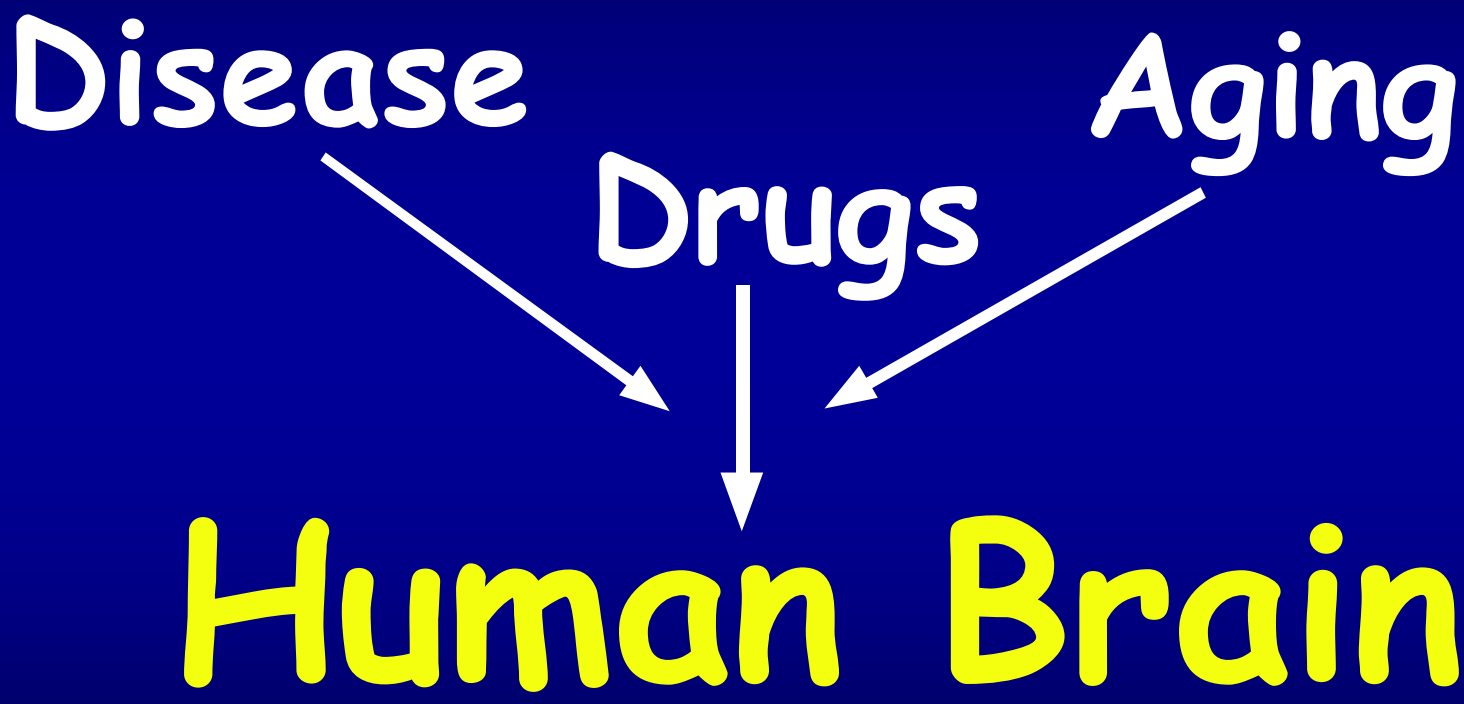

Disease
Drugs
Aging
Human Brain

# Positron Emission Tomography

PET visualizes a radioisotope in a volume element of tissue

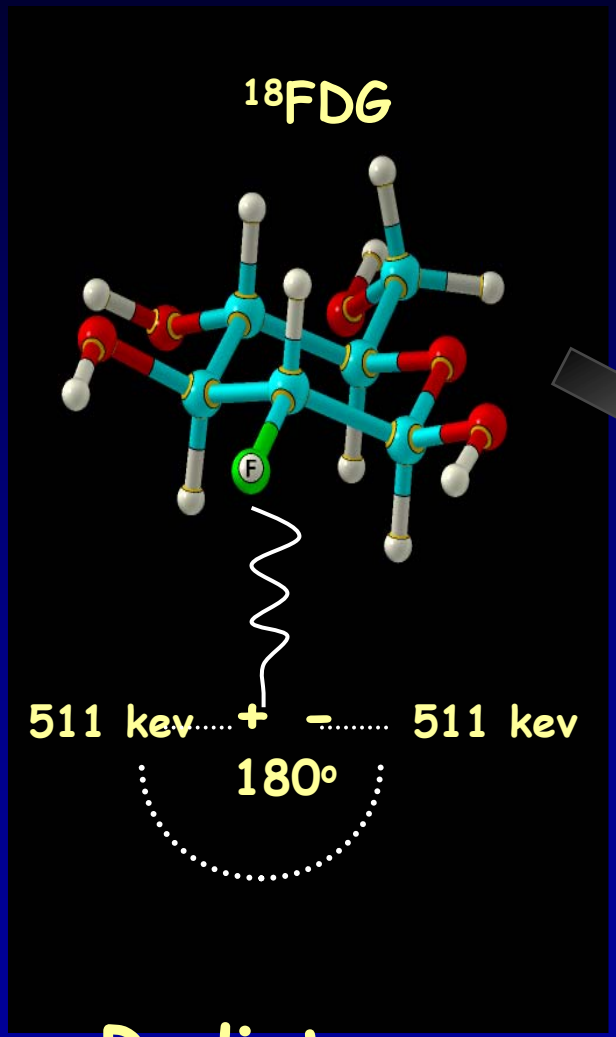
Biochemical transformations and the movement of drugs in the living body

# SHORT-LIVED POSITRON EMITTERS

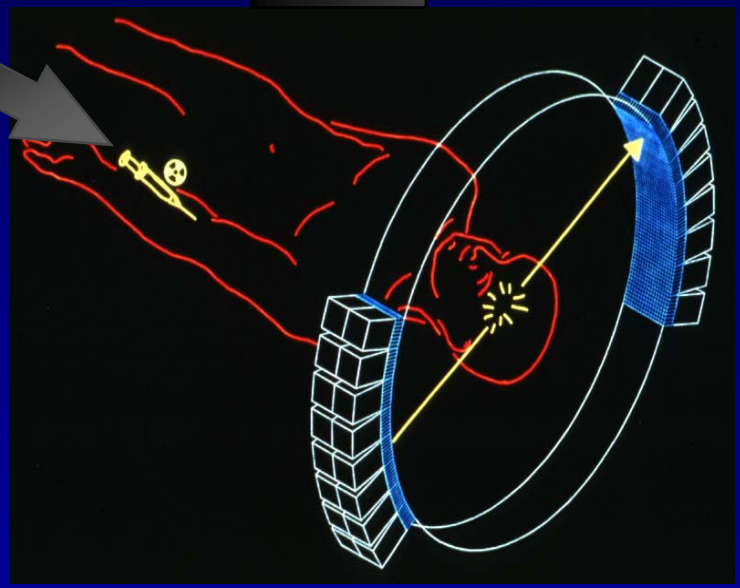
| Isotope | half-life |
|---|---|
| carbon-11 | 20.4 min |
| fluorine-18 | 110 min |
| nitrogen-13 | 10 min |
| oxygen-15 | 2 min |

*Isotopes of the elements of life*
*Cyclotron produced as needed*

# Positron Emission Tomography




Radiotracer



PET Scanner

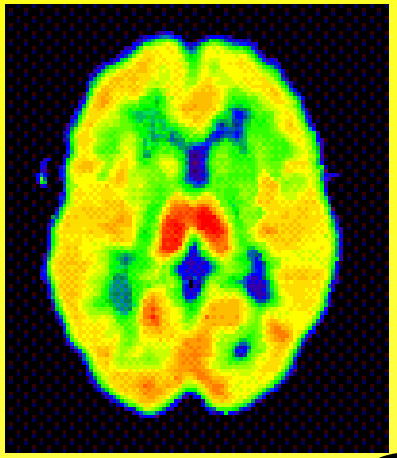

PET Image

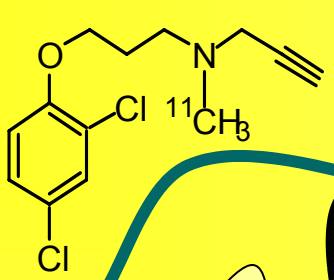
# PET Scanners

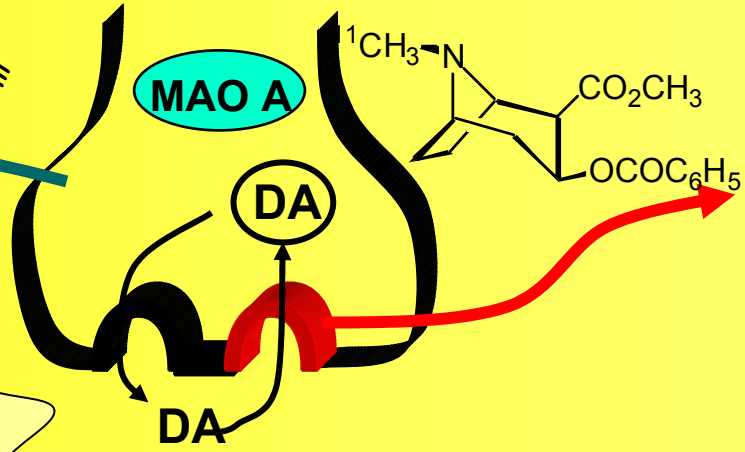


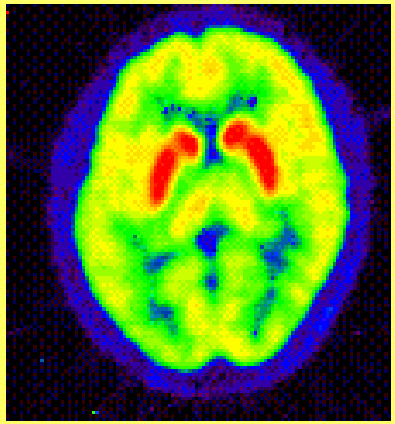
RATCAP-Rat Conscious Animal PET

# Molecular Imaging and Addiction





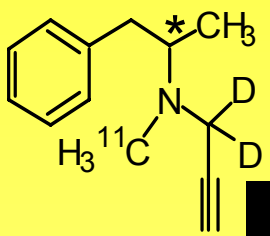



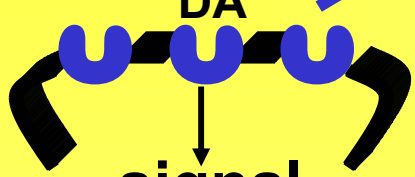
DA transporters

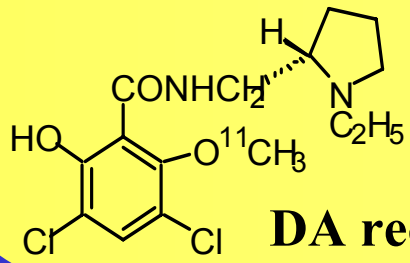
MAO B

MAO A

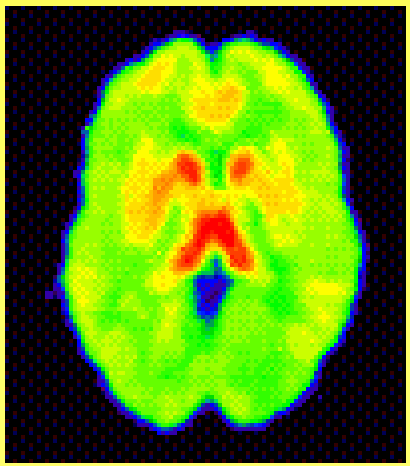
MAO B



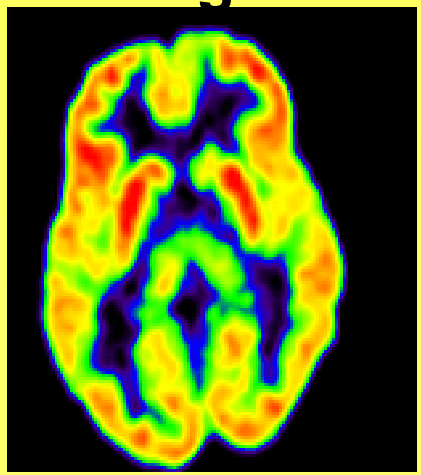



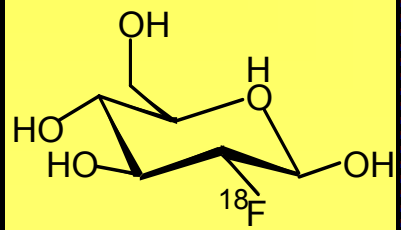



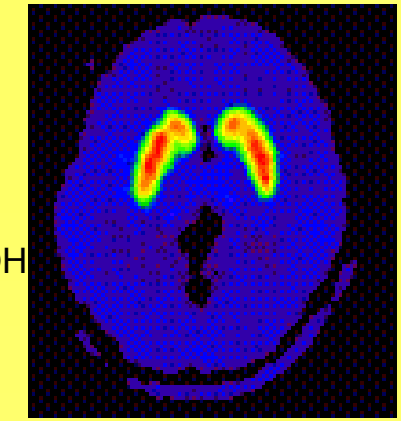

DA receptors



signal

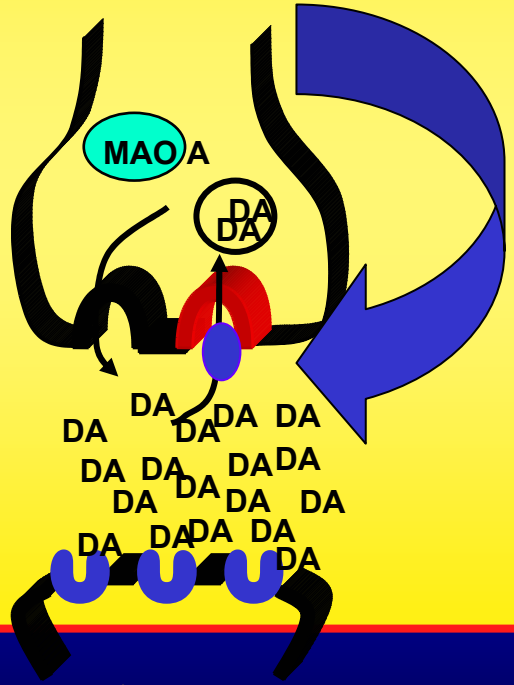


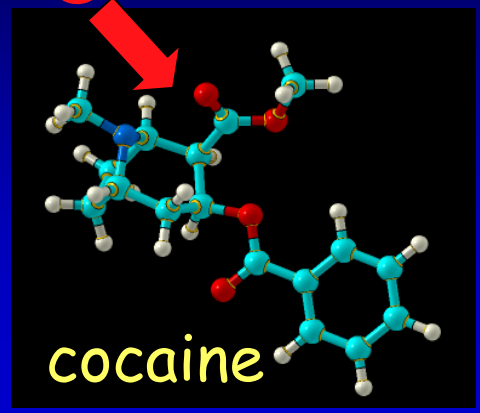


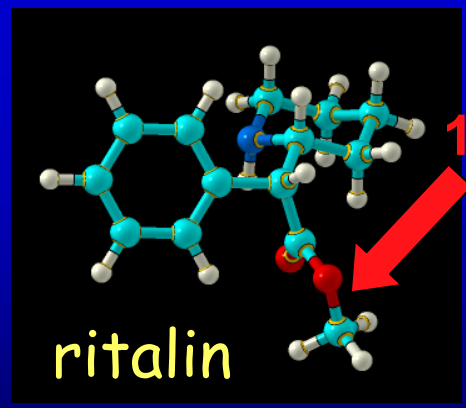



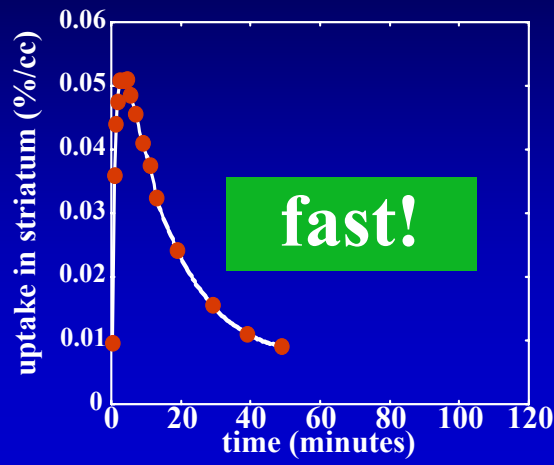
# Cocaine, Ritalin and ADHD Treatment

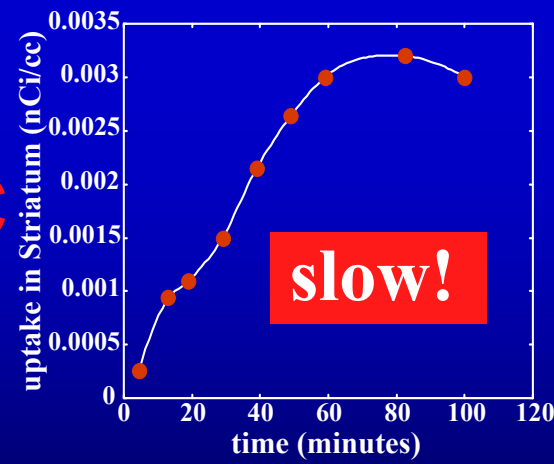
Cocaine and ritalin both bind to reward centers in the brain




The slow uptake of ritalin in the brain contrasts with the rapid uptake of cocaine and increases attention without a "high." (Volkow, Ding, BNL)

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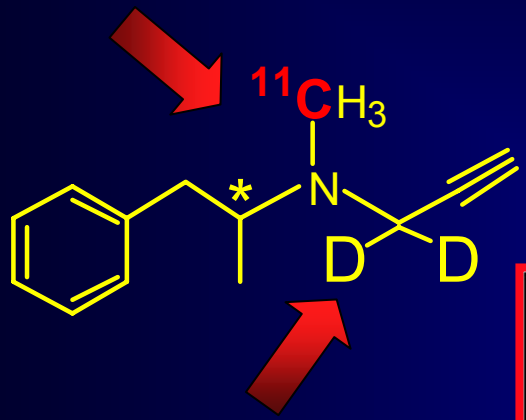
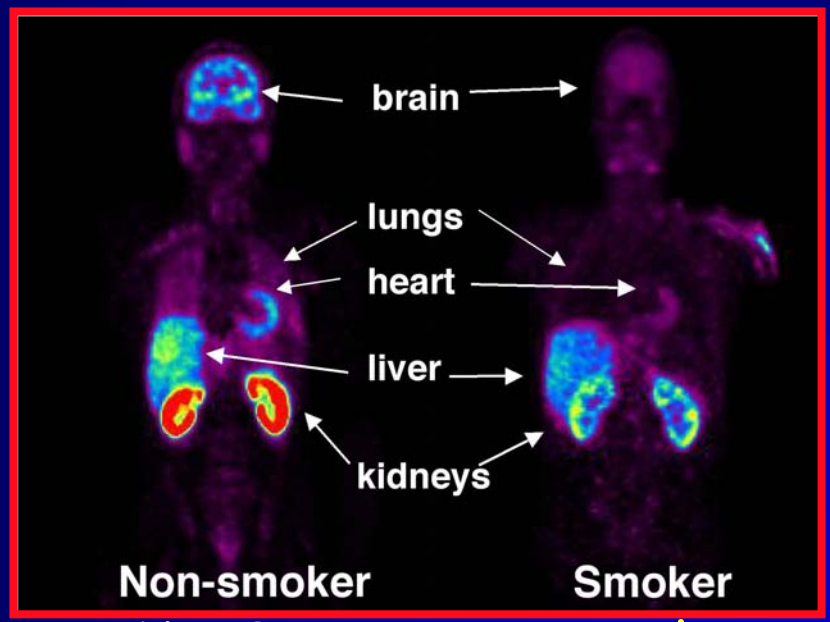
# Smoking and Monoamine Oxidase




Dual isotope labeling (C-11 and Deuterium) for quantitatve imaging of the enzyme monoamine oxidase (MAO) in the humans




Smoking reduces MAO, an enzyme that controls neurotransmitter concentration in the body. This may contribute to smoking behavior and epidemiology.

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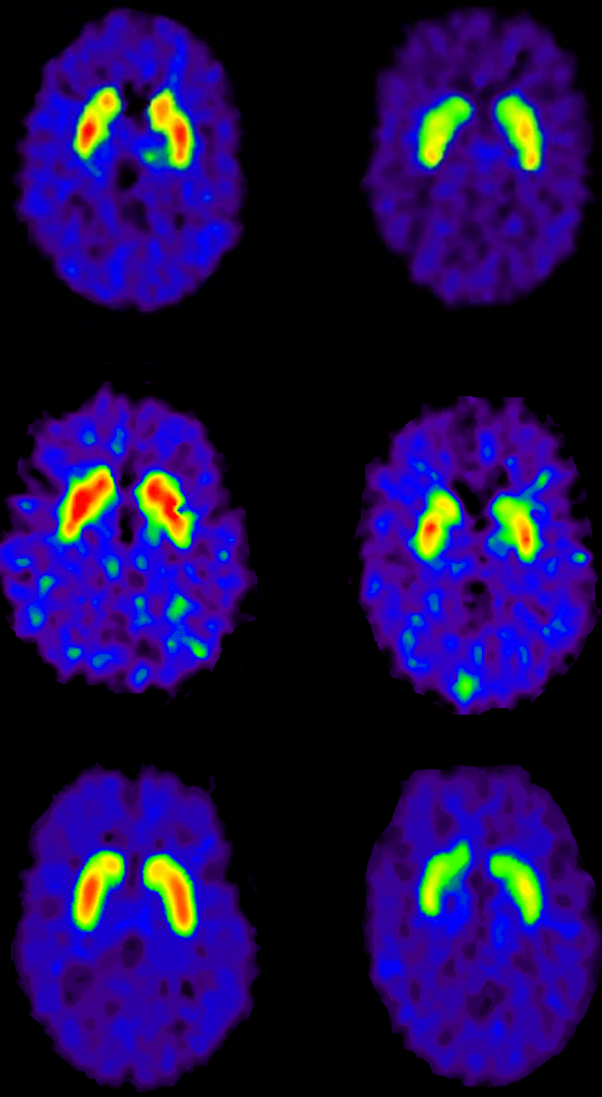
# Dopamine D2 Receptors are Lower in Addiction

Cocaine

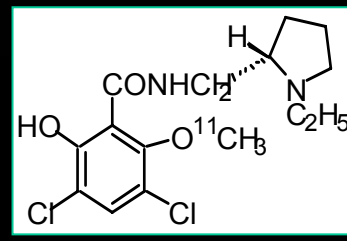
Alcohol

Heroin



control addicted

DA D2 Receptor Availability

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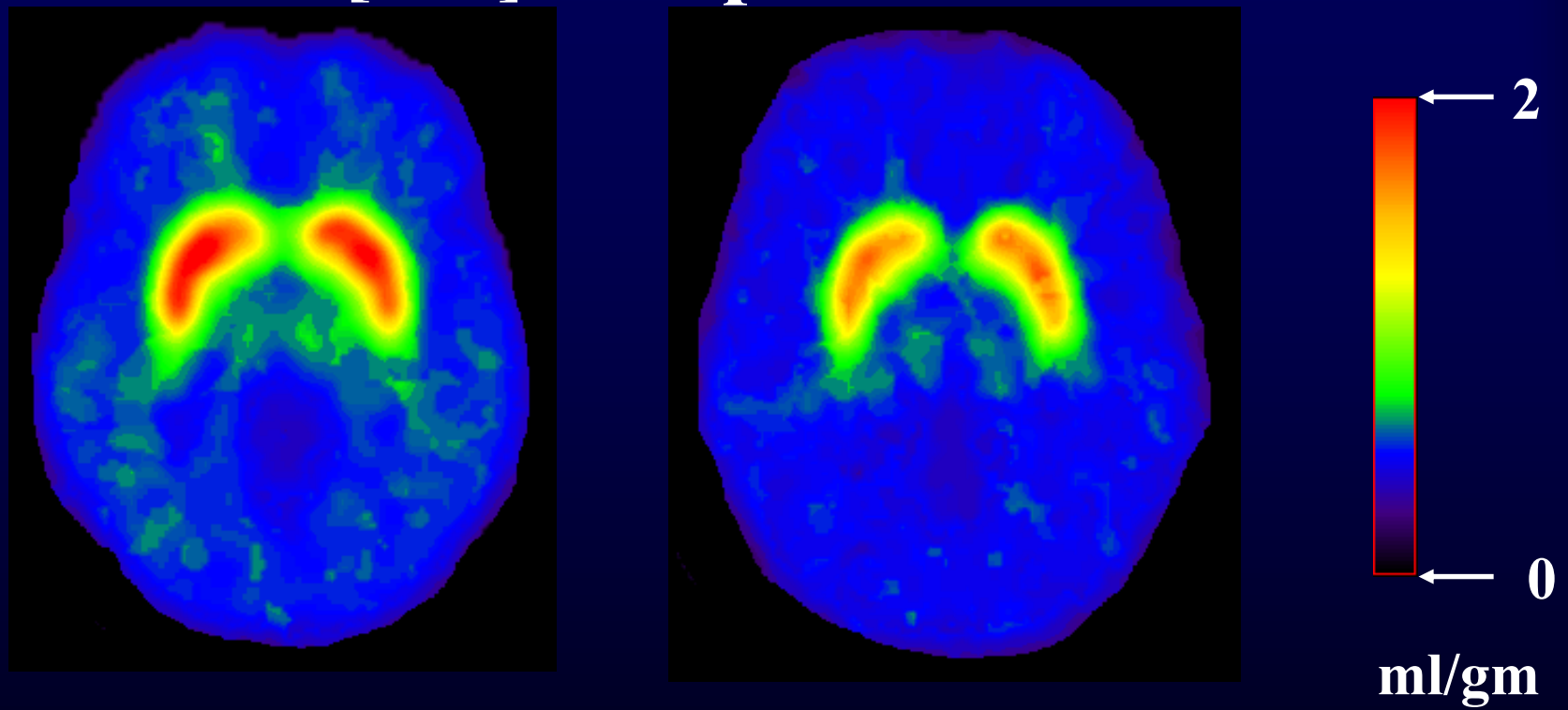
# Dopamine Receptors

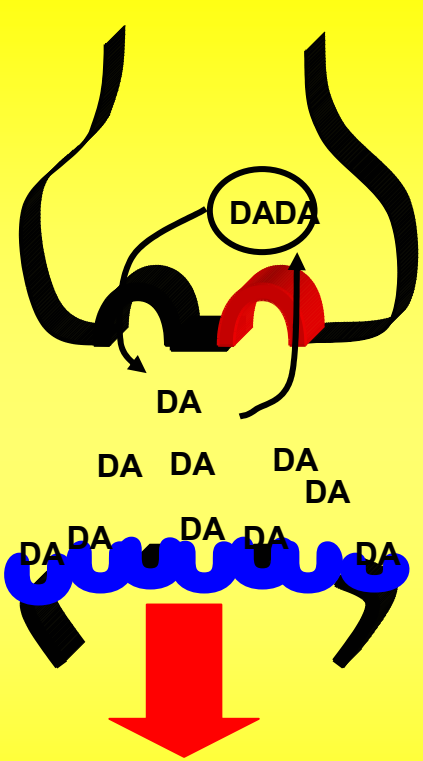
## [$^{11}$C]raclopride




**Control Subjects** **Obese Subjects**

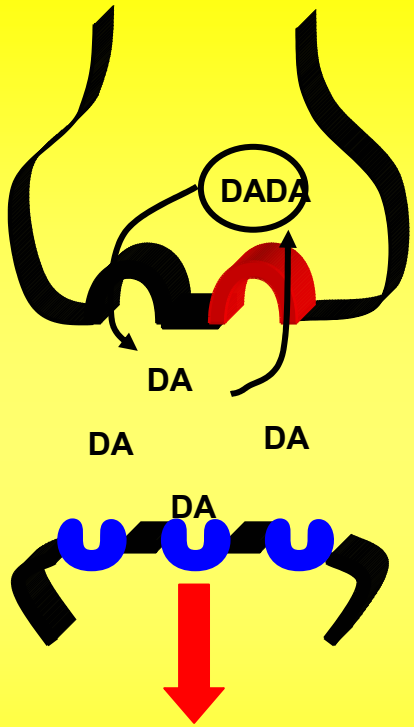
Wang et al., Lancet 2001; 357: 354-357.

# Low Reward Stimulation




Reward Circuits

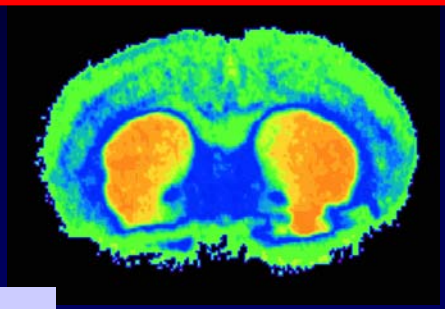
*Control*

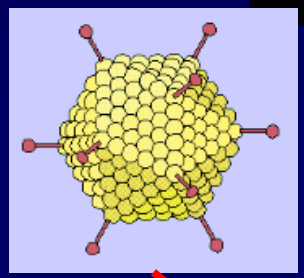



Reward Circuits

*Addicted Person*

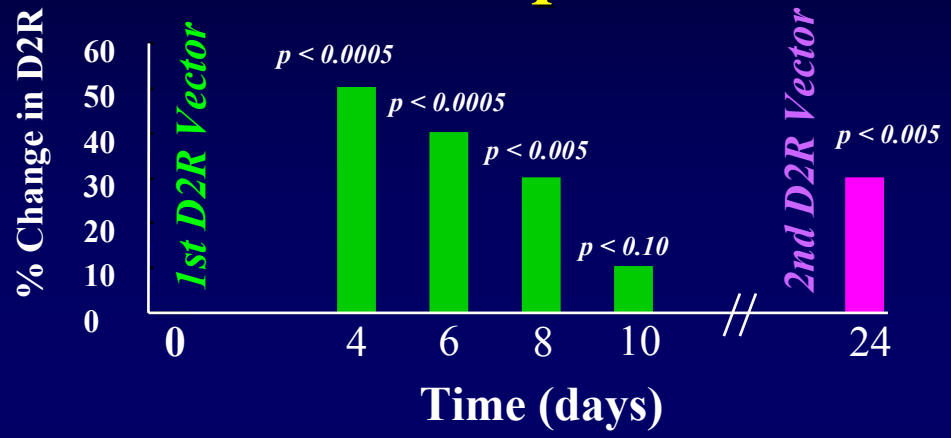
# Can increases in dopamine receptors change addictive behavior?



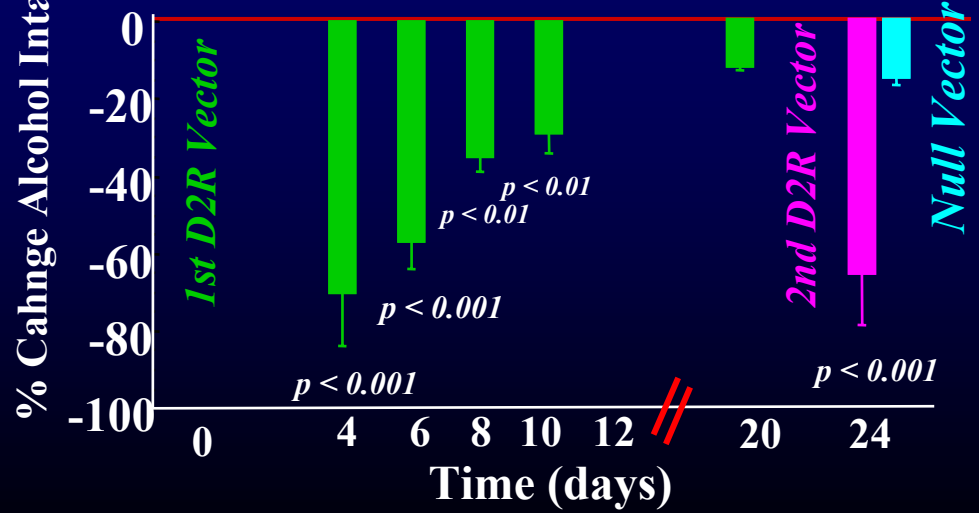


Thanos et al., 2001

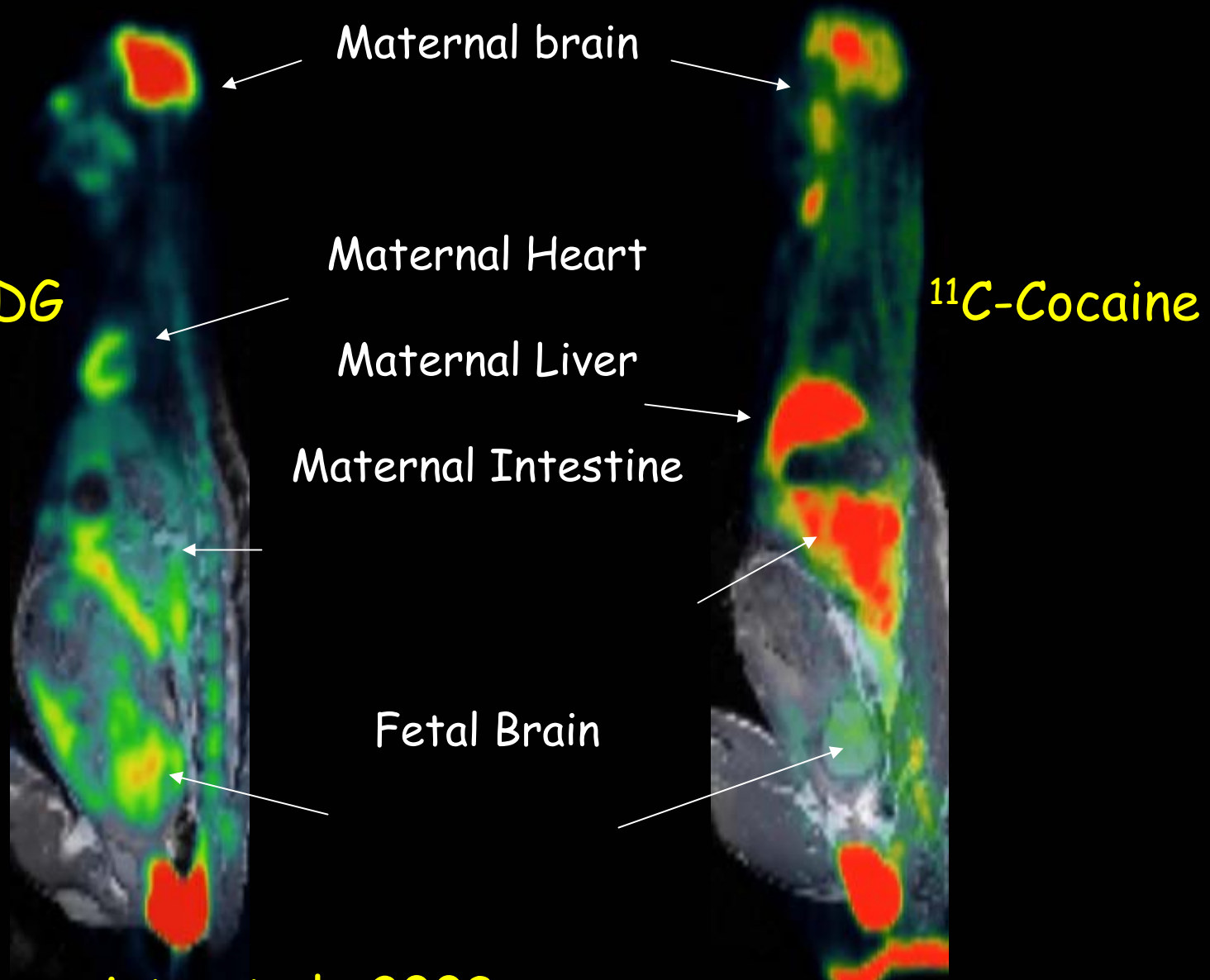
## D2 Receptors




## Alcohol Intake

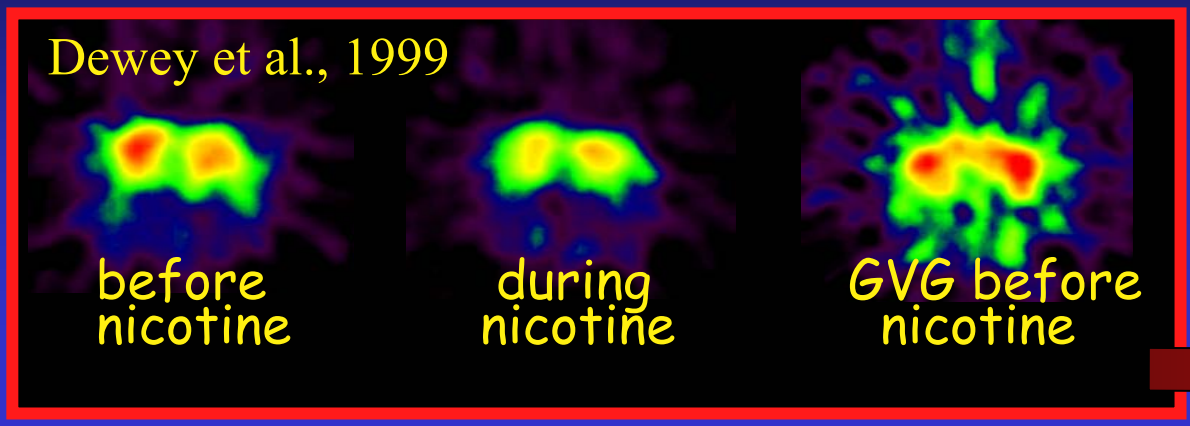


# Maternal-Fetal Transfer of Drugs



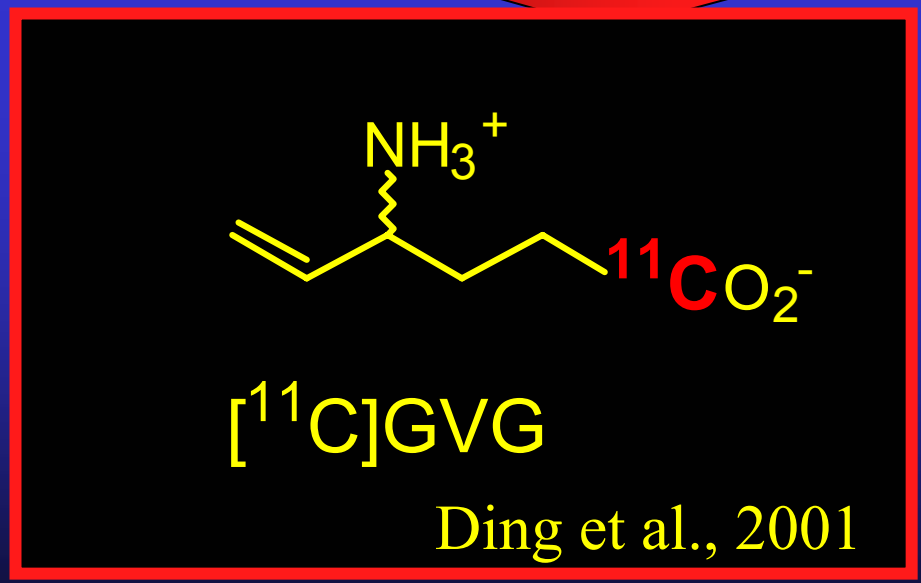

Benveniste et al., 2003

# Radiotracer Technology Driven by Medical Needs
## Addiction Treatment




The epilepsy drug Gamma Vinyl GABA (GVG) abolishes the effects of nicotine.

A new synthesis of GVG was developed and applied to the synthesis of [$^{11}$C]GVG for PET imaging of GVG distribution in the human body to speed approval of GVG for addiction treatment.

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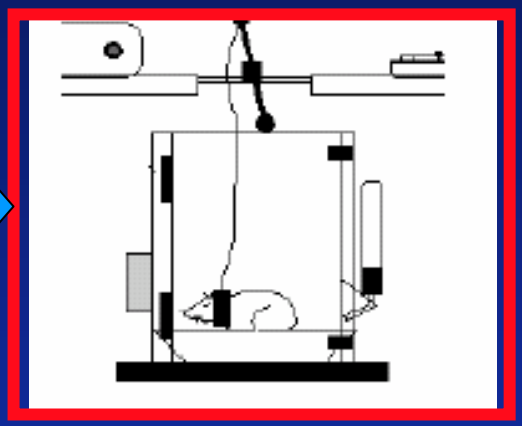
# RATCAP – RAT Conscious Animal PET
# Small Animal Imaging Without Anesthesia

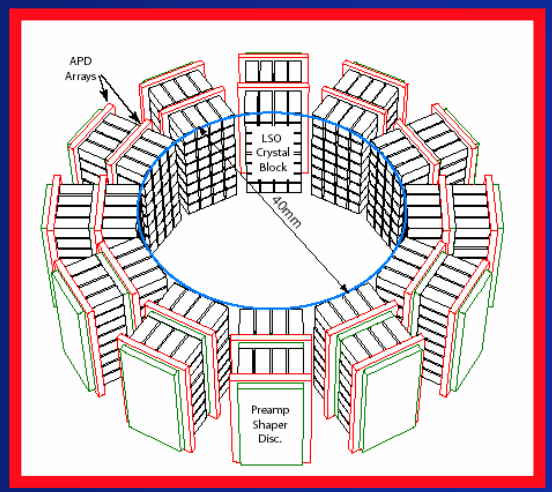
A head mounted PET imager for an awake rat

**A septa-less, full-ring tomograph with a diameter of 4 cm and an axial extent of 2 cm, suspended by a tether in a Ratturn bowl to allow nearly free movement of the awake animal**



**Ring containing 12 block detectors**
**Up to two layers of 5 mm deep crystals with APDs and integrated readout electronics**

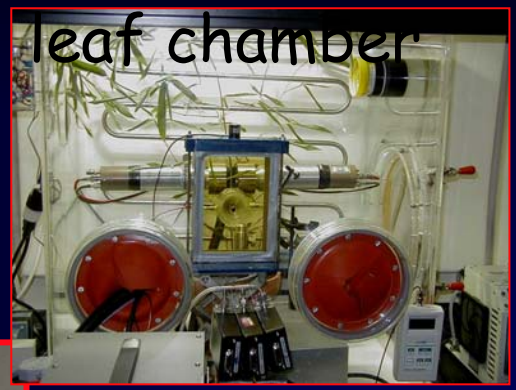

**2x2 mm² LSO crystals read out with APD arrays**



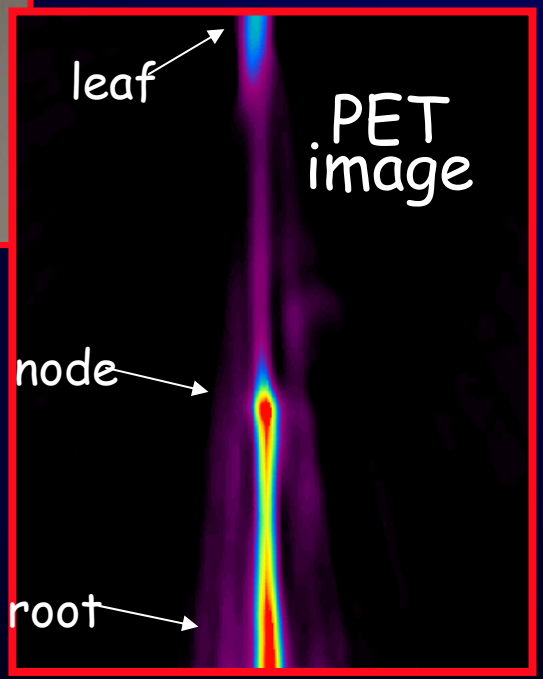

**Mockup of the portable ring on the head of a rat**

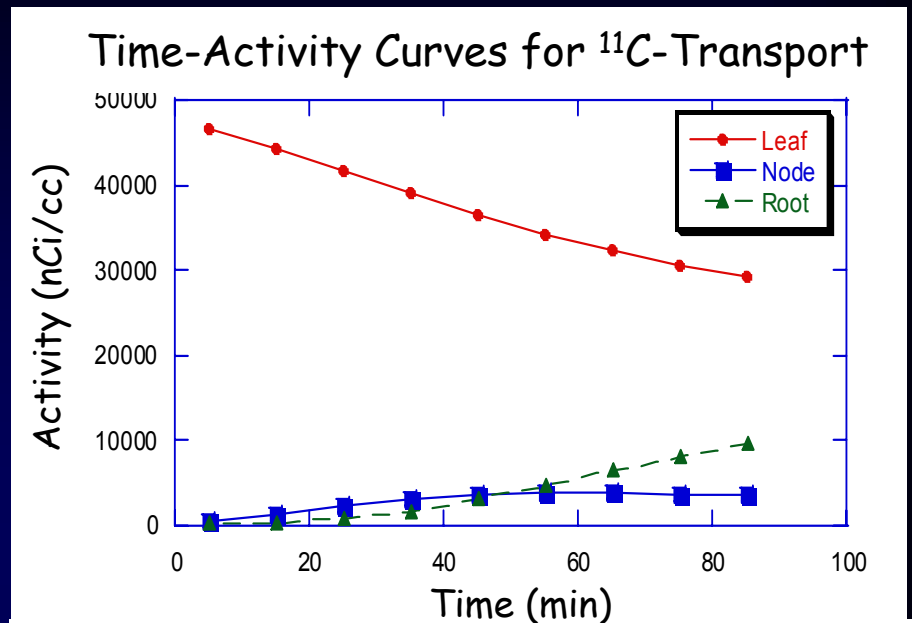
Schlyer et al., BNL

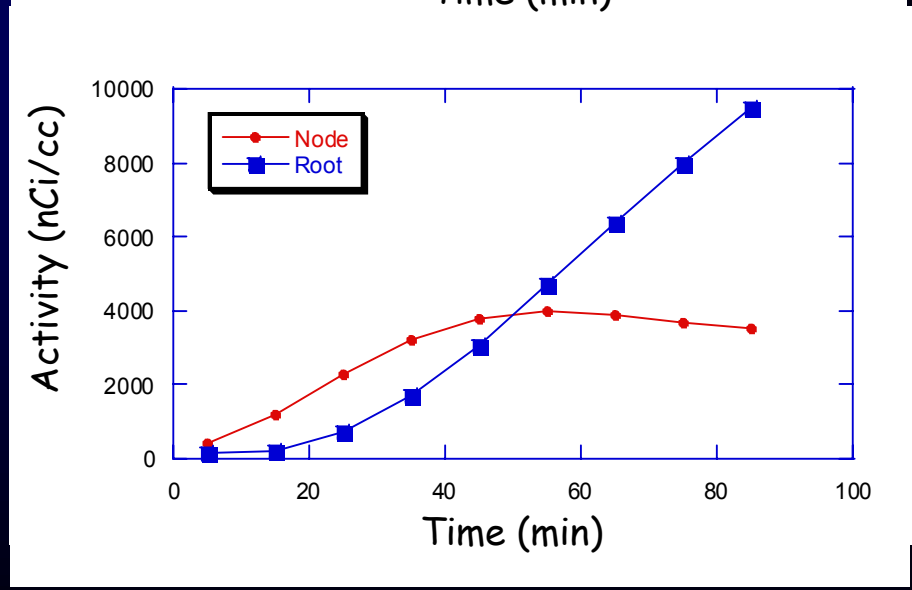
# PET and Plant Science







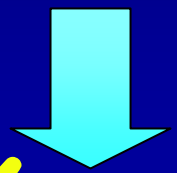




Ferrieri et al., BNL

# Summary

Advances in PET Science



New Knowledge

New Treatments

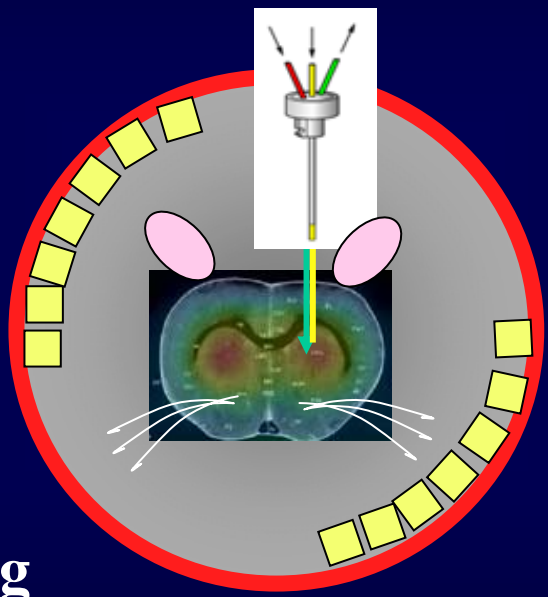
# Brookhaven PET Group

Y-S Ding, GJ Wang, C Shea, ,J Fowler, K Apelskog, V Garza, M Gerasimov, Y Xu, N Volkow, W Schiffer, S Dewey, D Marsteller, D Alexoff, R Ferrieri, P Vaska, M Jayne, P King, C Wong, P. Carter, P Thanos, Z li, J Gatley, A Gifford, N Pappas, J Logan, F.Telang, D Warner

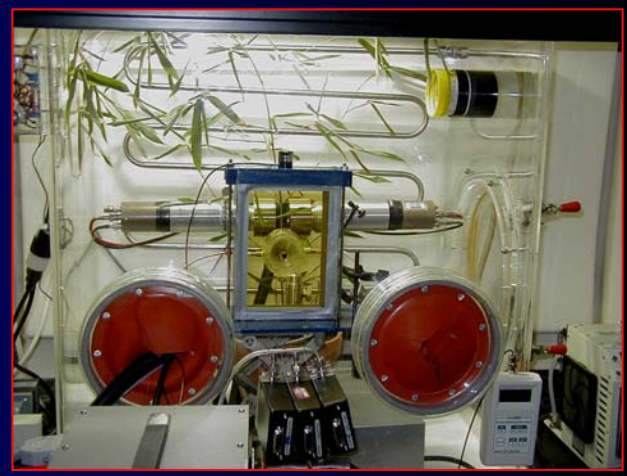
Funding from BNL (LDRD), DOE-OBER, NIH, ONDCP

# New Research/Technology

Awake Animal Imaging

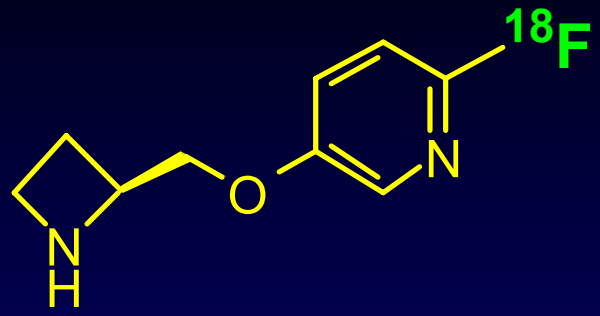


Microdialysis/MicroPET



Plant Science

# Distribution of 6-[$^{18}$F]A85380 in Human Brain

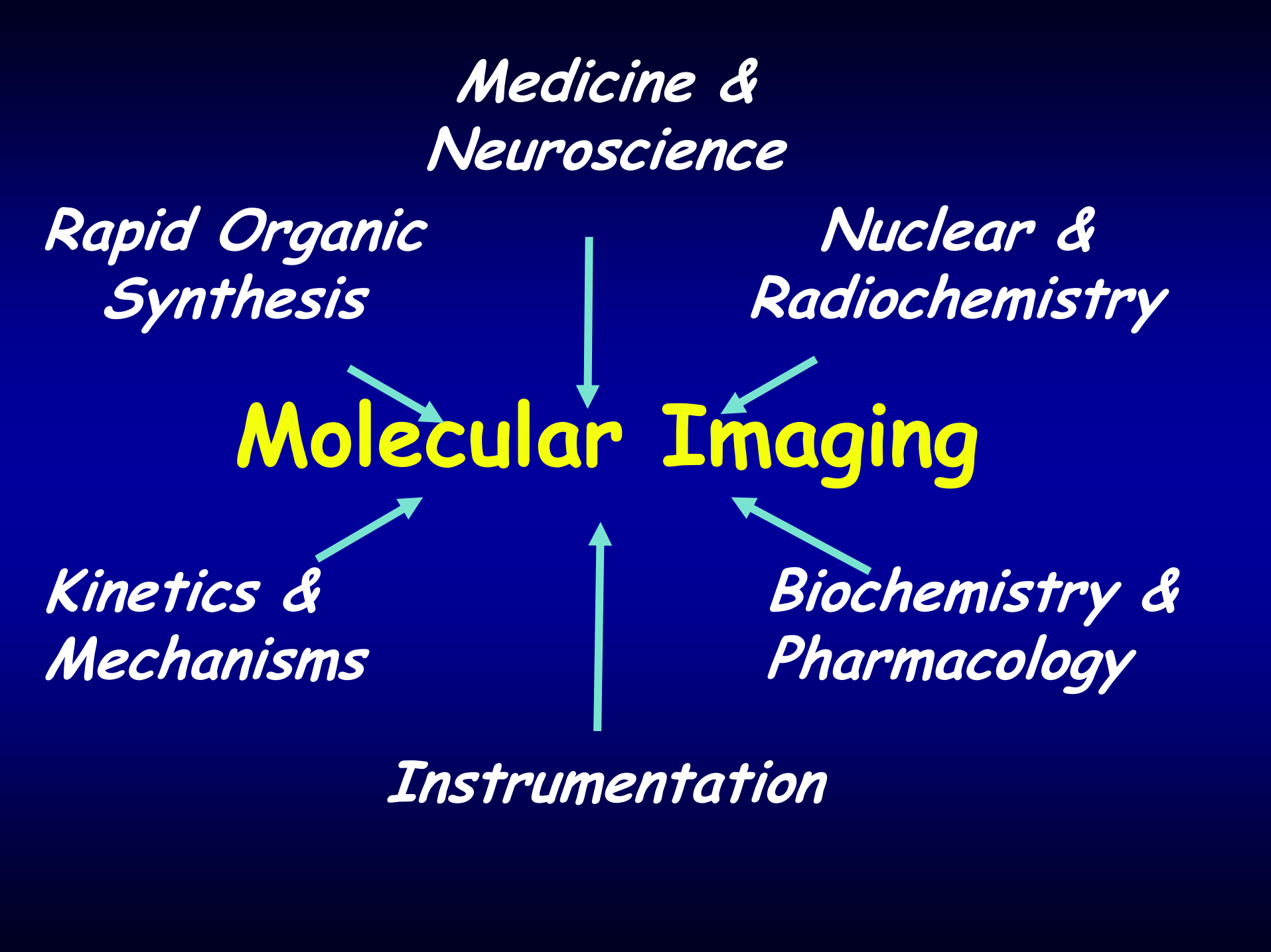



thalamus

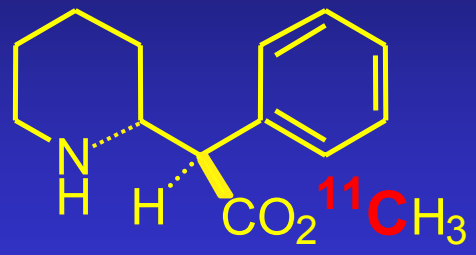
stem

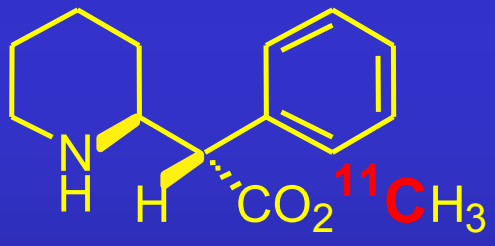
cerebellum

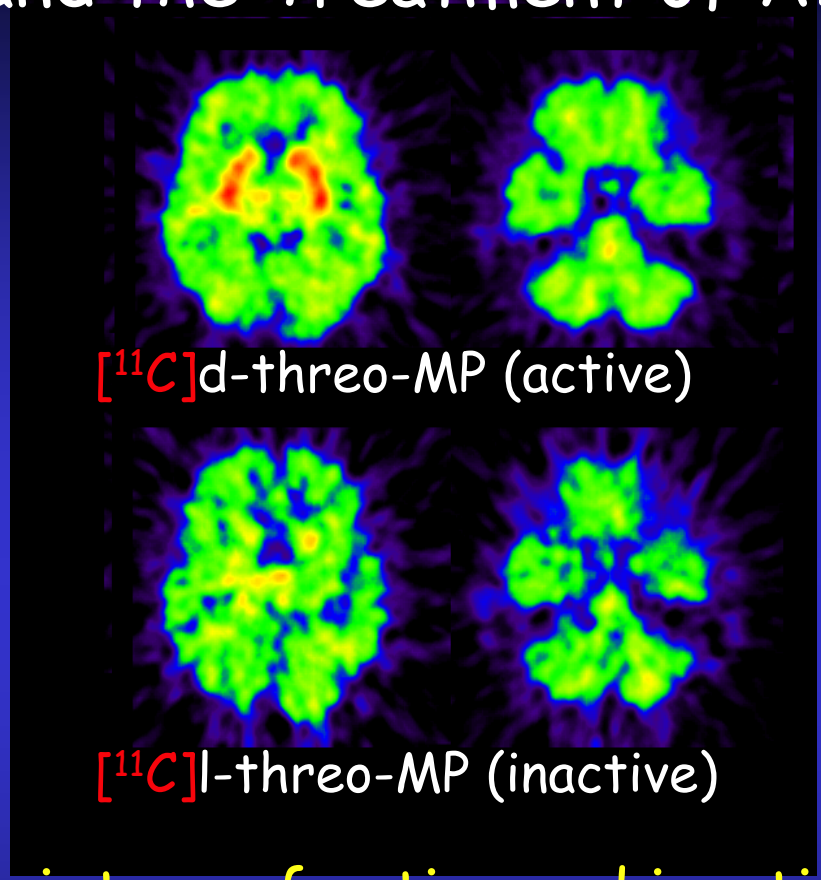
Ding et al., 2003


Medicine &
Neuroscience
Rapid Organic
Synthesis
Nuclear &
Radiochemistry
Molecular Imaging
Kinetics &
Mechanisms
Biochemistry &
Pharmacology
Instrumentation

# RadiotracerTechnology Driven By Medical Needs
# Ritalin, Cocaine and the Treatment of ADHD




- Ritalin is marketed as a mixture of active and inactive forms.
- The development of a rapid synthesis of both forms for PET imaging revealed for the first time that only the d-threo form binds in the human brain.

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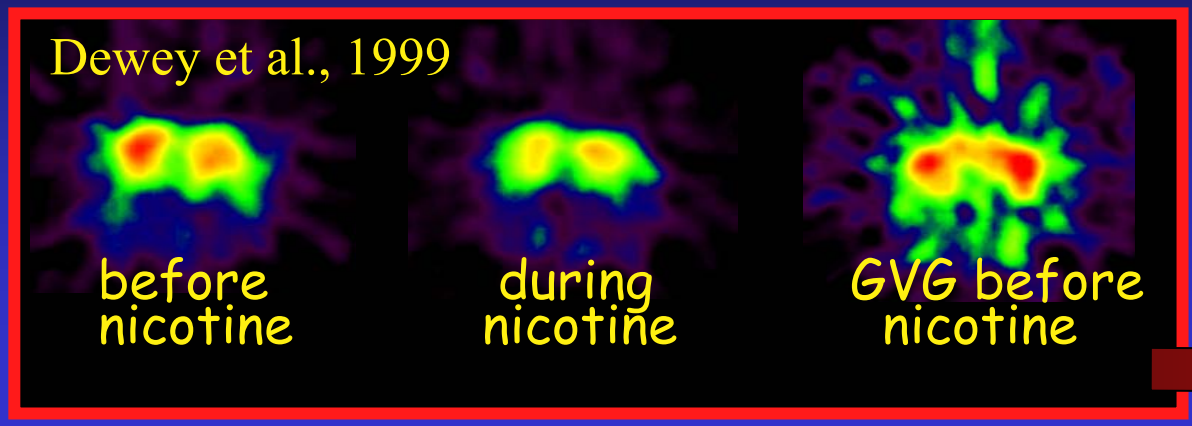
# New Technology Driven by Medical Needs

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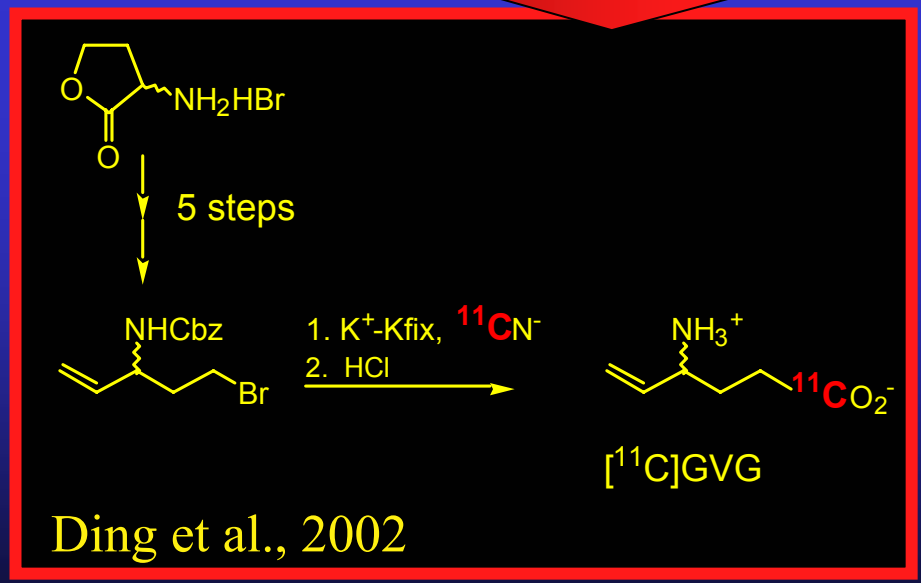
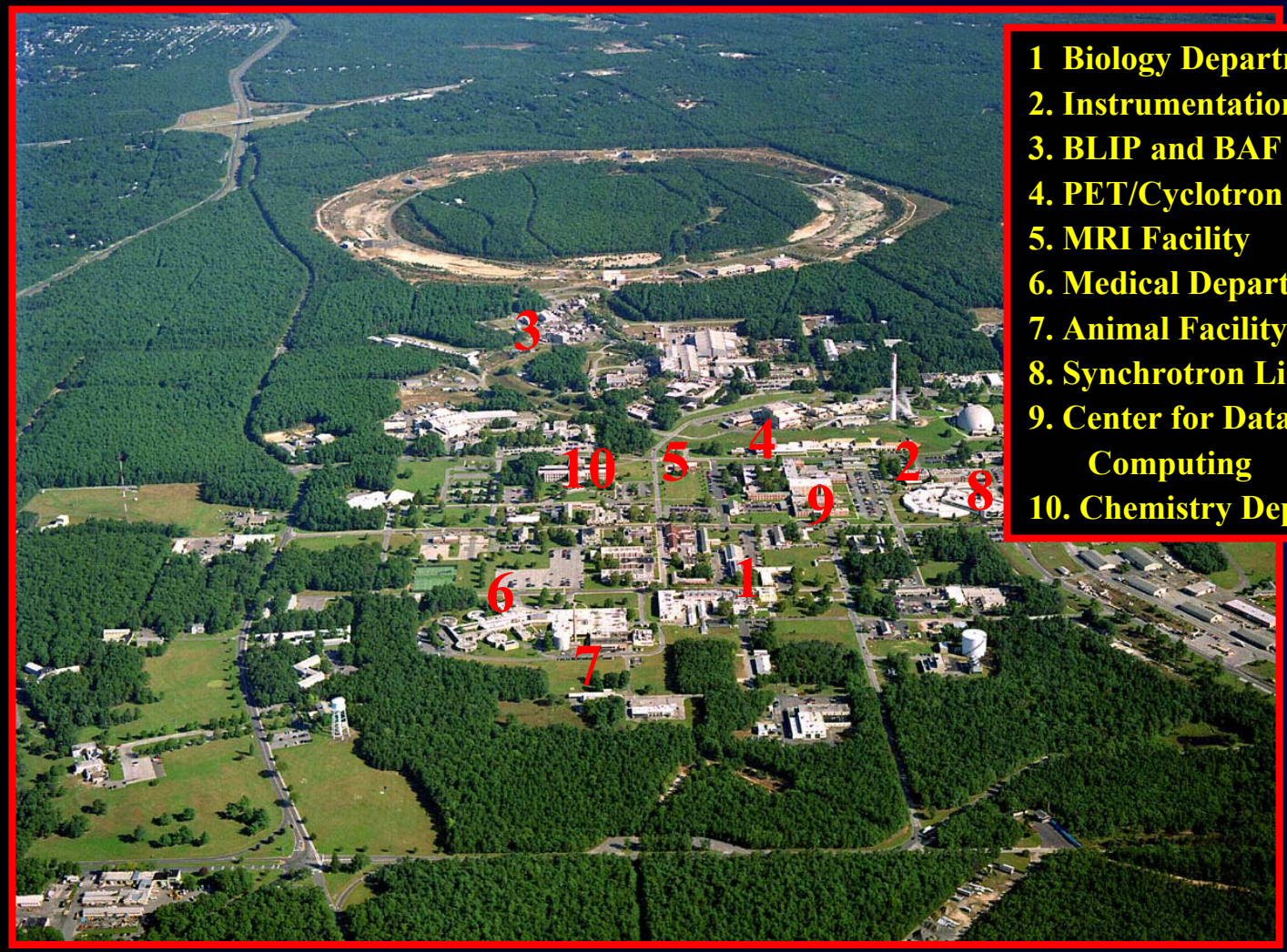
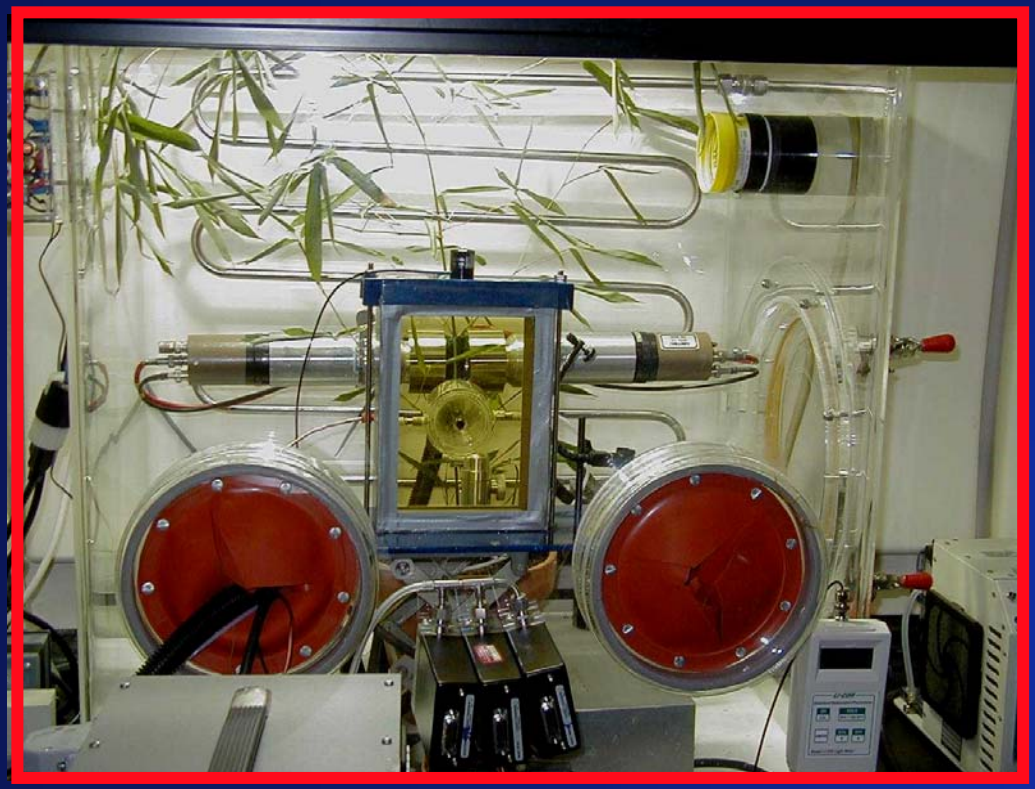


# Brookhaven National Laboratory
# Life Sciences Facilities




1 Biology Department, STEM
2. Instrumentation Division
3. BLIP and BAF
4. PET/Cyclotron Facility
5. MRI Facility
6. Medical Department
7. Animal Facility
8. Synchrotron Light Source
9. Center for Data Intensive Computing
10. Chemistry Department

# Use of C-11 and N-13 to Study the Effects of Environmental Stressors on Plant Metabolism



Environmental Plant Chamber

Coincidence Detection

Leaf Photosynthesis Cell