V CONGRESO NACIONAL DE TECNOLOGÍA APLICADA A CIENCIAS DE LA SALUD

"Generación de Nuevas Técnicas de Diagnóstico y Tratamiento"

TOMOGRAFÍA POR EMISIÓN DE POSITRONES.
EL PODER DE LAS IMÁGENES MOLECULARES

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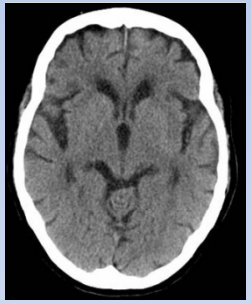
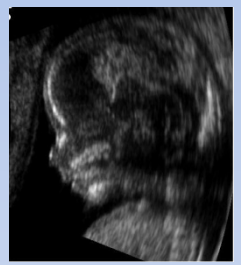
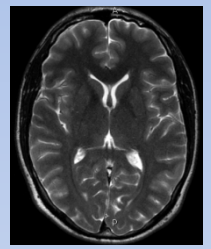
División de Investigación
Unidad PET/CT-Ciclotrón

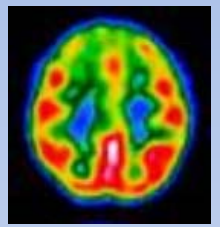
Instituto Nacional de Astrofísica, Óptica y Electrónica, 5-7 Junio de 2014

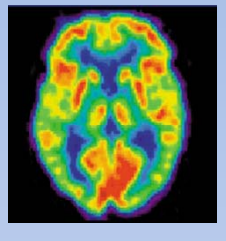
Modalidades de Imagenología Médica











Rayos X

CT

US

RMN

SPECT

PET

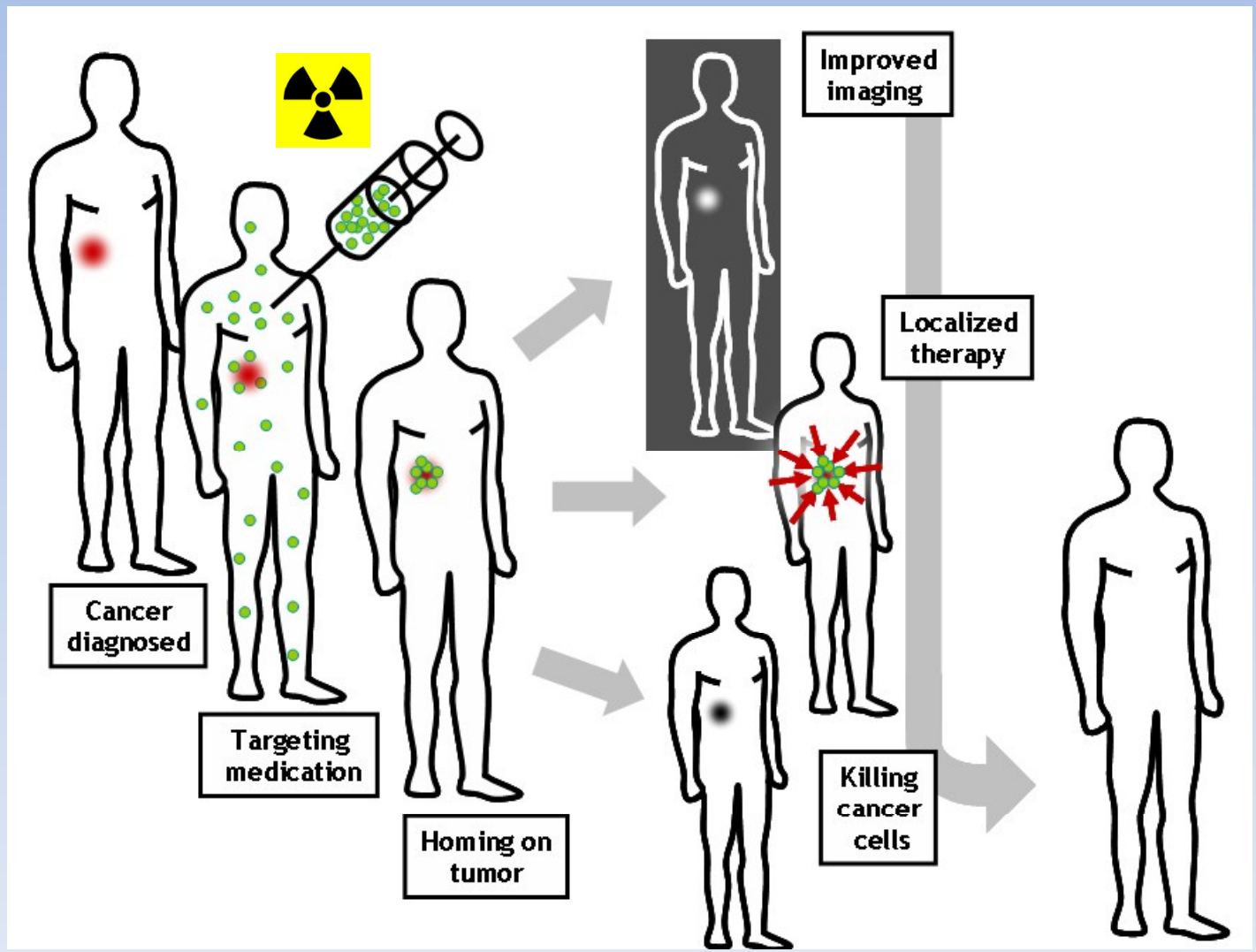
Anatomía

Fisiología

Sensibilidad y especificidad

Medicina Nuclear Molecular

Medicina Nuclear Molecular



http://es.wikipedia.org/wiki/Imagen_molecular

Tomografía por Emisión de Positrones (PET)

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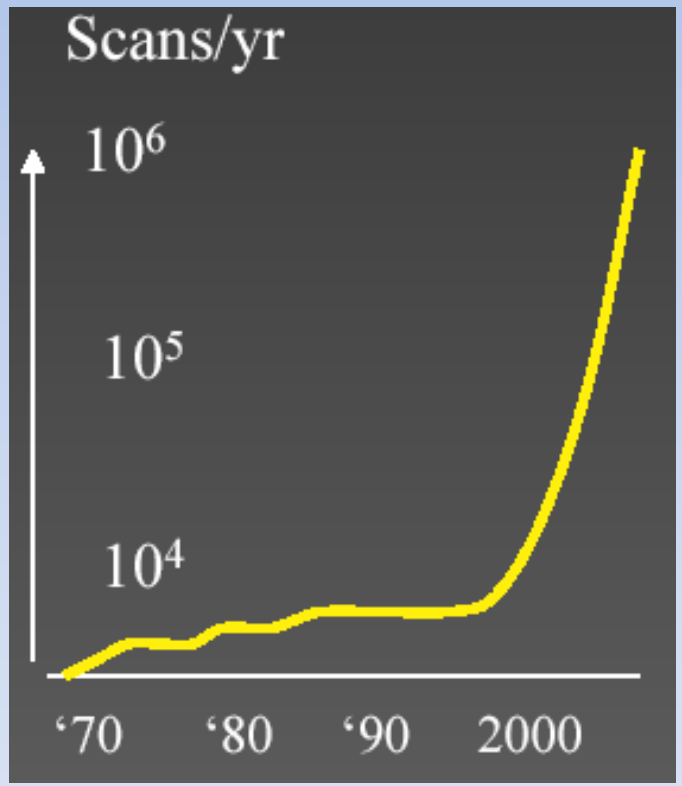
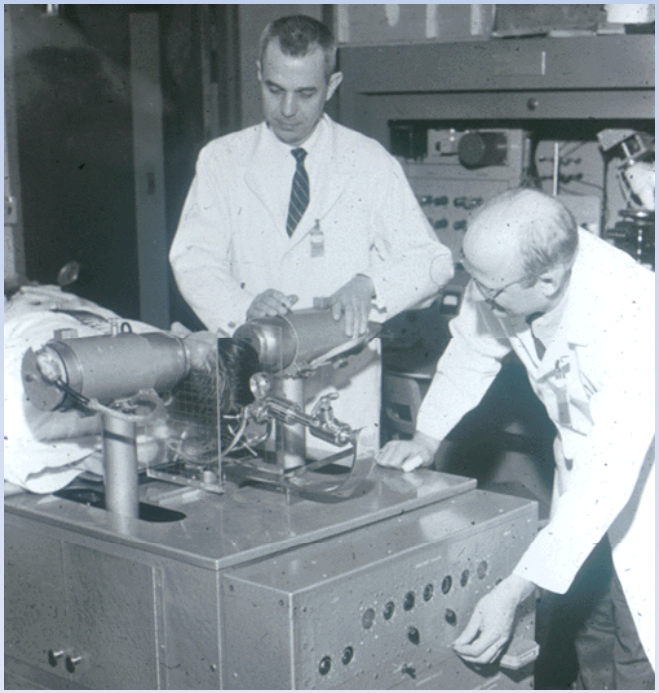
Es una técnica de diagnóstico médico mediante la cual se obtienen imágenes funcionales a partir de la distribución espacio-temporal de radiofármacos emisores de positrones dirigidos a blancos moleculares específicos

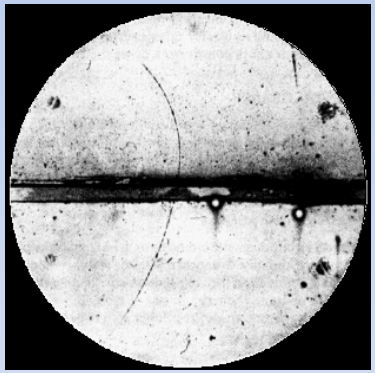


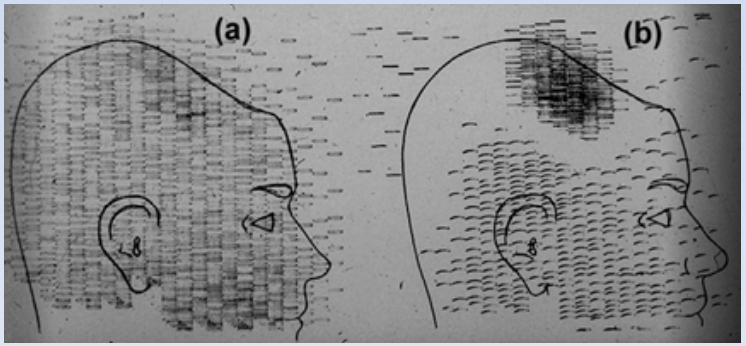
Positrón: Antipartícula del Electrón

- **1928: Paul Dirac postula su existencia**
- **1932: Carl Anderson lo descubre**
- **1953: Brewnell & Aronow primer uso médico**

$$\left(\beta mc^2 + \sum_{\kappa=1}^{3} \alpha_\kappa p_\kappa c\right)\psi(x,t) = i\hbar \frac{\partial \psi(x,t)}{\partial t}$$

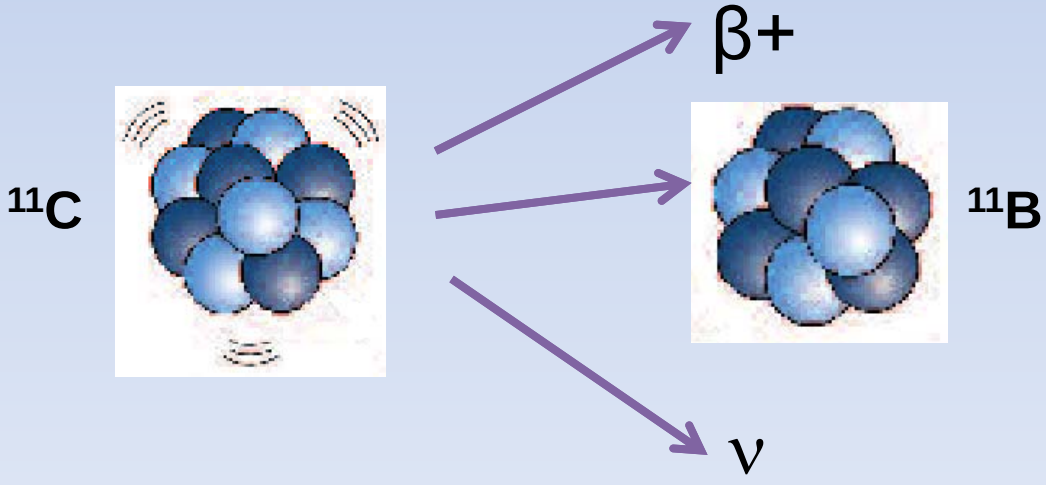


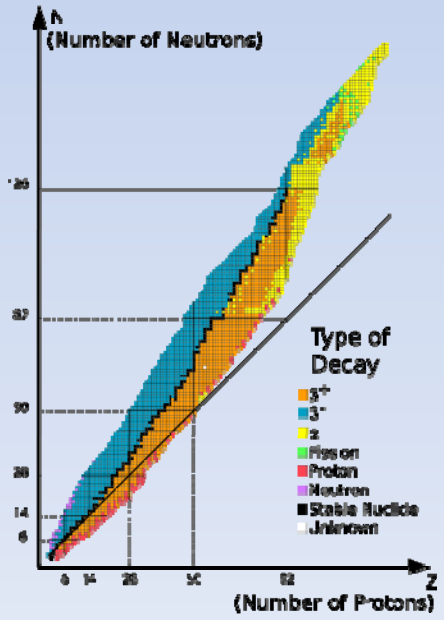




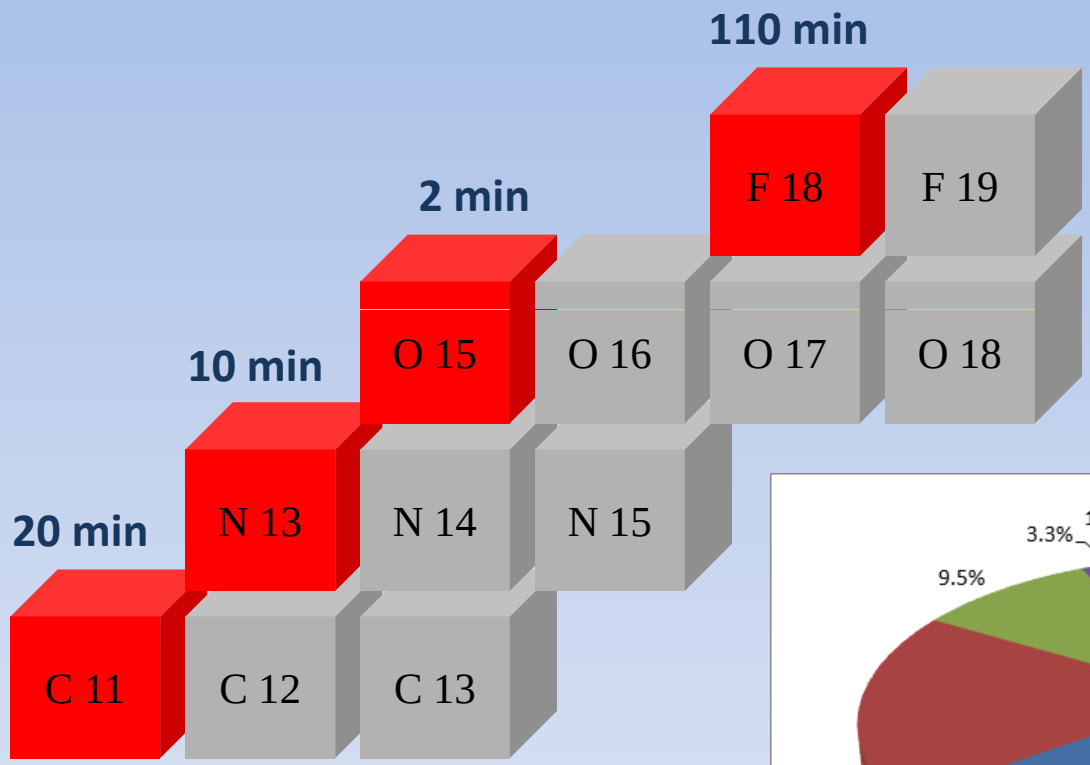
Radionúclidos Emisores de Positrones

- Isótopos inestables con un exceso de protones
- Tienden a la estabilidad convirtiendo protones en neutrones, transformándose en otro elemento
- Regularmente tienen vidas medias cortas
- Se producen en aceleradores de partículas



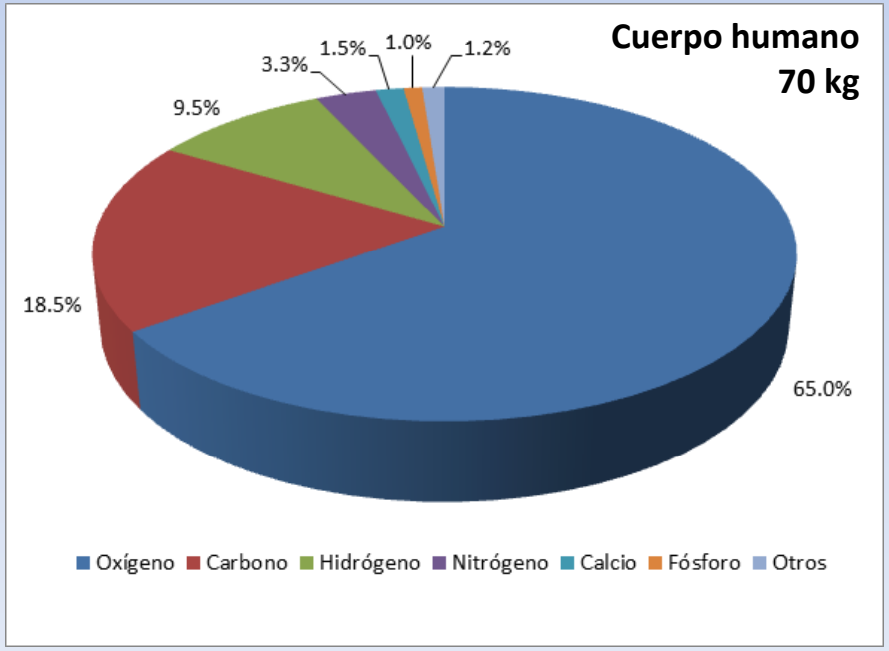


Radionúclidos Convencionales para PET

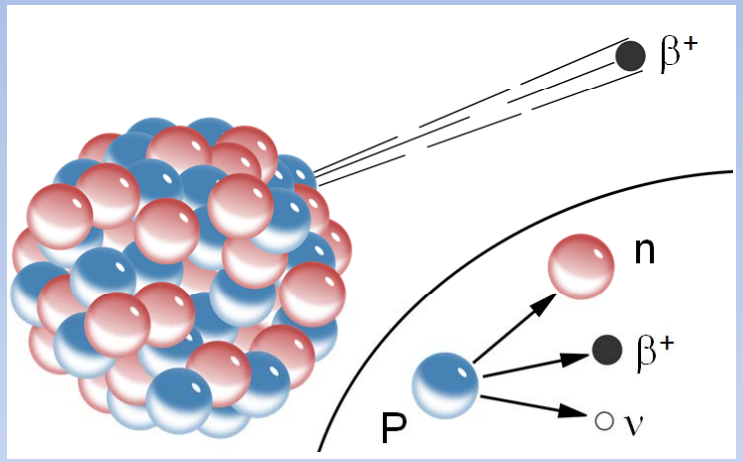


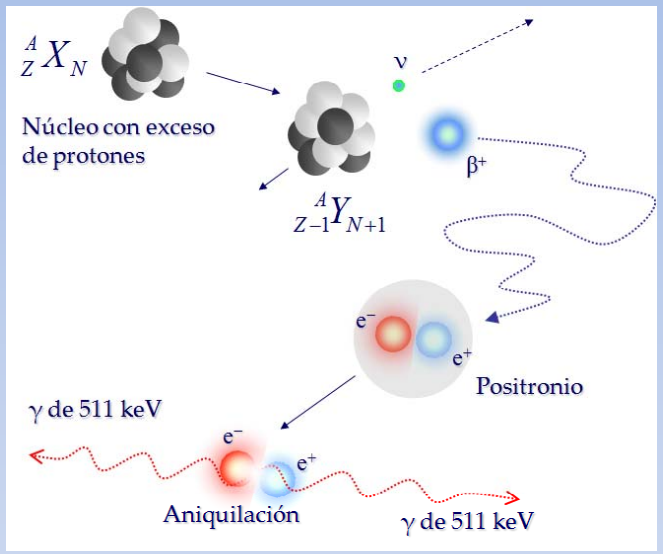
Reacciones nucleares

$^{14}N(p,\alpha)^{11}C$
$^{16}O(p,\alpha)^{13}N$
$^{15}N(p,n)^{15}O$
$^{18}O(p,n)^{18}F$

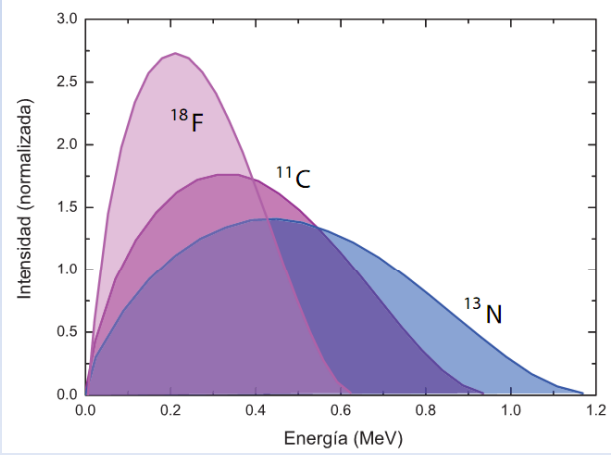


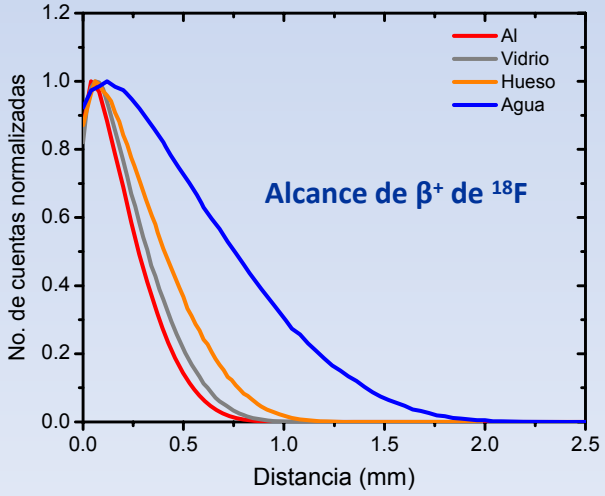
Emisión y Aniquilación de Positrones



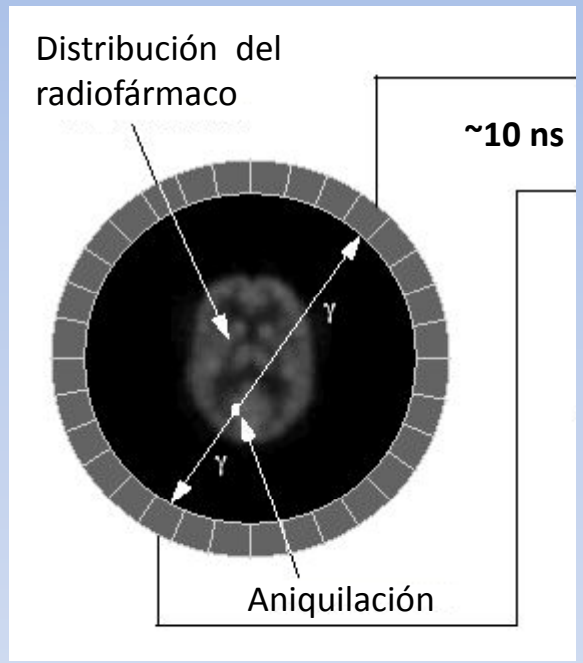


$$ {}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + \beta^{+} + \nu + Q $$





Detección en Coincidencia



$E_\gamma = 511\ keV \pm \Delta E$

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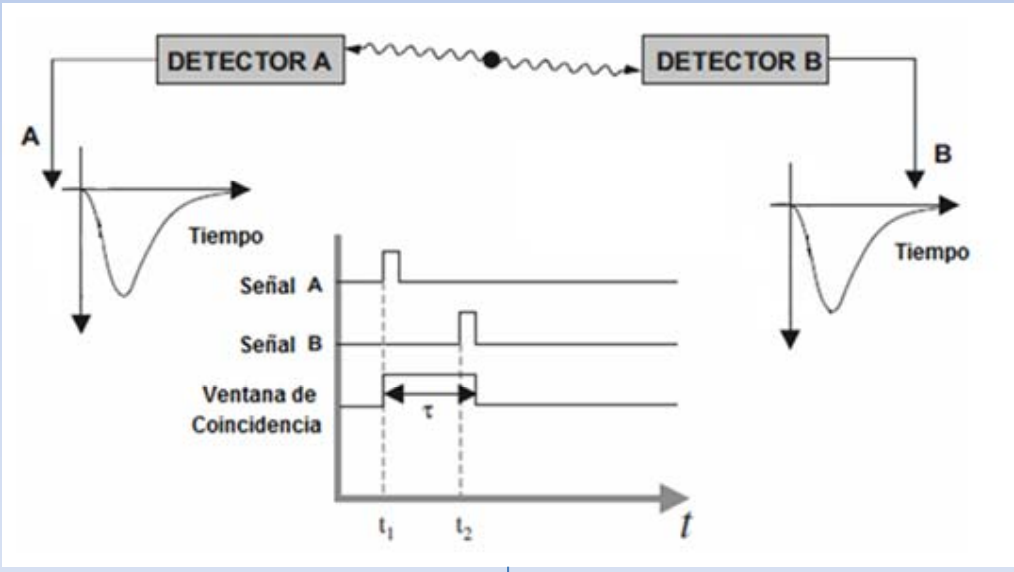
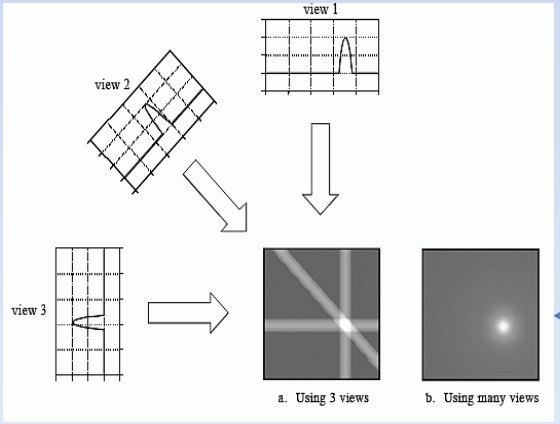
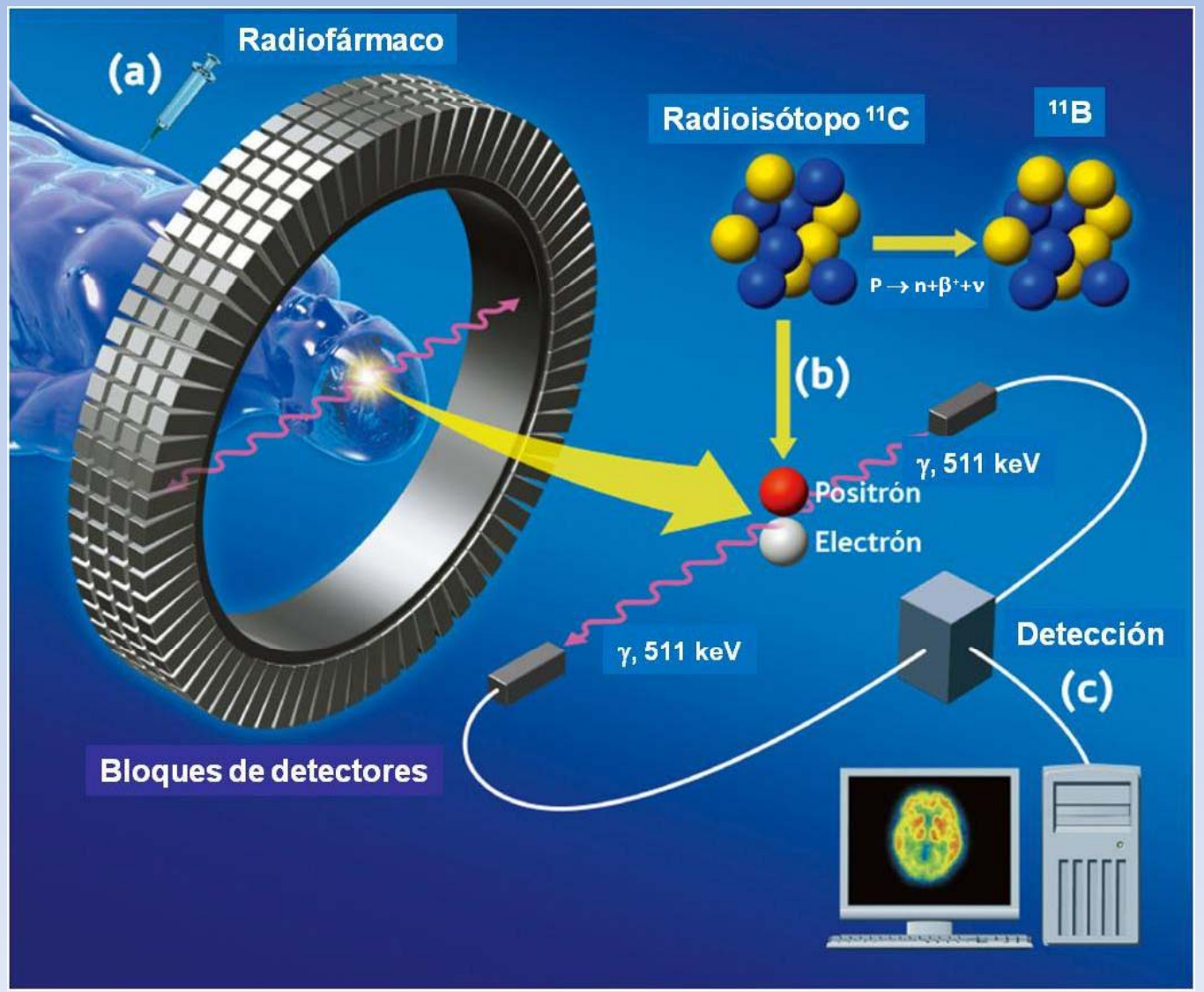
Detección en coincidencia





Reconstrucción de imagen

Tomografía por Emisión de Positrones (PET)



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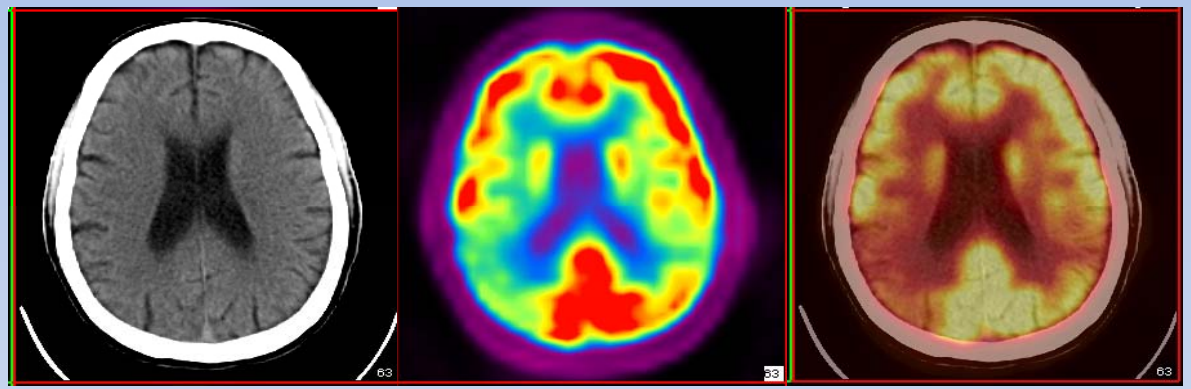
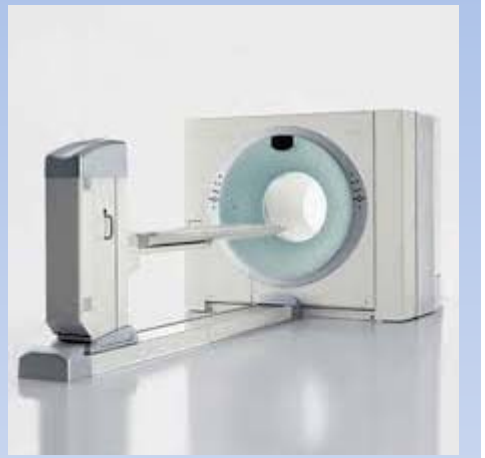
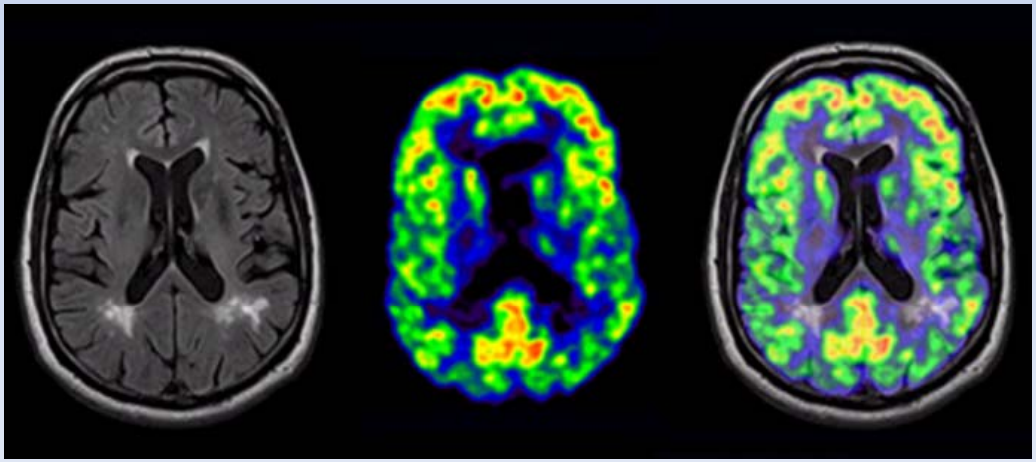
Equipos e Imágenes Híbridas

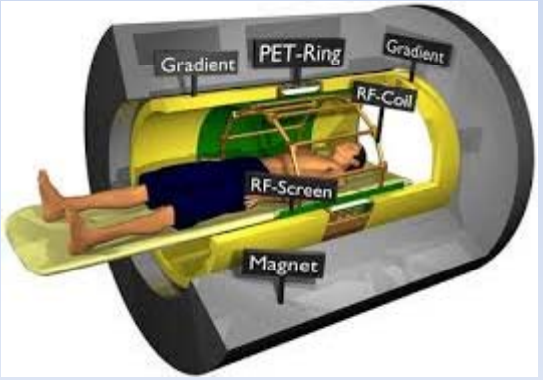
CT PET PET/CT



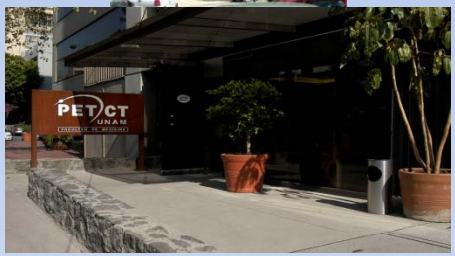


RM PET PET/RM

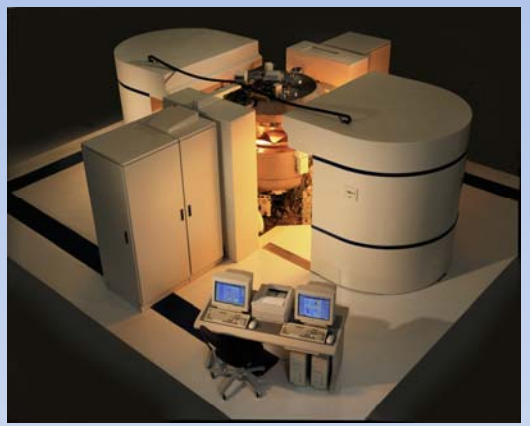




Unidad PET Integral de la UNAM

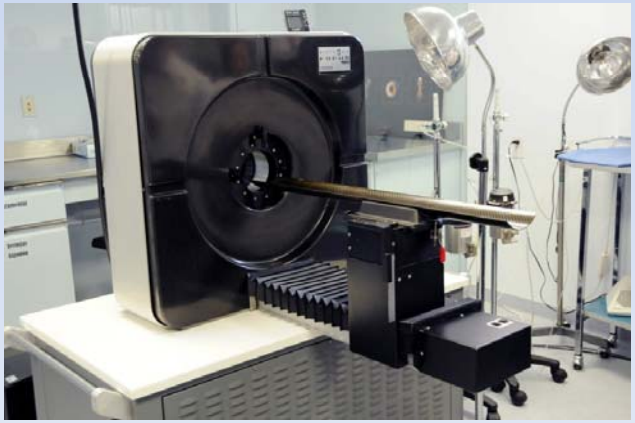


Ciclotrón (11 MeV, p)



Radiofarmacia

MicroPET



PET/CT

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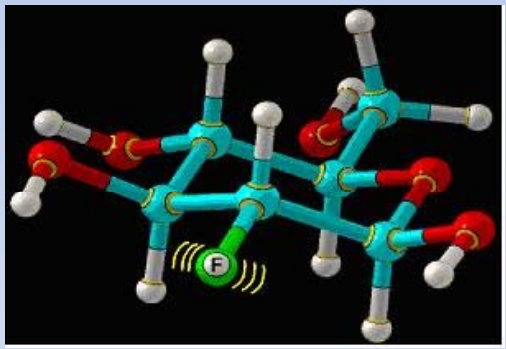
Radiofármacos

Sustancias que contienen átomos radiactivos en su estructura química y que por su forma farmacéutica, cantidad y calidad de radiación emitida, son adecuados para su administración en seres humanos con fines de diagnóstico y/o tratamiento.

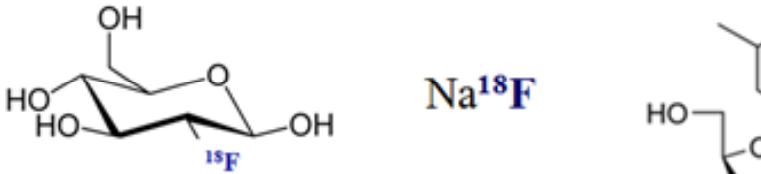


❖Componentes:

a) Molécula específica de interés biológico (fármaco) que determina su ruta metabólica y biodistribución

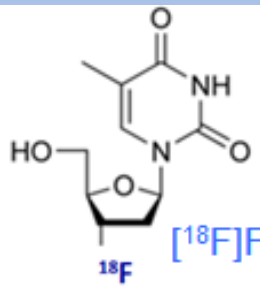
b) Radionúclido que por su característica de emitir radiación ionizante permite la detección externa de su localización

Radiofármacos en Producción Actual

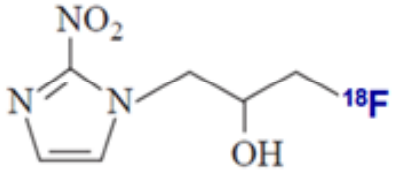


[^{18}F]FDG

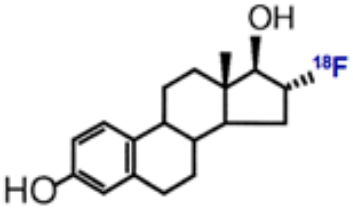
[^{18}F]NaF



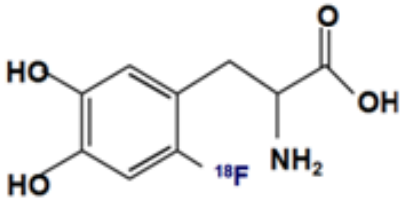
[^{18}F]FLT



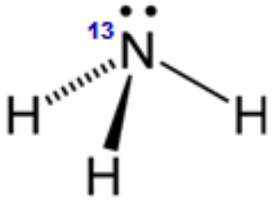
[^{18}F]FMISO



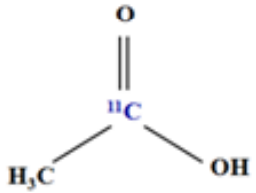
[^{18}F]FES



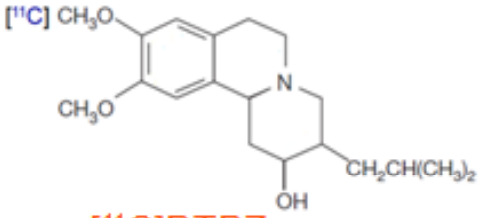
[^{18}F]FDOPA



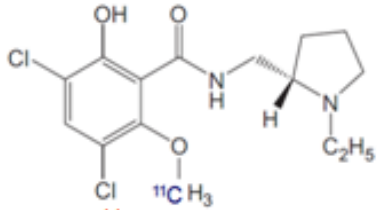
[^{13}N]Amoníaco



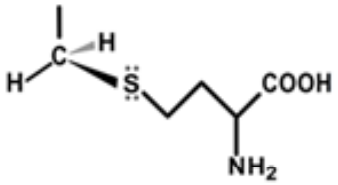
[^{11}C]Acetato



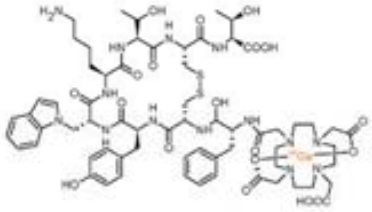
[^{11}C]DTBZ



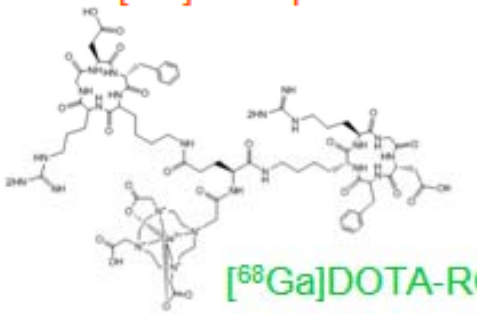
[^{11}C]Raclopride



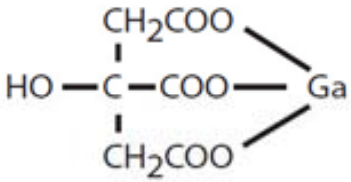
[^{11}C]Metionina



[^{68}Ga]DOTA-TATE



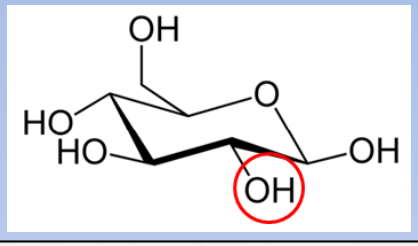
[^{68}Ga]DOTA-RGD$_2$



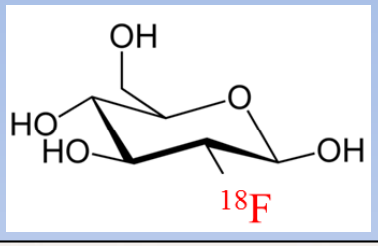
[^{68}Ga]Citrato

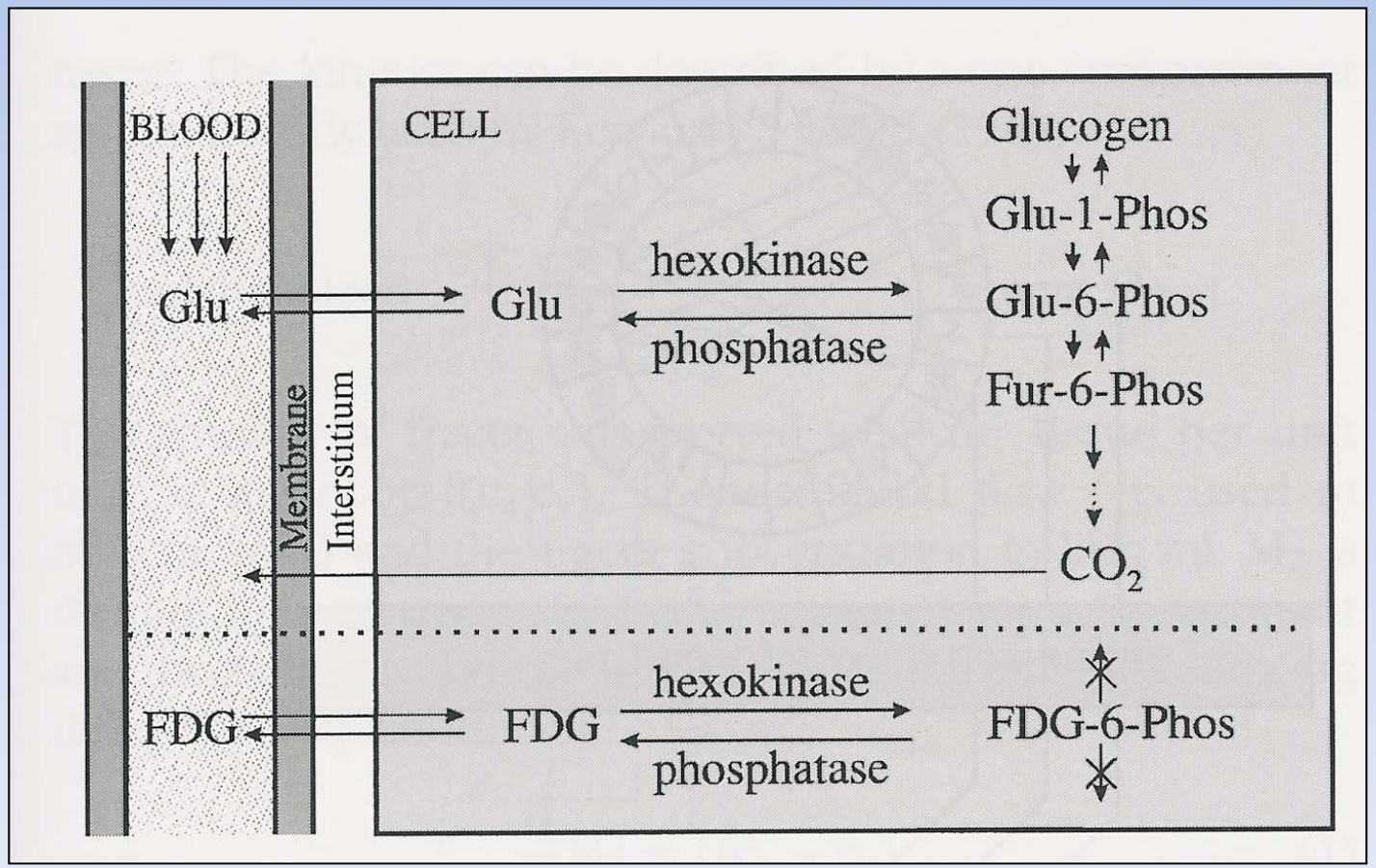
FDG *vs* Glucosa: Rutas Metabólicas

Glucosa



FDG





FDG: Biodistribución Normal y Aplicaciones

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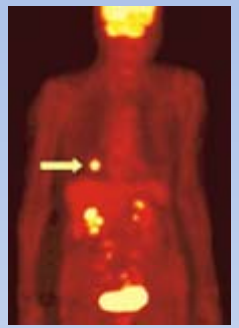
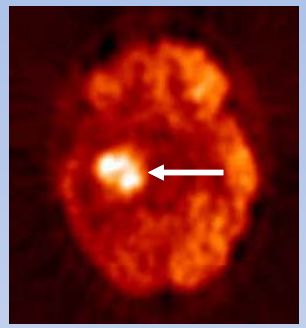
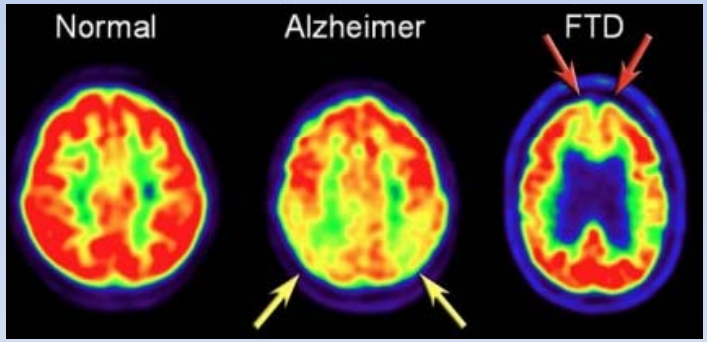
Biodistribución normal

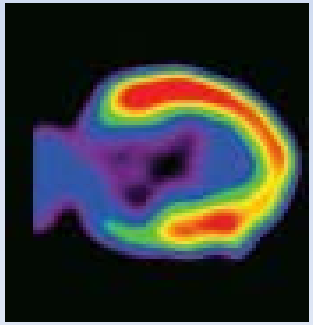


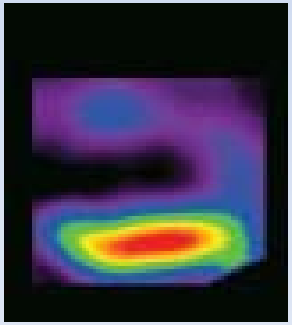


Oncología



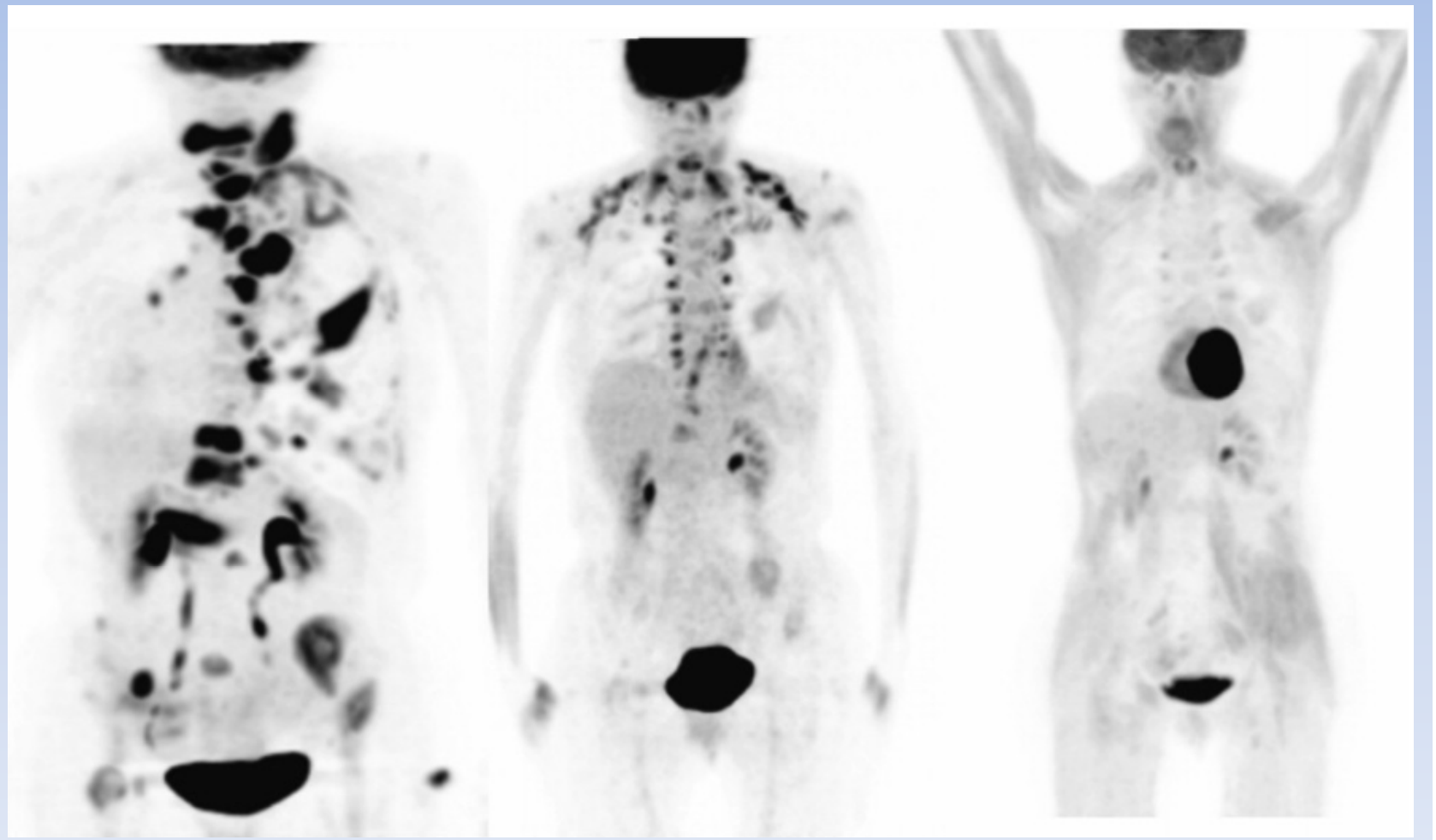
Neurología



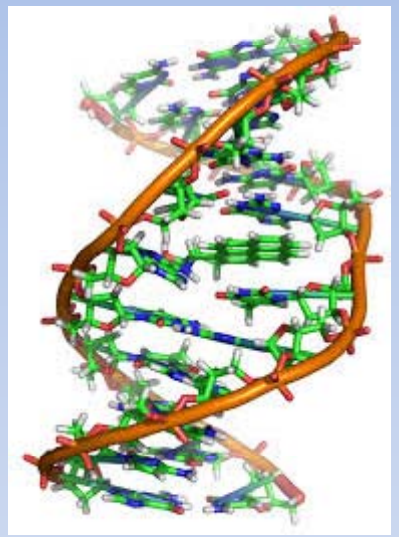


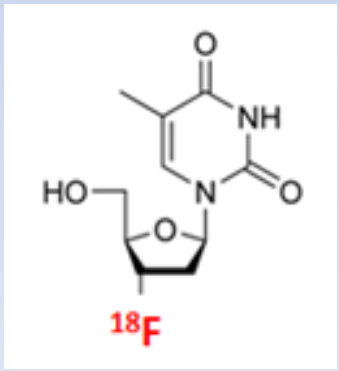
Cardiología

FDG-PET en Oncología: Manejo y Seguimiento



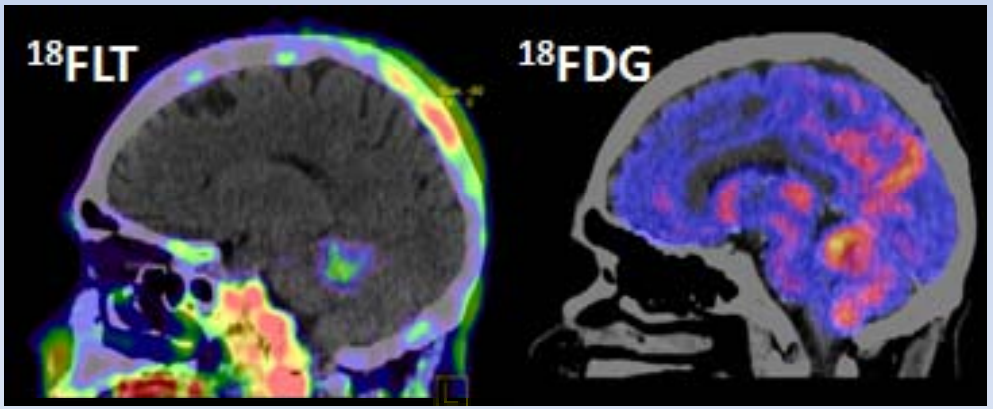
3-DEOXY-[^{18}F]FLUORO-L-TIMIDINA [^{18}FLT]





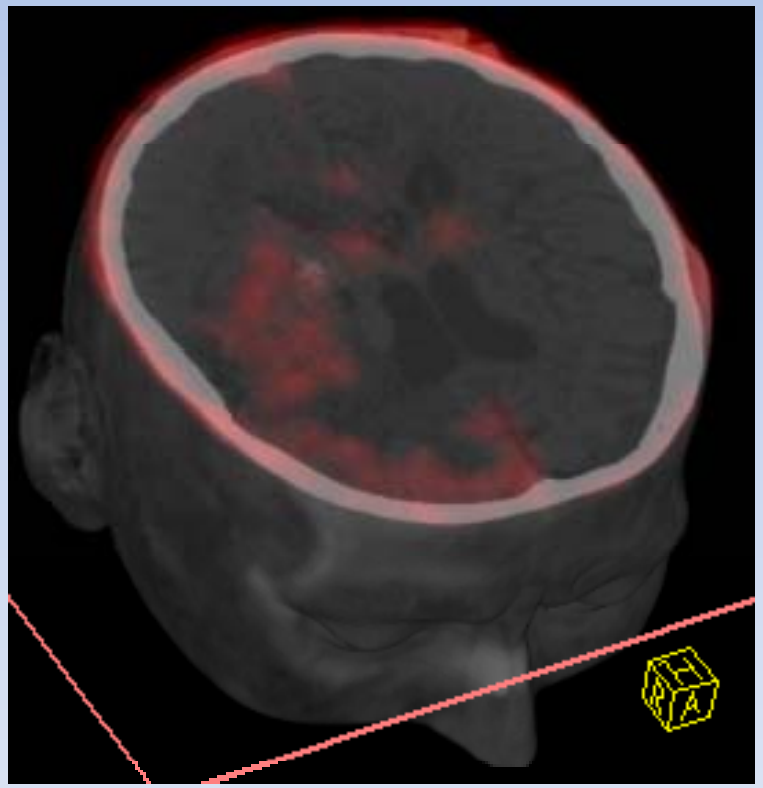
PROLIFERACIÓN CELULAR *IN VIVO*

- Tumores cerebrales
- Planificación de tratamientos de RT
- Valoración de respuesta temprana a la terapia

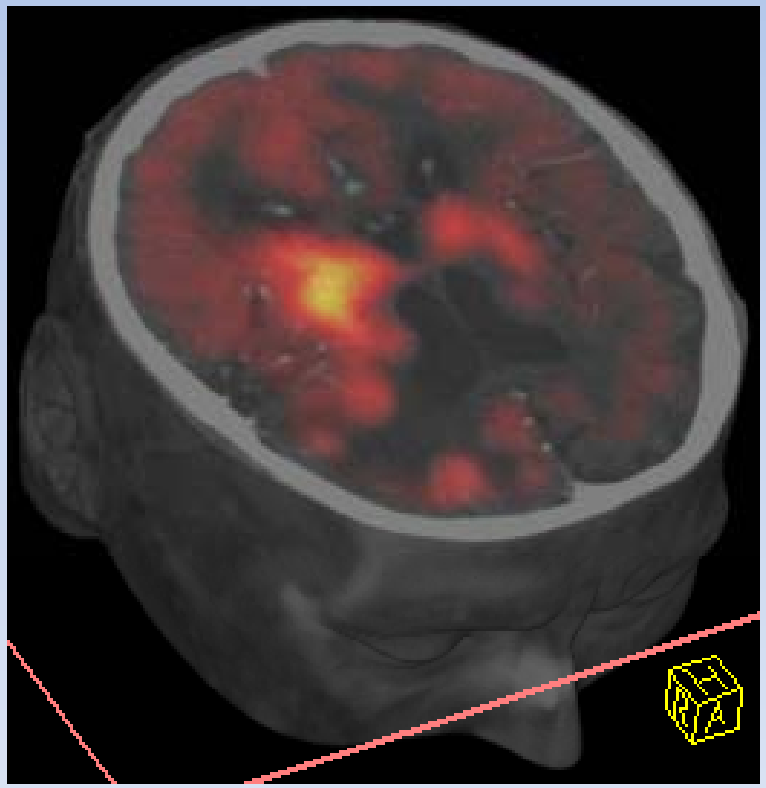


[^{18}F]Fluorotimidina vs [^{11}C]Metionina

M, 35 años, Astrocitoma Anaplásico



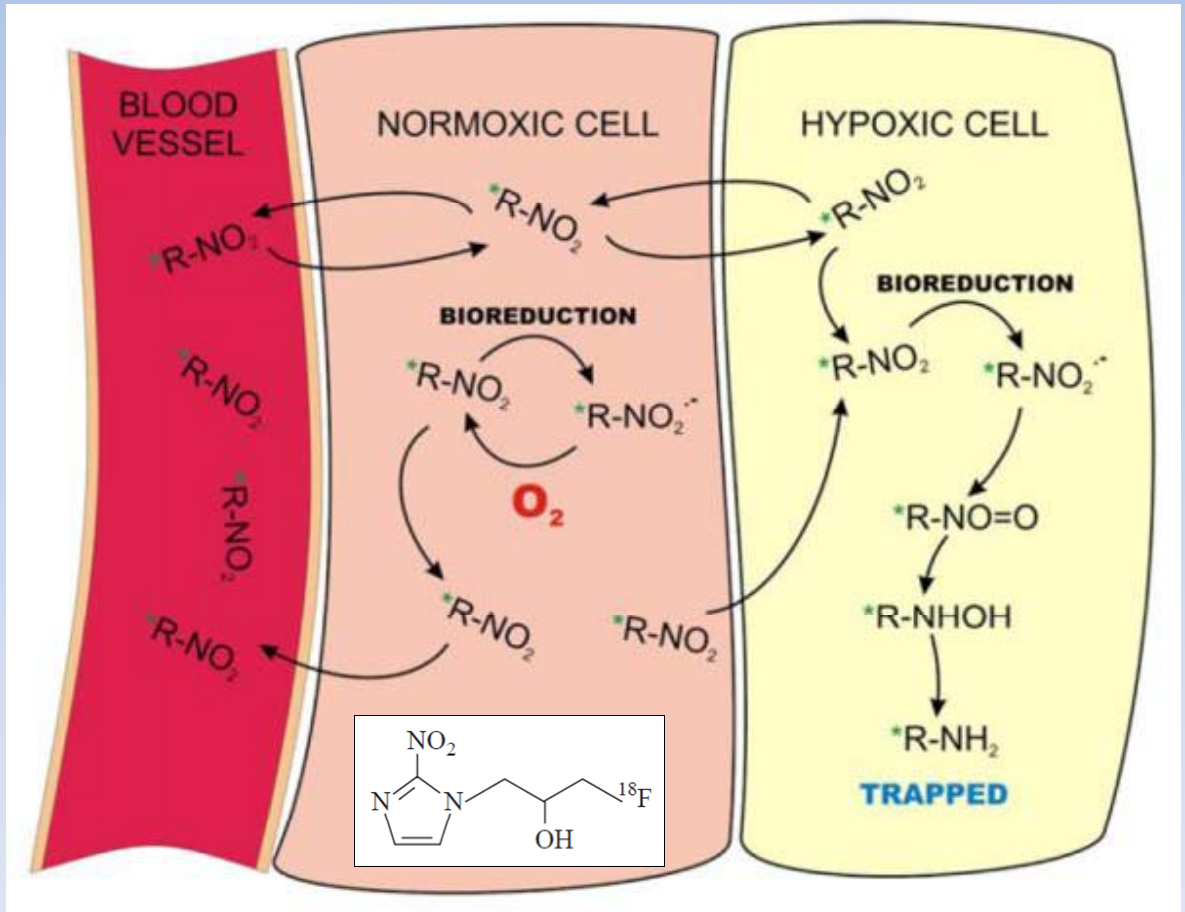
[^{18}F]FLT



[^{11}C]MET

DETECCIÓN *IN VIVO* DE HIPOXIA

[^{18}F]Fluoromisonidazol ([^{18}F]F-MISO)

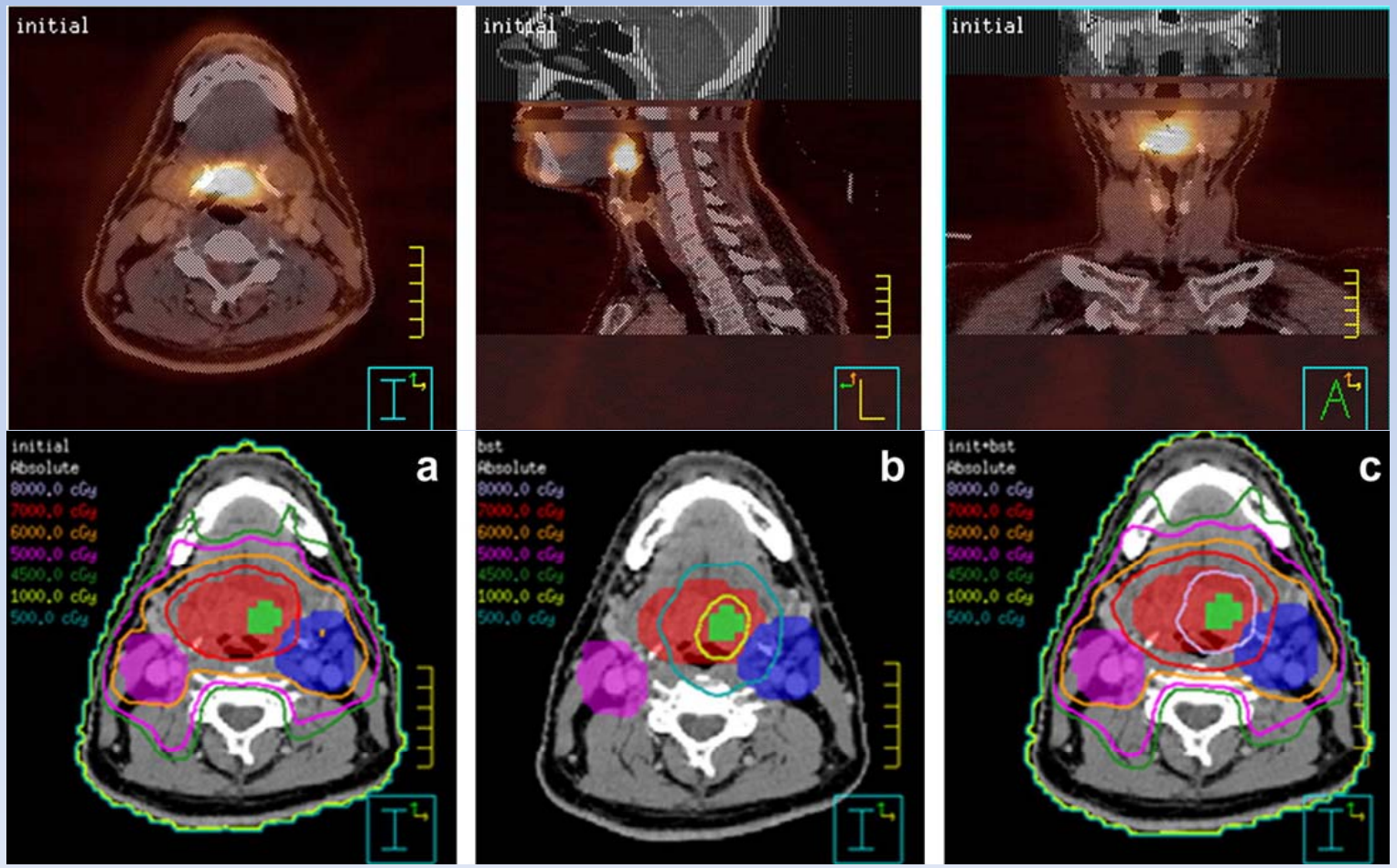


$$R{-}NO_2 \underset{+O_2}{\overset{+e^-}{\rightleftharpoons}} R{-}NO_2^{-\cdot} \xrightarrow{+3\,e^-} R{-}NHOH$$

Handley et al. (2011), J Mol Cell Cardiol.

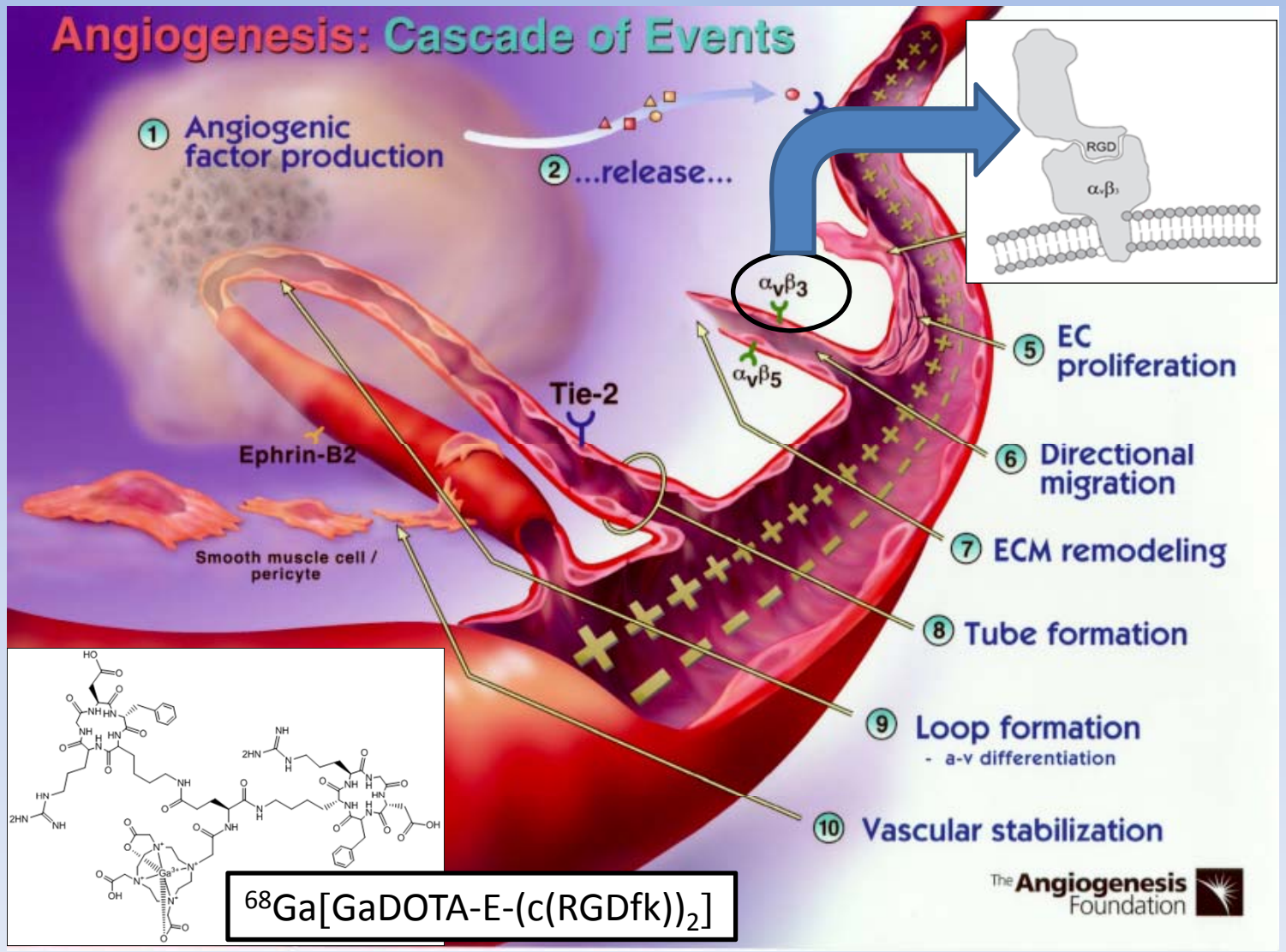
Tratamiento Guiado por Imagen Molecular

[^{18}F]FMISO in HNC



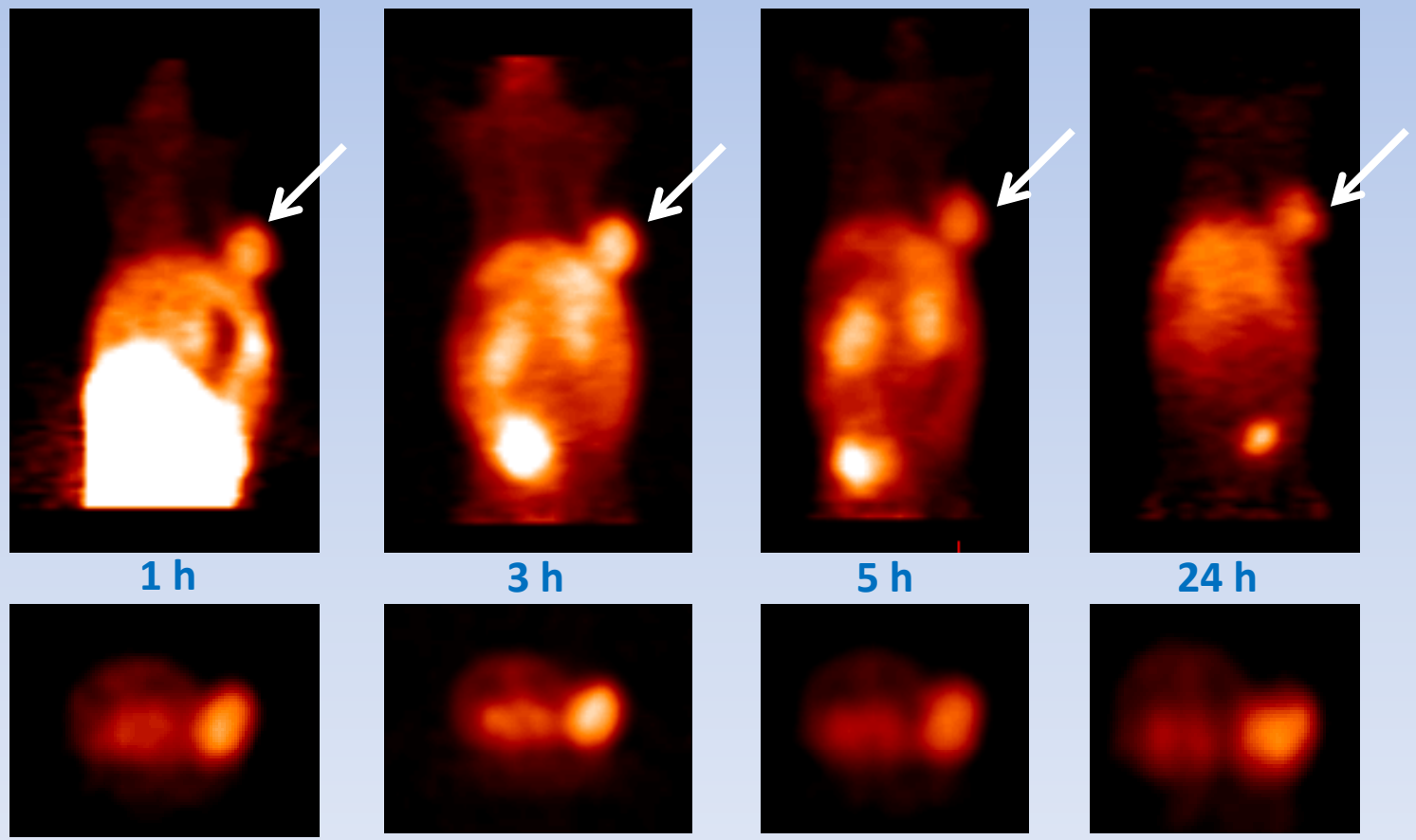
Hendrickson et al. Radiother. Oncol. (2011)

Detección *in vivo* de Angiogénesis

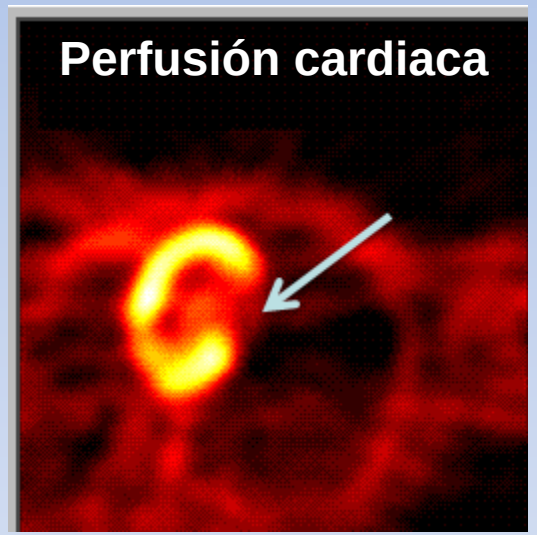


^{66}Ga-DOTA-Glu-[cyclo(Arg-Gly-Asp-D-Phe-Lys)]$_2$

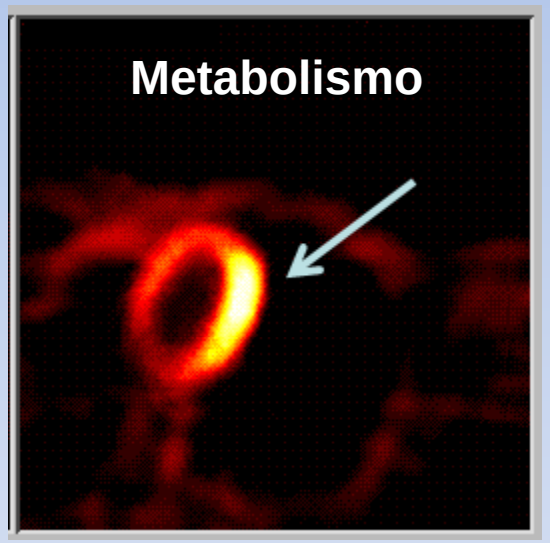
Nude mice bearing *U-87 MG (glioblastoma) xenografts*



Principales Aplicaciones en Cardiología

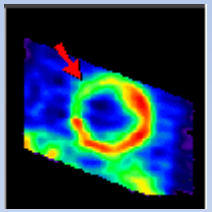


[^{13}N]Amoniaco

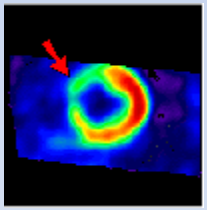


[^{18}F]FDG

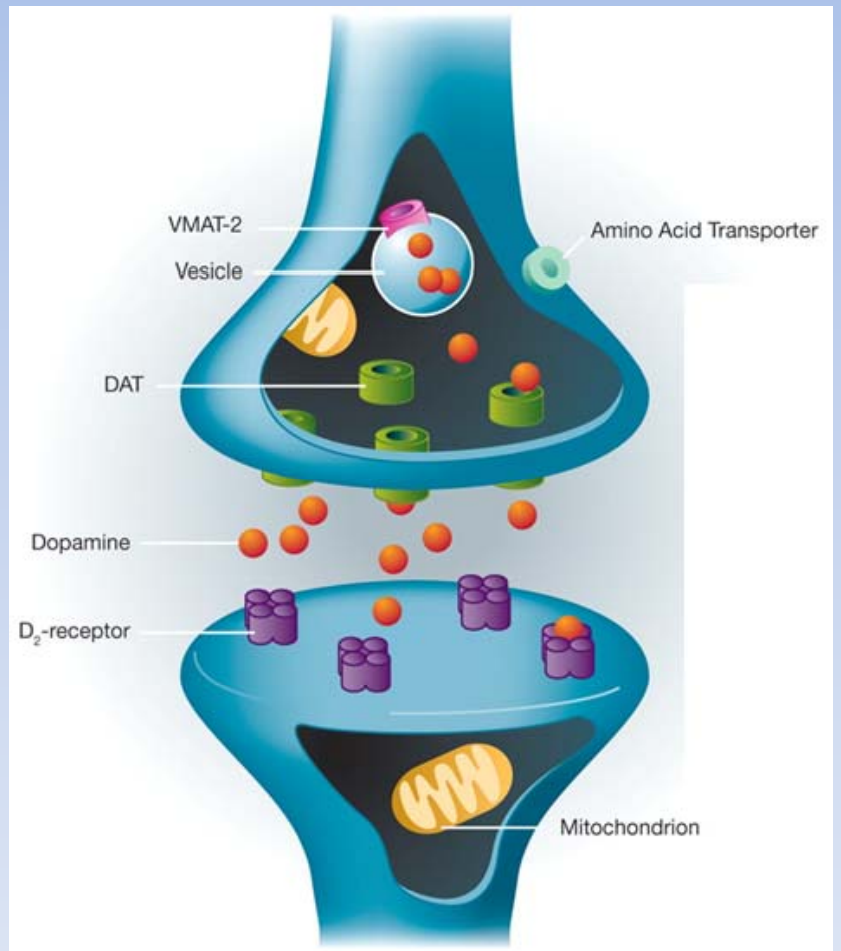
Perfusión



Metabolismo



RADIOFÁRMACOS PARA ESTUDIOS NEUROLÓGICOS (SISTEMA DOPAMINÉRGICO)



Radioligandos presinápticos

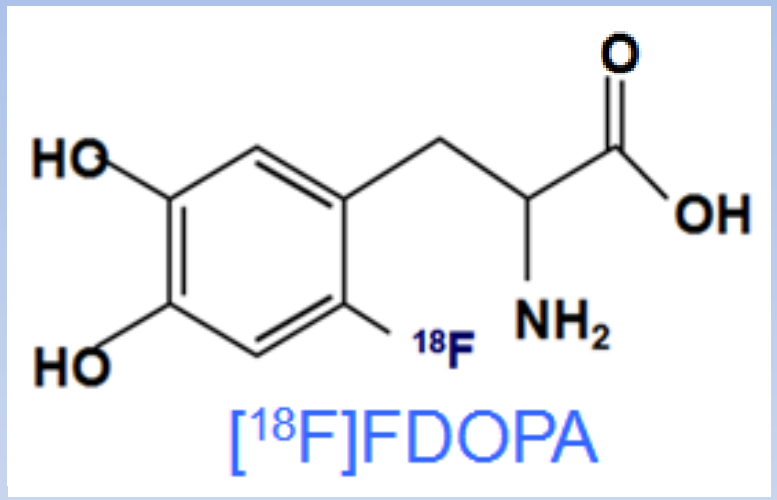
- DOPA descarboxilasa
  (mide la síntesis de dopamina)
- DAT
  (provee una medida de las terminales dopaminérgicas funcionales)
- VMAT2
  (marcador para terminales dopaminérgicas)

Radioligandos postsinápticos

- Receptores D_2

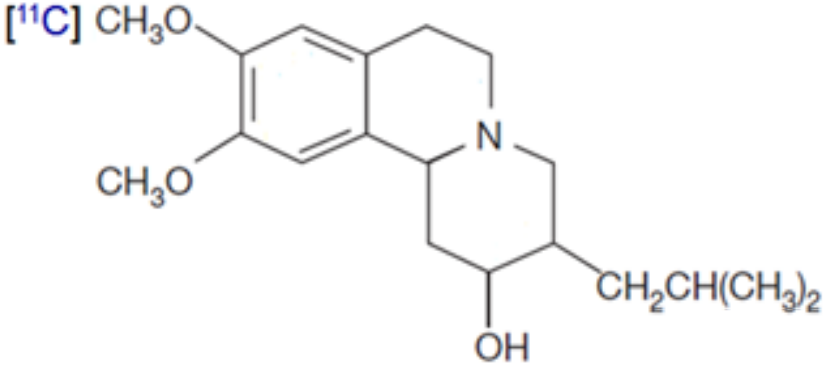
J.L. Cummings *et al*., Brain 11 (2011) 3146-3166

RADIOFÁRMACOS PARA SISTEMA DOPAMINÉRGICO

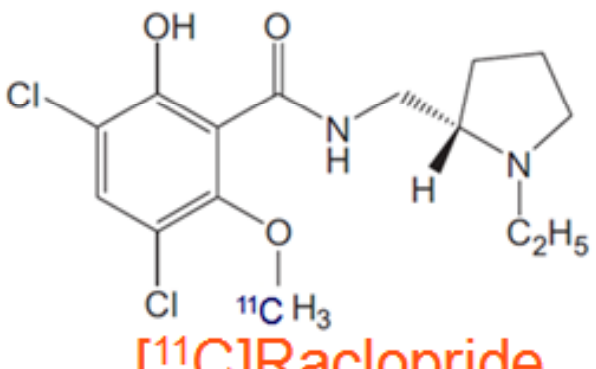


[^{18}F]FDOPA

Wikipedia

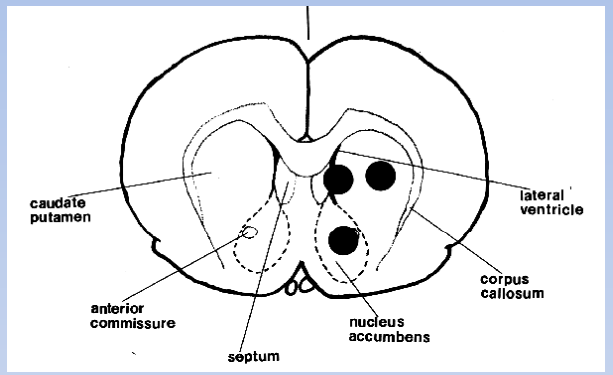


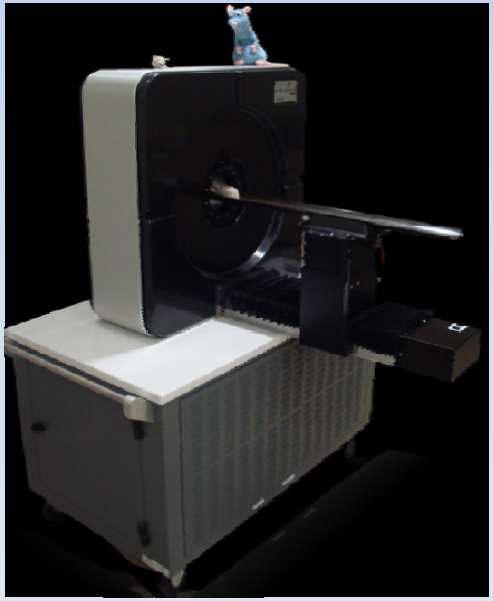
[^{11}C]DTBZ

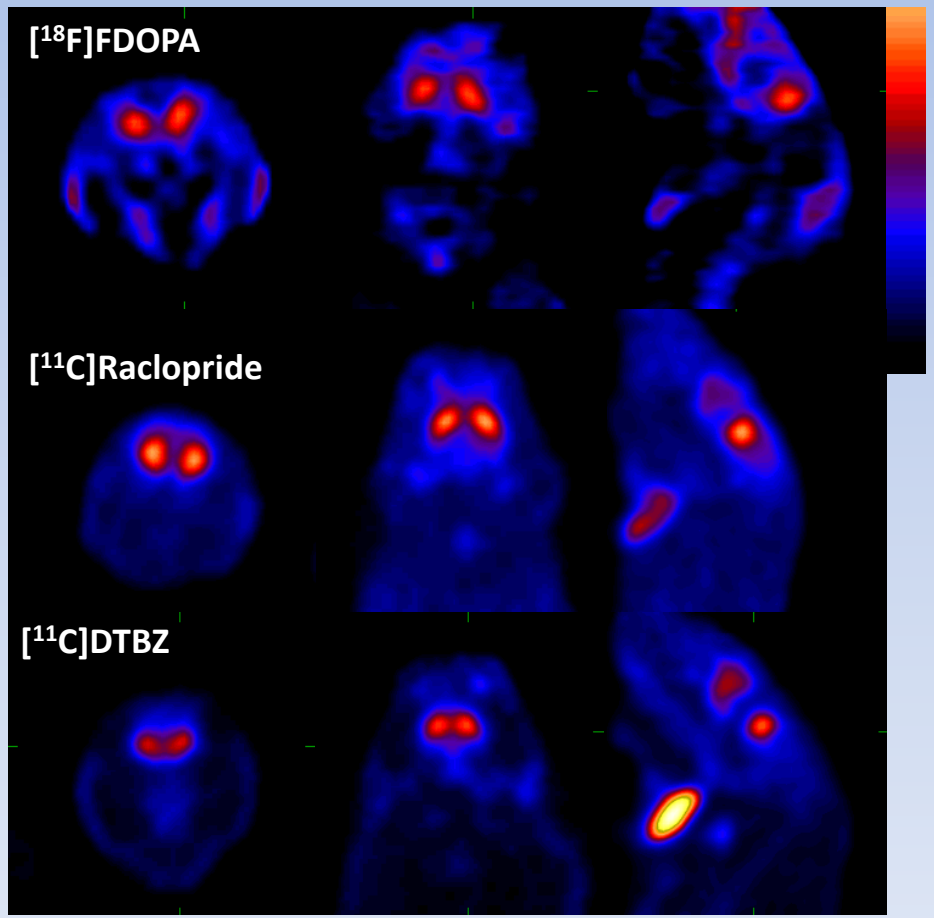


[^{11}C]Raclopride

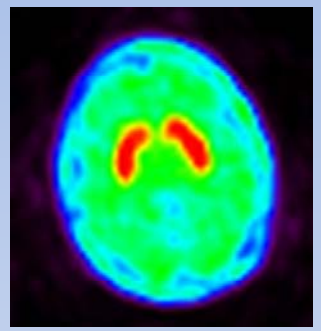
ESTUDIOS PRECLÍNICOS EN MICROPET



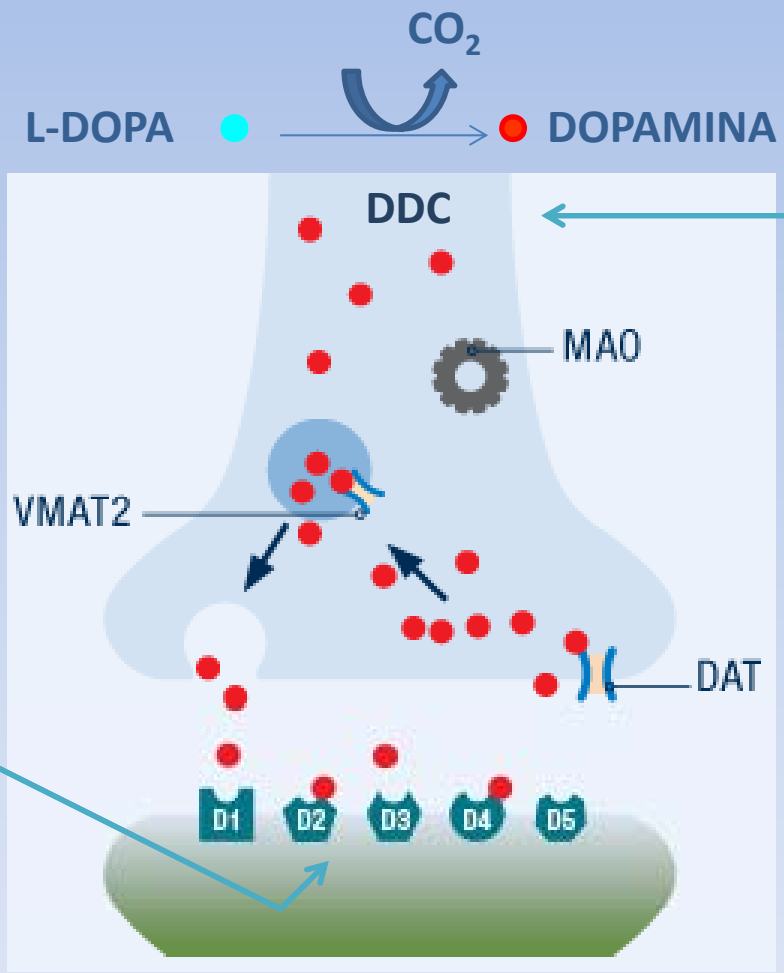


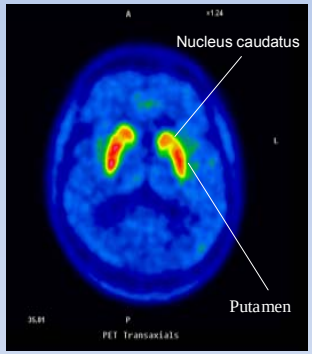


ESTUDIOS PRECLÍNICOS EN SUJETOS SANOS

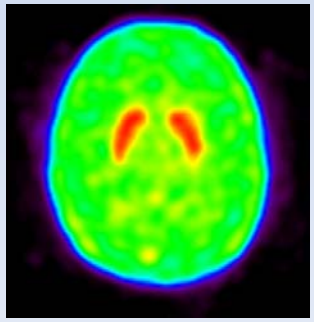


[11C]DTBZ

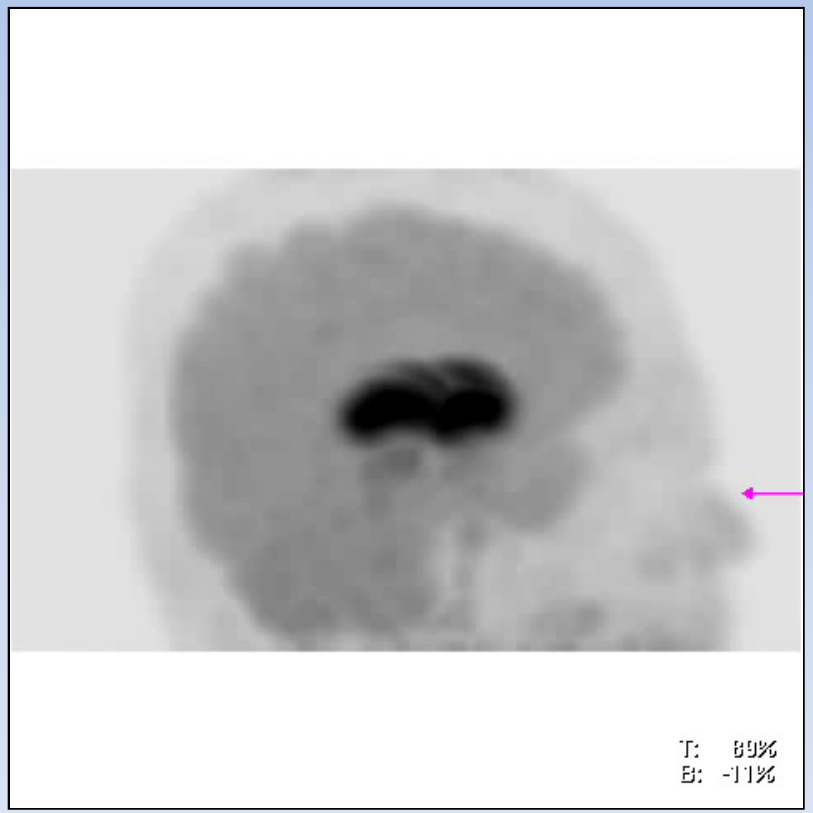


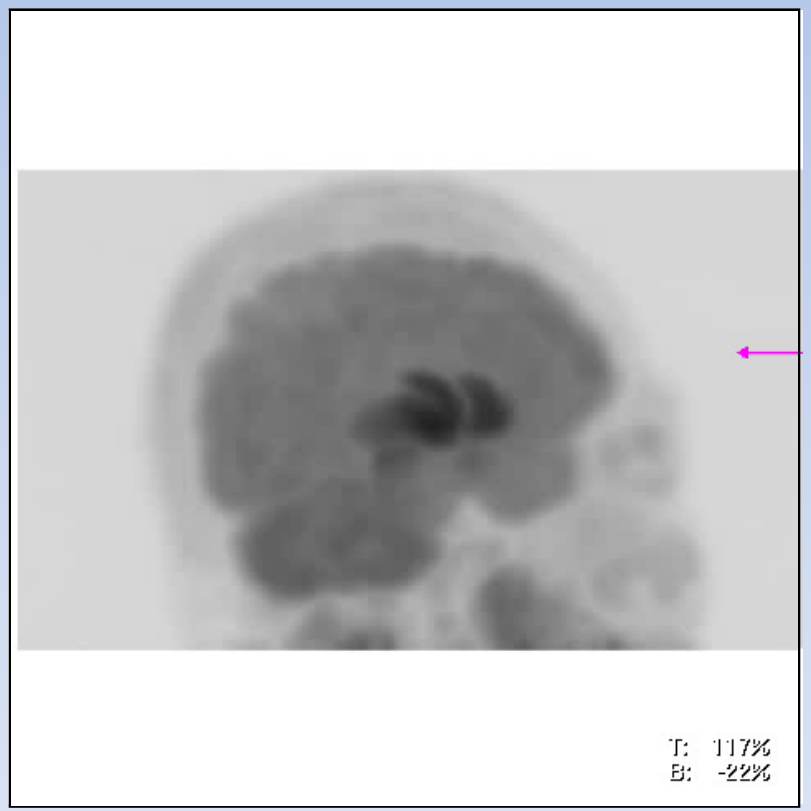


[11C]Raclopride



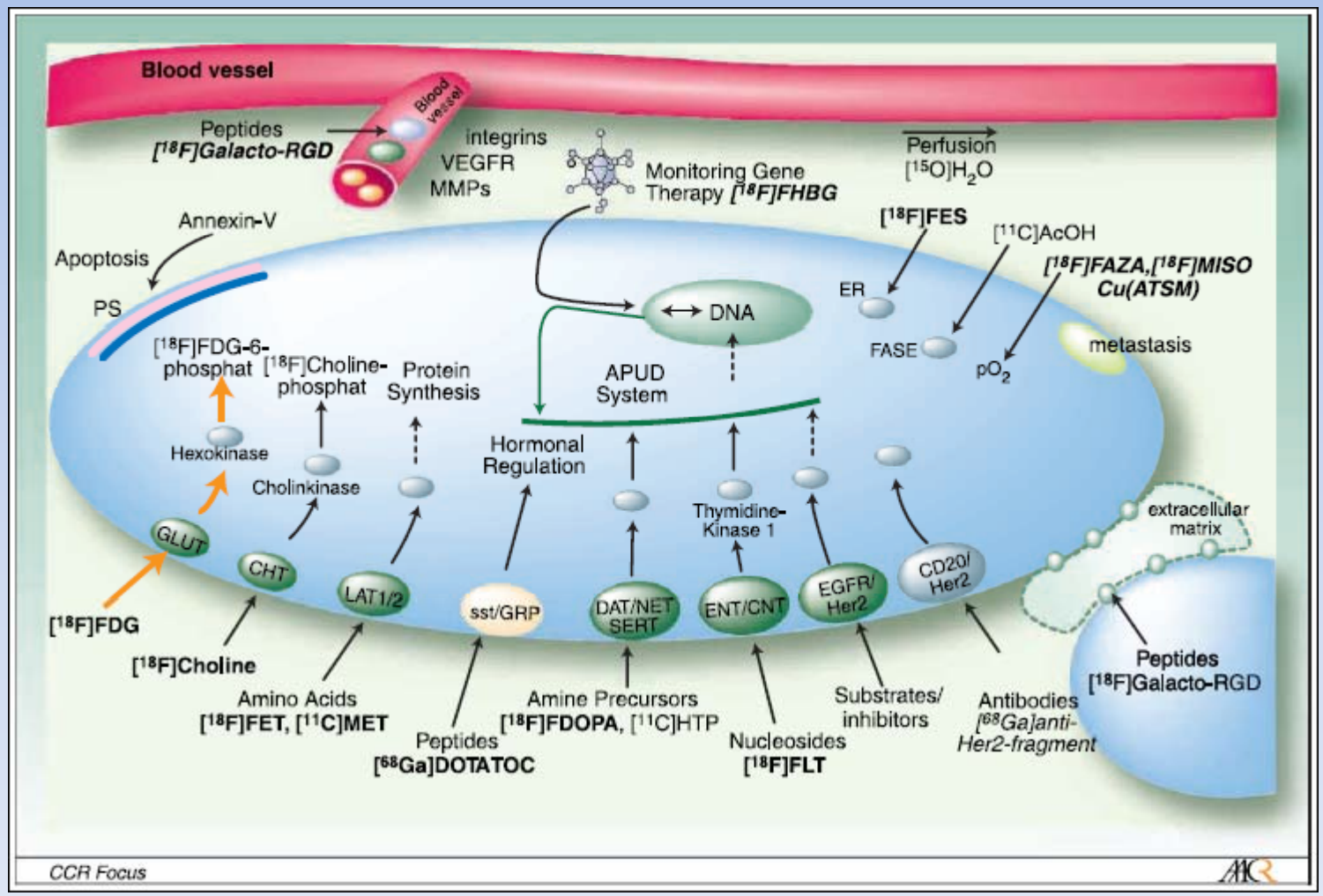
[^{11}C]DTBZ : SUJETO NORMAL *VS* PD





Nuestra Meta:

Radiofármacos Dirigidos a Blancos Moleculares Específicos



Wester, Clin Cancer Res 2007;13:3470-3481