

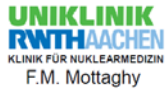


Deutsche Gesellschaft für Nuklearmedizin e.V.

Translational Research in Molecular Imaging and Radionuclid Therapy

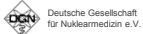
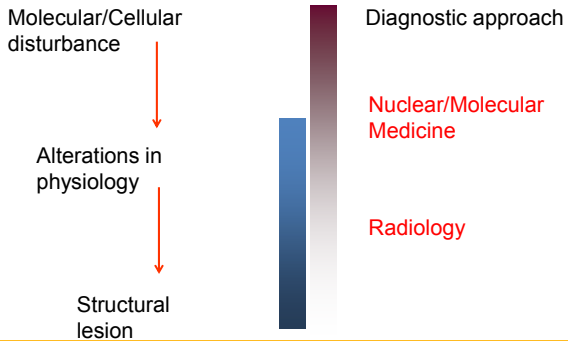
August 30 – September 1, 2018

Overview Molecular Imaging PET and SPECT





Medical imaging and the pathology cascade



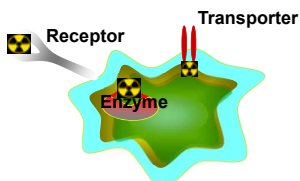
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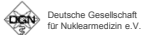
Molecular interactions of radiolabeled probes

In vivo imaging of biological processes with radiolabeled molecular probes



Visualization of overexpression or increased activity of:

- Receptors
- Enzymes
- Transporters

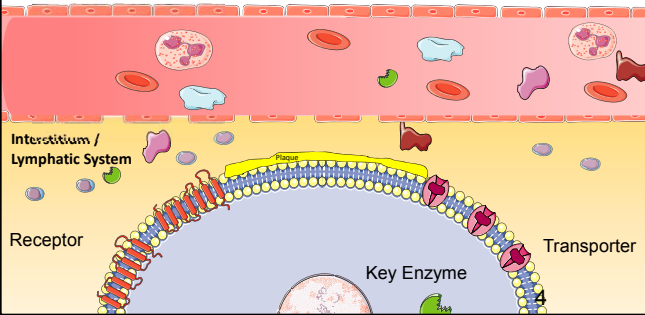


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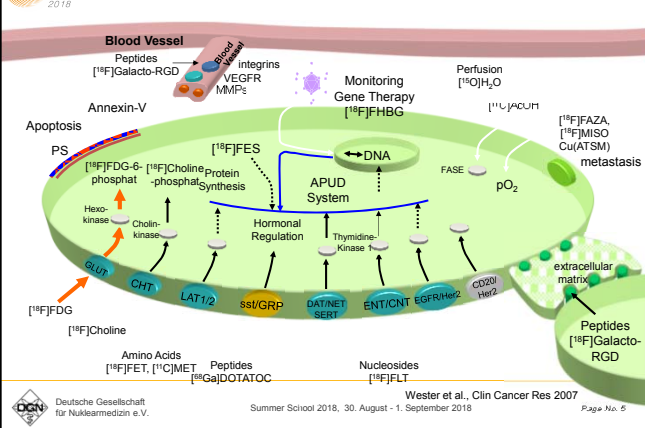
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Nuclear Molecular Imaging

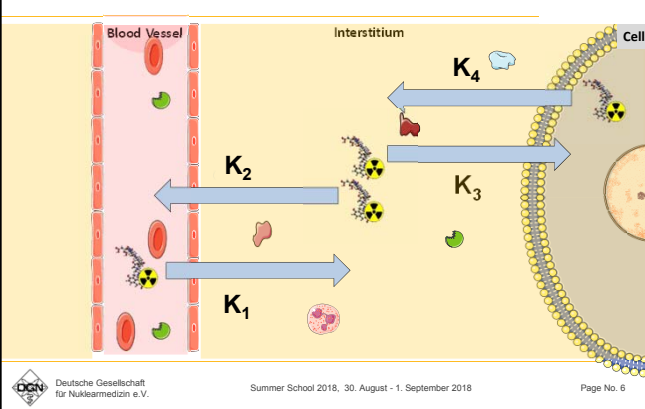
In vivo imaging of biological processes with radiolabeled molecular probes



Molecular Probes (Tracers)






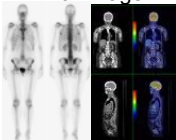



COMPARTMENT MODEL



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Steps to molecular image acquisition

- 1. Radionuclide**

- 2. Synthesis of radiopharmaceutical**

- 3. Radiopharmaceutical**

- 4. Application**

- 5. Scan**

- 6. Image**


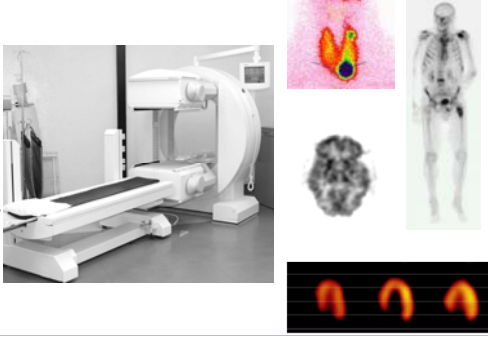
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Planar Scintigraphy

^{99m}Tc
 6h HWZ
 140 keV
Nuklid 

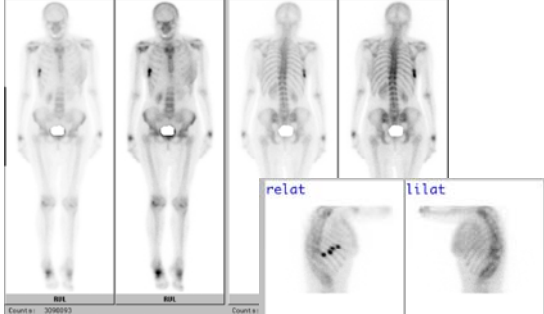
target-specific radiopharmaceuticals




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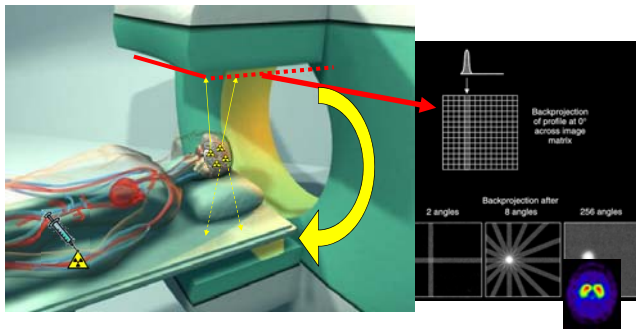
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Bone-Scintigraphy (^{99m}Tc -MDP)

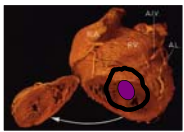


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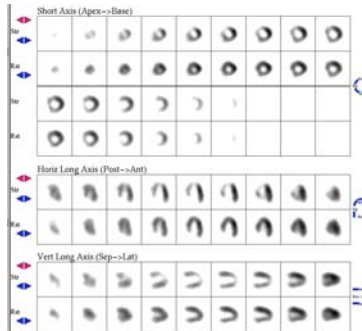
Single Photon Emission Computed Tomography (SPECT)



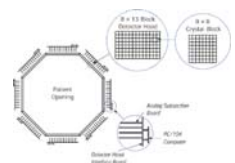
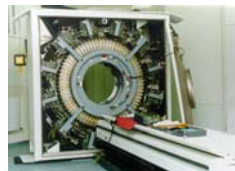
Myocardial SPECT Cardiovascular disease, ergometry until 75 Watt



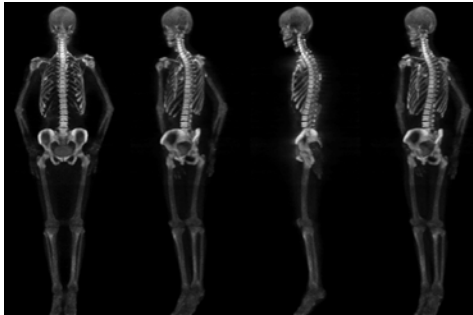
short axis
horiz. long axis
vert. long axis



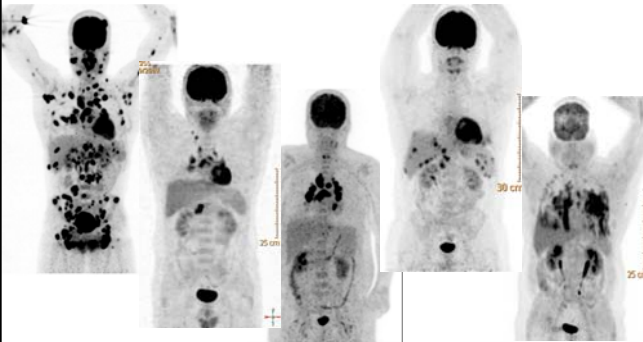
Positronen-Emissions-Tomographie (PET)



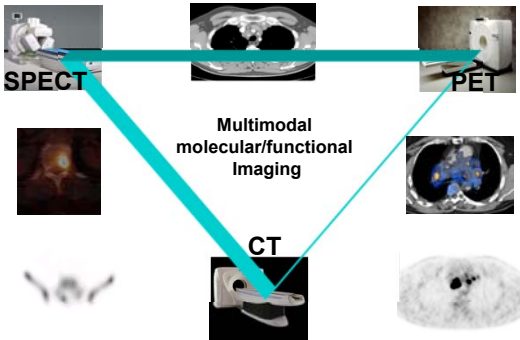
¹⁸F-Fluoride PET



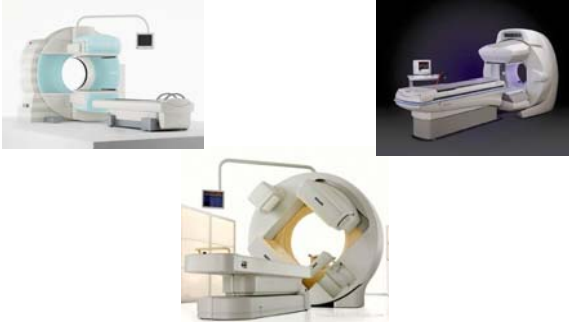
Fluorodeoxyglucose-PET (Sarkoidosis)



Multimodal molecular/functional Imaging



SPECT/CT



**SPECT/CT Prostate Cancer
Bone Scan**

Staging I

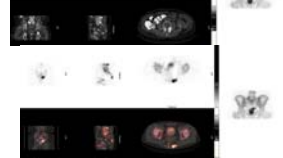


- Age 68 yrs., Post OP
- PSA increased
- Bone Scan, (745 MBq Tc-99m-HDP)
- SPECT/CT

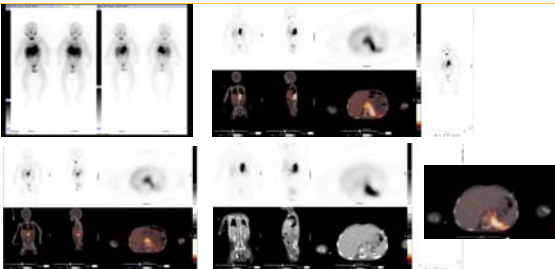
Staging II
Pedicle of vertebral arch



Staging III
Metastasis Os sacrum

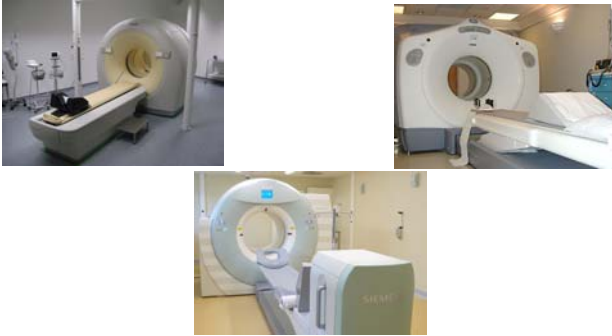


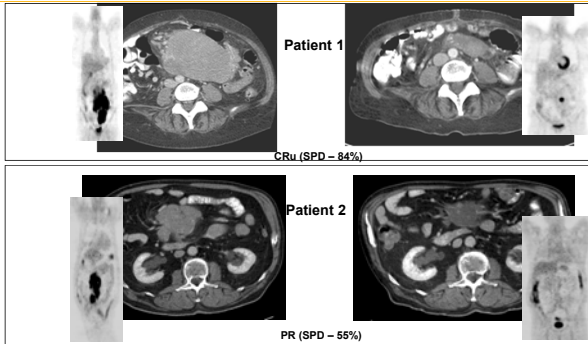
MIBG SPECT/CT



- 2 yrs., Neuroblastoma Stage IV, post therapy, Neuroblastoma recurrence with cerebral and abdominal metastases, Tumour progress under recurrence therapy
- Planar imaging and SPECT/CT with contrast agent 5 days post therapy

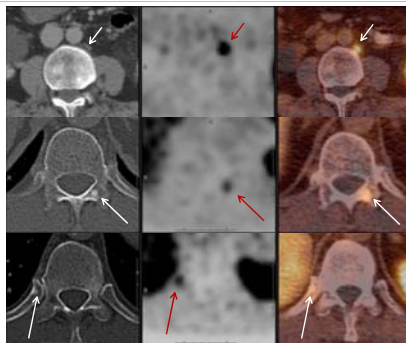
PET/CT





PSMA PET/CT

CT PET Fusion



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Bronchial carcinoid with sudden onset of blurry vision

FDG

DOTATATE

a b c d e f

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Small animal imaging

- Important for development of new tracer
- Final preclinical step in the process from bench to bedside
- μ SPECT / CT
- μ PET / CT

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Small Animal Imaging / Model Examples

Small Animal - PET/CT

Small Animal SPECT/CT

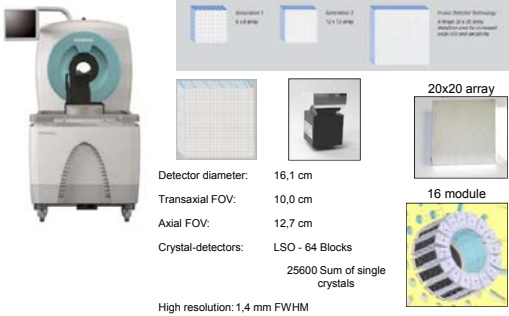
Small Animal PET/SPECT

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Micro PET: Dedicated Small Animal System

Micro PET Siemens Inveon



Detector diameter: 16,1 cm
 Transaxial FOV: 10,0 cm
 Axial FOV: 12,7 cm
 Crystal-detectors: LSO - 64 Blocks
 25600 Sum of single crystals
 High resolution: 1,4 mm FWHM
 Absolute Sensitivity: 100,0 cps / 1kBq , 10 %

20x20 array
 16 module

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Micro PET: Dedicated Small Animal System

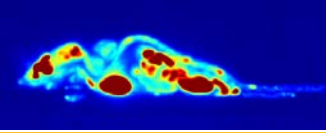
Micro PET Siemens Inveon

Micro PET - measurement of the glucose metabolism with ^{18}F -FDG and of the skeleton with the bone affine radiopharmaceutical ^{18}F -NaF in a mouse.

^{18}F -Sodium fluoride




^{18}F -Fluorodesoxyglucose



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Digital PET Sub-System



- Digital PET = direct coupling of scintillator to solid-state detectors
- No light sharing between detectors (better image quality)
- Patented Fast 3D Tomographic Image Reconstruction (December 2013)
- => Improved detectability of small lesions
- => High count rate capability from very low activity to 80MBq
- => Superior image quality with excellent contrast ratio

◆ Bore diameter: 15cm
 ◆ Transaxial FOV: User-selectable 46-100 mm
 ◆ Axial FOV: 30cm (continuous motion)
 - LabPET4
 - LabPET8
 - LabPET12

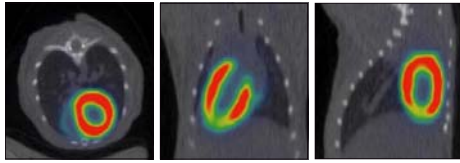
• Quad-APD detector modules coupled with LYSO/LGSO phaswich scintillators
 • Individual readout, parallel signal processing
 • Fully integrated with SPECT and CT;
 • field-upgradable

TriFoil

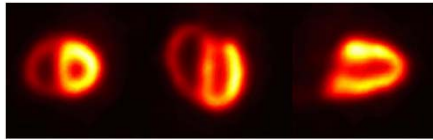
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PET/CT Cardiac Imaging - Mouse

PET/CT:
0.7mCi of
FDG, 20min.
Post injection,
5 min. scan

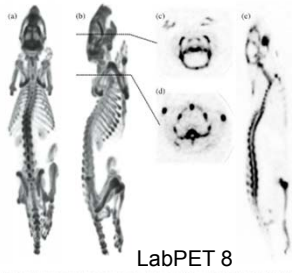


Detail of gated
cardiac images



Courtesy of Dr. Ren-Shyan Liu, National Yangming University, Taipei, Taiwan

Excellent isotropical resolution: 185 g rat



LabPET 8



TriFoil

Figure 10. Volume-rendered images (a), (b) of a 185 g rat injected with 31 MBq of ^{18}F and scanned 68 min post-injection on the LabPETS. Transaxial slices of the skull (c) and the ribcage (d) and a sagittal slice (e) are shown. The whole-body image was obtained by acquiring five overlapping decay-compensated scans with 3.78 cm steps for a total of 60 min. The image was obtained with a lower energy threshold of 350 keV and reconstructed using 80 3D MLEM iterations.

Reference: Imaging performance of LabPET APD-based digital PET scanners for pre-clinical research; M. Bergeron et al.; Université de Sherbrooke, QC, Canada; Phys. Med. Biol. 59 (2014) 1-18

Small Animal Imaging / Model Examples



Small Animal -SPECT/CT



Small Animal -SPECT/CT

MMP - SPECT

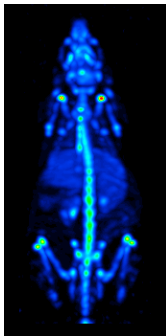


MMP - SPECT

Micro SPECT: Measurement with MMP-Technology by a clinically used SPECT gamma camera

SPECT

^{99m}Tc-HDP



MMP - SPECT

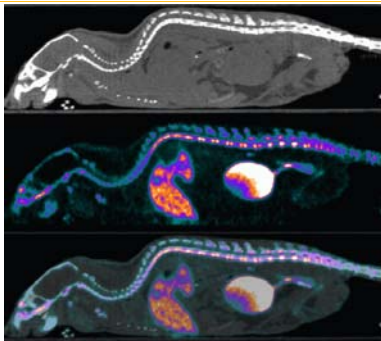
Micro SPECT: Measurement of a mouse bone skeleton with ^{99m}Tc-HDP

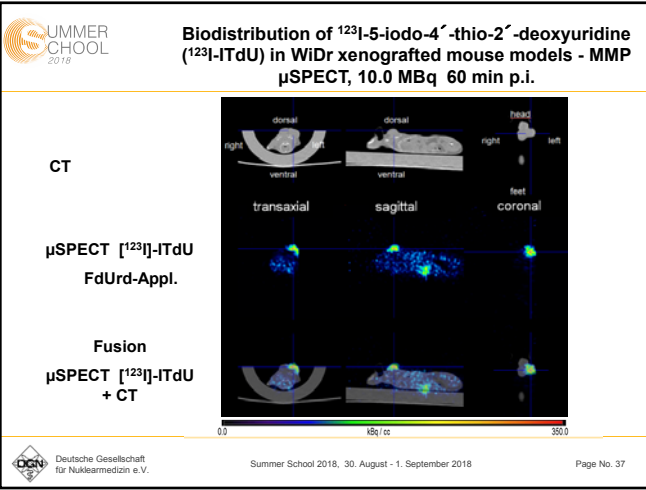
CT

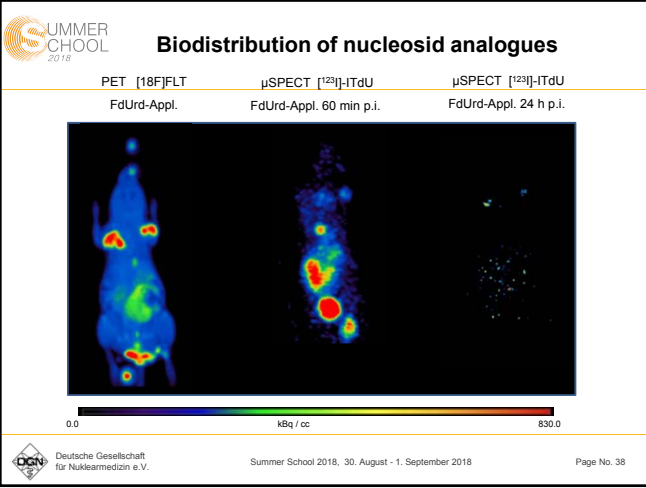
^{99m}Tc-Hydroxy-Diphosphonat

Fusion

CT - ^{99m}Tc-HDP SPECT







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Examples for small animal imaging: biodistribution studies play a major role

- **New tracer development**
- **New pharmaca development**
- **Therapy studies**

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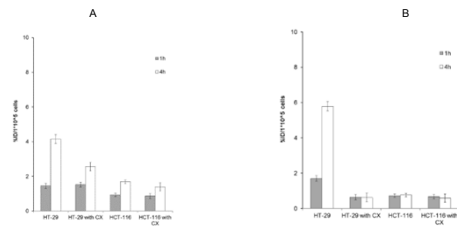


Fig. 4. Cellular uptake with ¹²⁵I-1 and ¹²⁵I-2 compounds in colon carcinoma cells after 1h and 4h incubation (in % of incubated dose (ID) weil). (A) Cellular uptake of ¹²⁵I-1 in HT29 and HCT-116 cells w/o and with CX. (B) Cellular uptake of ¹²⁵I-2 in HT29 and HCT-116 cells w/o and with CX.

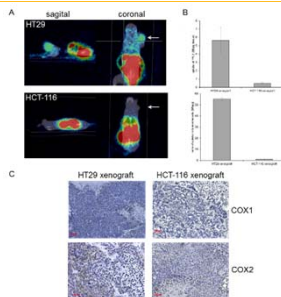
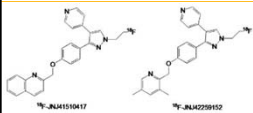
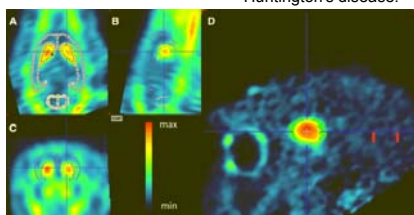


Fig. 5. *In vivo* study with ¹²⁵I-2 compound in colon carcinoma xenografted SCID mice. (A) μPET/CT molecular imaging of COX-2 with ¹²⁵I-1 in HT29 (upper panel) and HCT-116 (lower panel) xenografted SCID mice at 4h p.i.. (B) Uptake of ¹²⁵I-2 in HT29 and HCT-116 tumors (in kBq/g tissue) (upper panel); tumor to muscle uptake ratio of ¹²⁵I-2 in HT29 and HCT-116 tumor xenografted mice (lower panel). (C) Immunohistochemical analysis of COX-1 and COX-2 in HT29 and HCT-116 xenografts.

New pharmaca development



Phosphodiesterase-10A (PDE10A) is implicated in several neuropsychiatric disorders involving basal ganglia neurotransmission, such as schizophrenia, obsessive-compulsive disorder and Huntington's disease.



Take home

- SPECT and PET
 - provide a broad spectrum of diagnostic approaches
 - help to understand biological processes
 - are an important link in the „bench to bedside“ concept of probe development
- Molecular Imaging
 - is important for non-invasive monitoring of disease
 - supports development of new theranostic concepts
