PET/SPECT LIGANDS AND RTP

H.J. Tochon-Danguy

2005

BACKGROUND

- The aim of Radiotherapy Treatment Planning is to apply a dose as high as possible to a tumor *without affecting too much adjacent healthy tissue*.

- The target volume definition appears to be a critical factor of the planning and is currently based on computer tomography (CT) and magnetic resonance imaging (MRI).

- Unfortunately, a significant number of these radiotherapy treatments still fail each year, and one of the reasons seems to be that the required radiation dosage is not delivered to *the critical tumor areas*.

BIOLOGICAL TARGET VOLUME

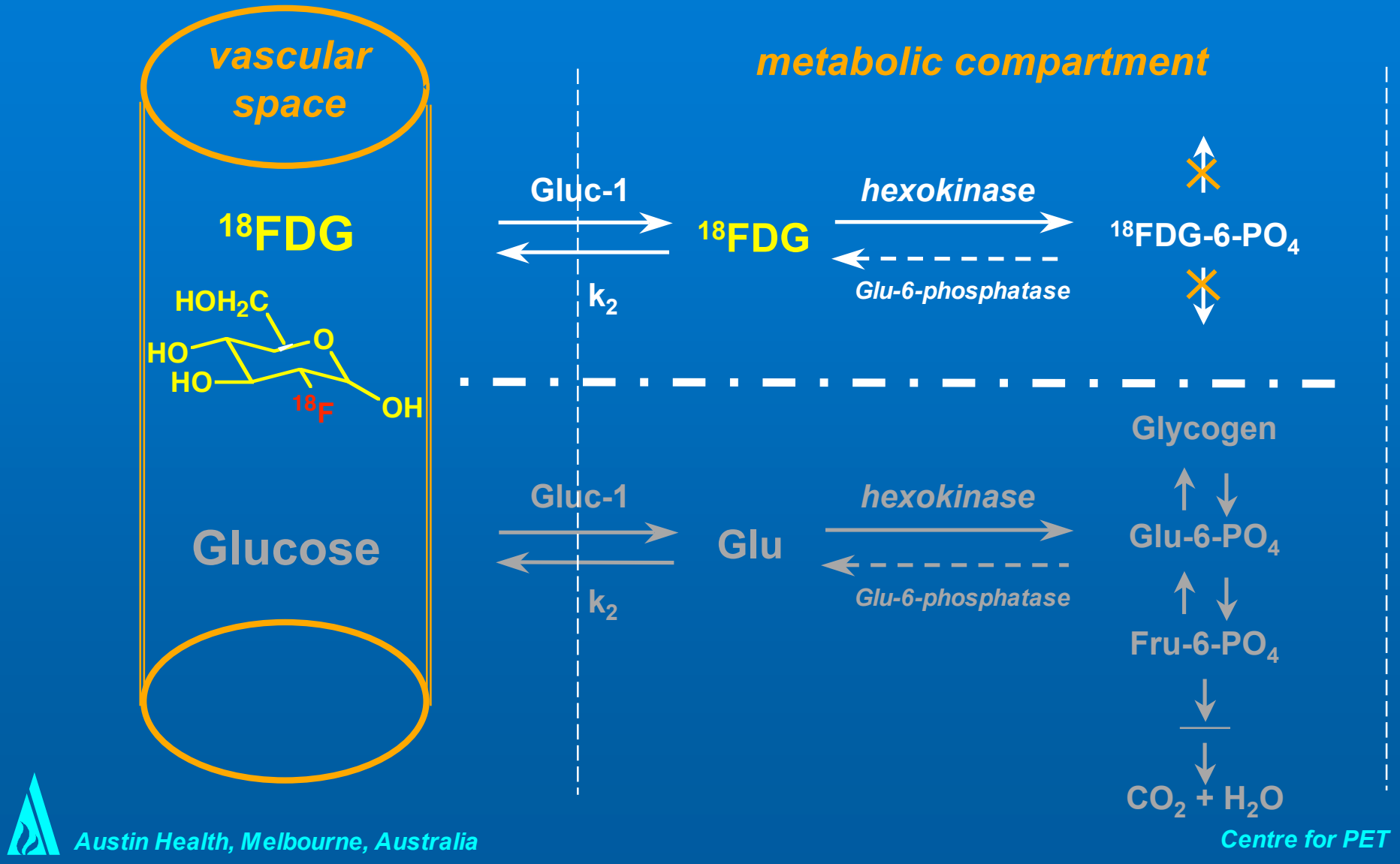
- Indeed, methods such as PET & SPECT which permit the visualisation of biological processes have begun to have a major impact on radiation therapy.

  - Which biological processes are involved in the retention of some specific PET tracers, and how are these tracers trapped in the cells?
  - Clinical studies to show the possible variation in tumor target volume, when imaging with CT/MRI techniques or with PET tracers.

PET/SPECT TRACERS USED IN ONCOLOGY

^{18}F-FDG, ^{11}C-methionine	→ Metabolism
^{15}O-H_2O, ^{99m}Tc-HMPAO	→ Blood flow
^{18}F-FLT, ^{11}C-choline	→ Cell proliferation/DNA
^{18}F-FMISO, ^{123}I-IAZA	→ Hypoxic tissue
^{18}F-caspase, ^{99m}Tc-annexin V	→Apoptosis markers
^{124}I-huA33, ^{18}F-AG1478	→ Molecular targeting

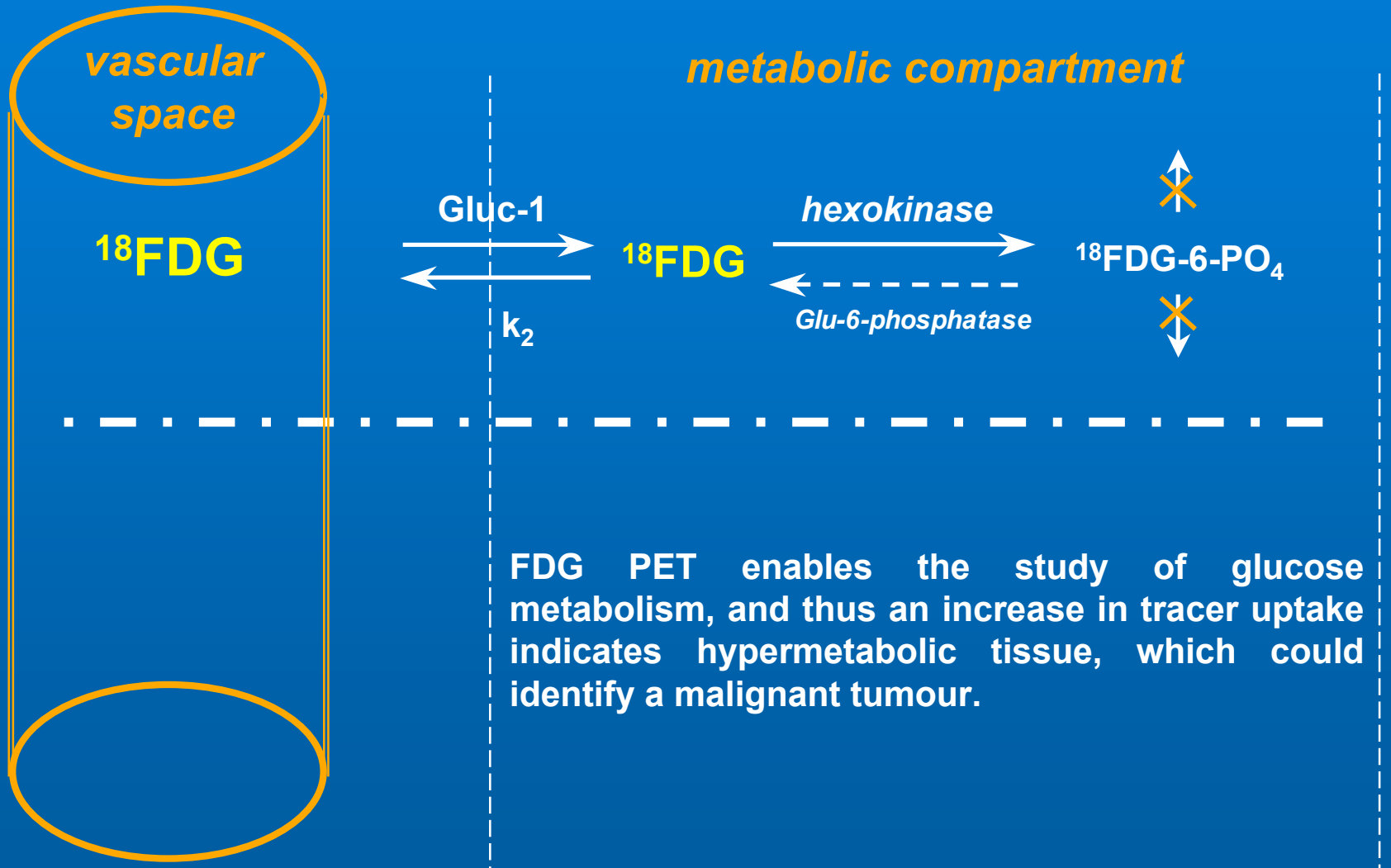
FDG CELL RETENTION MECHANISM



Austin Health, Melbourne, Australia

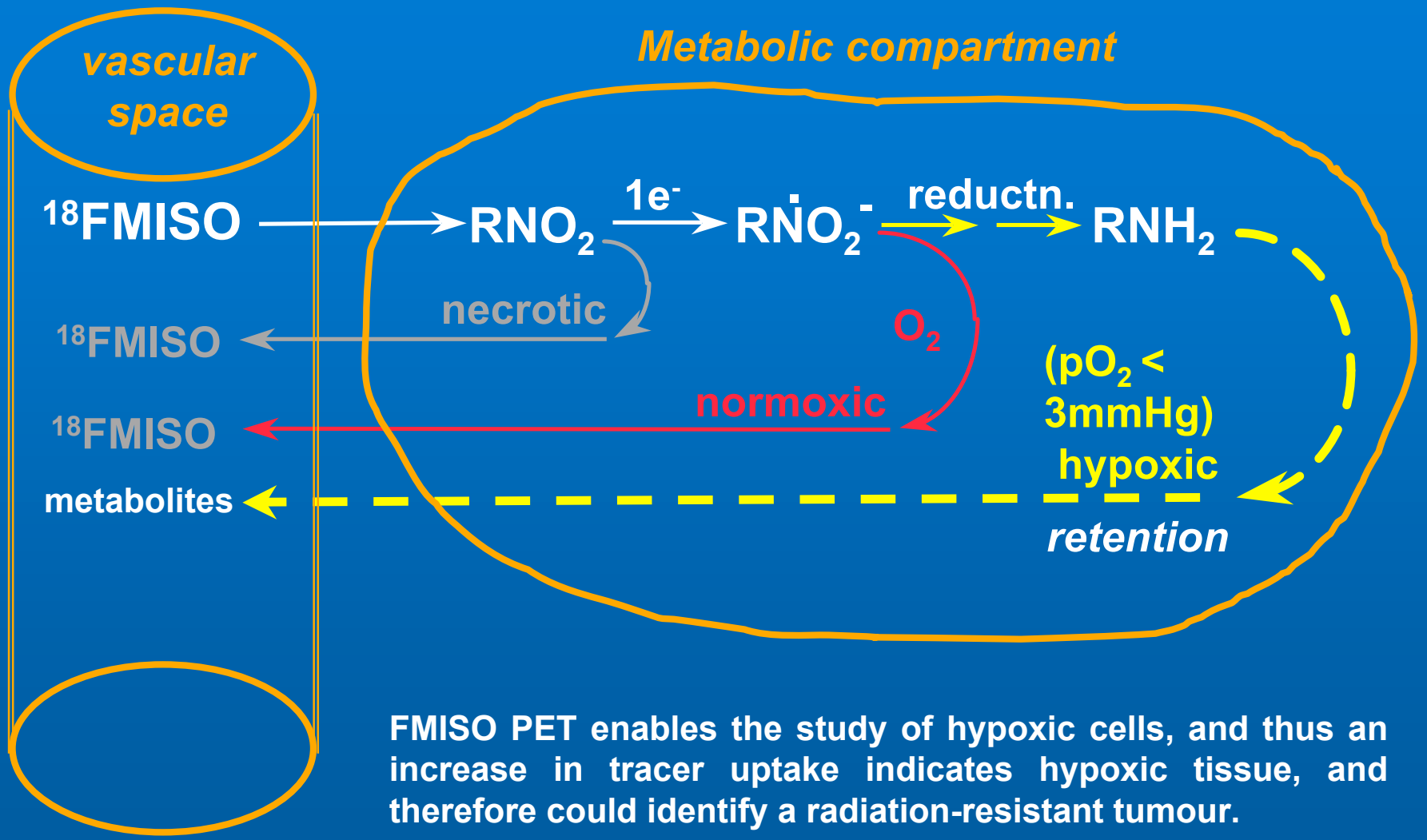
Centre for PET

FDG CELL RETENTION MECHANISM



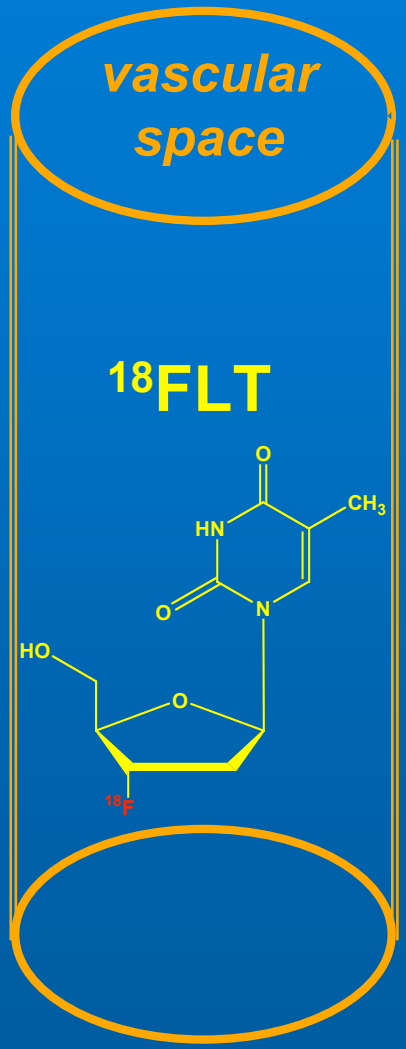
FDG PET enables the study of glucose metabolism, and thus an increase in tracer uptake indicates hypermetabolic tissue, which could identify a malignant tumour.

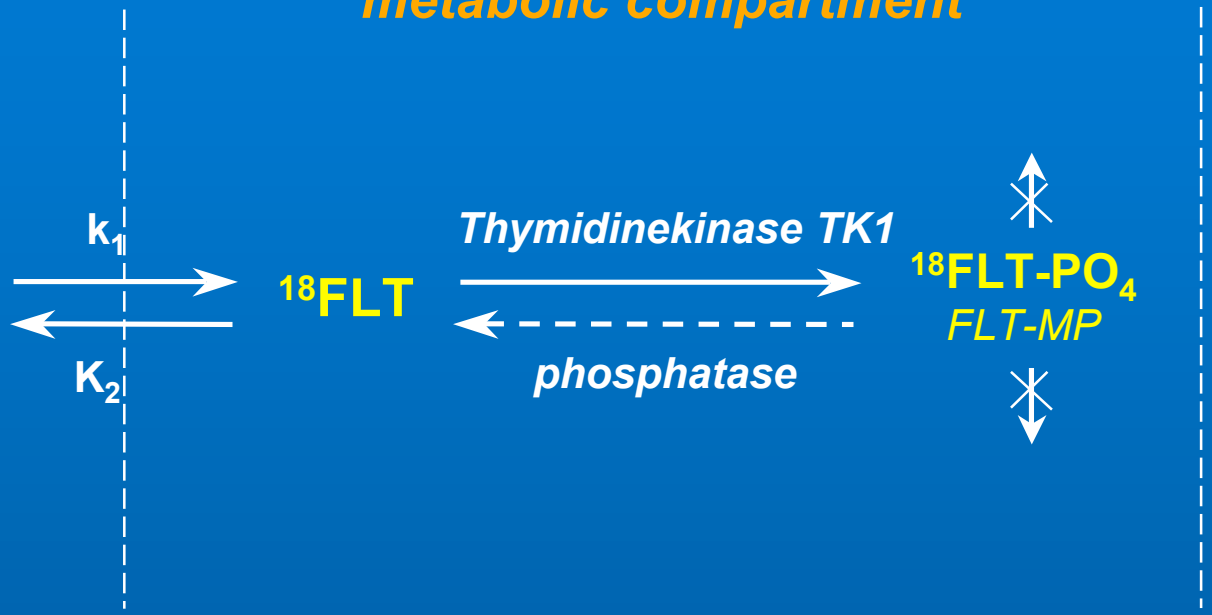
FMISO CELL RETENTION MECHANISM



FMISO PET enables the study of hypoxic cells, and thus an increase in tracer uptake indicates hypoxic tissue, and therefore could identify a radiation-resistant tumour.

FLT CELL RETENTION MECHANISM

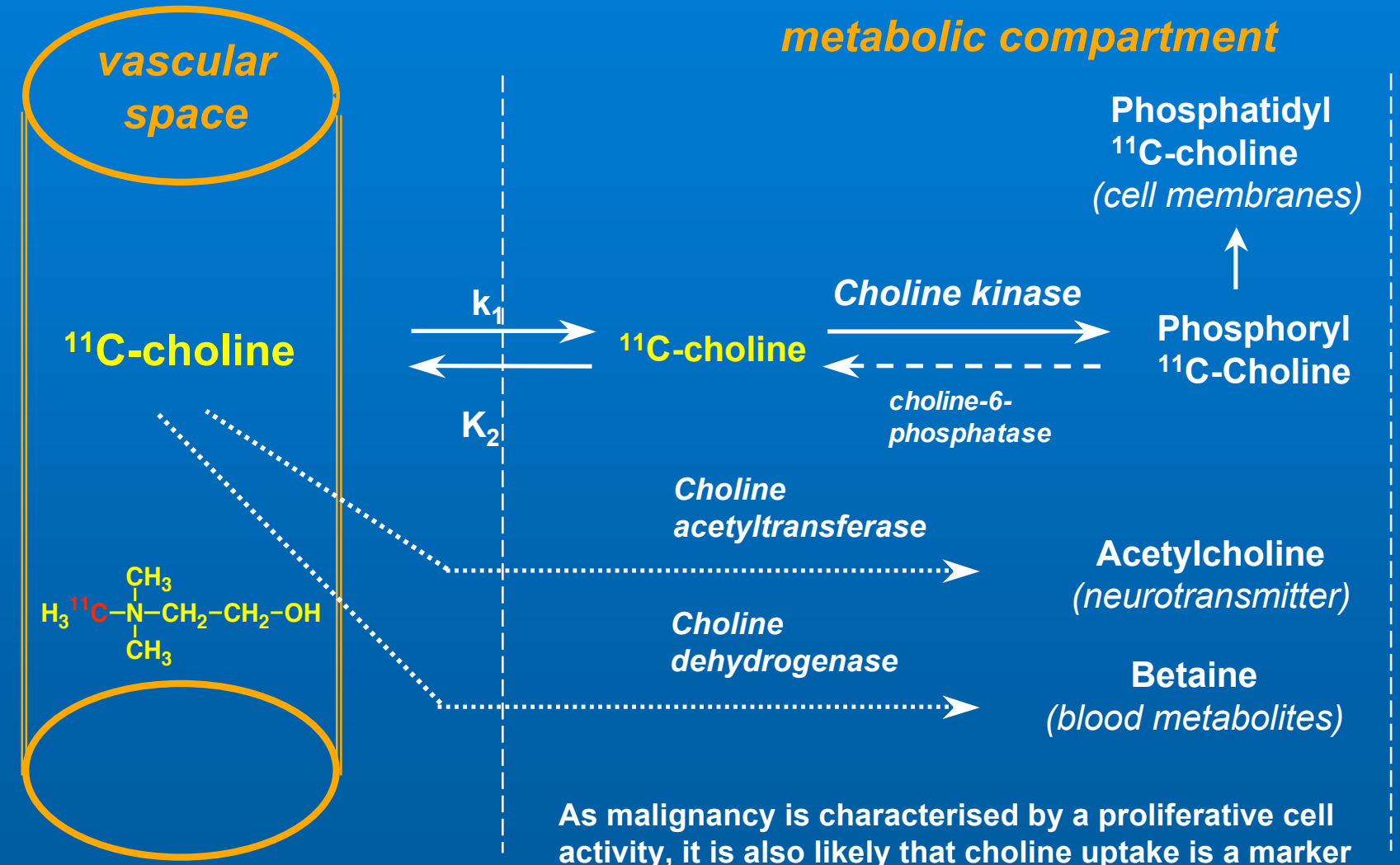




FLT PET enables the study of the activity of the *TK1*, and thus an increase in tracer uptake indicates hyperenzymatic activity, which could identify a malignant tumour.

Activity of the cytoplasmic enzyme thymidinekinase (TK1) is known to be high in proliferating and malignant cells.

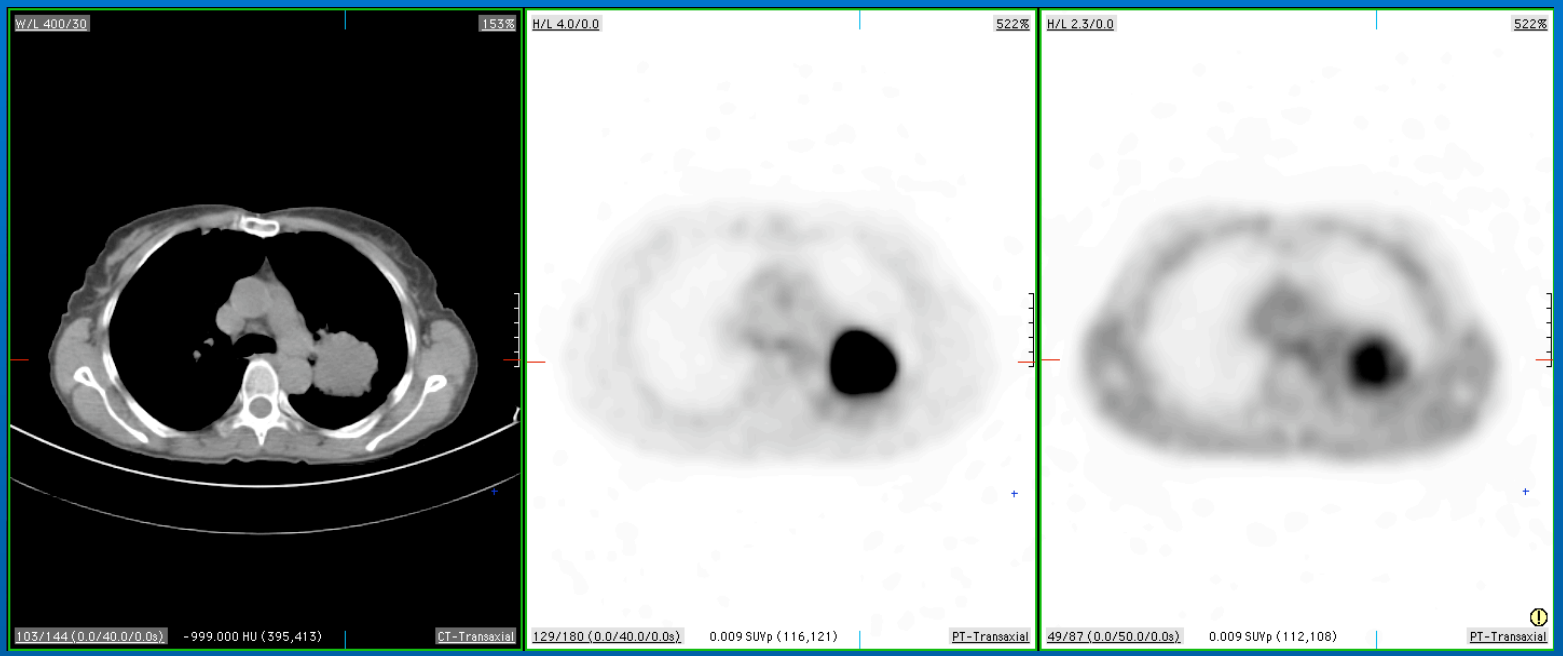
CHOLINE CELL RETENTION MECHANISM



As malignancy is characterised by a proliferative cell activity, it is also likely that choline uptake is a marker for tumoral tissue.

TARGET DEFINITION

CT FDG FMISO

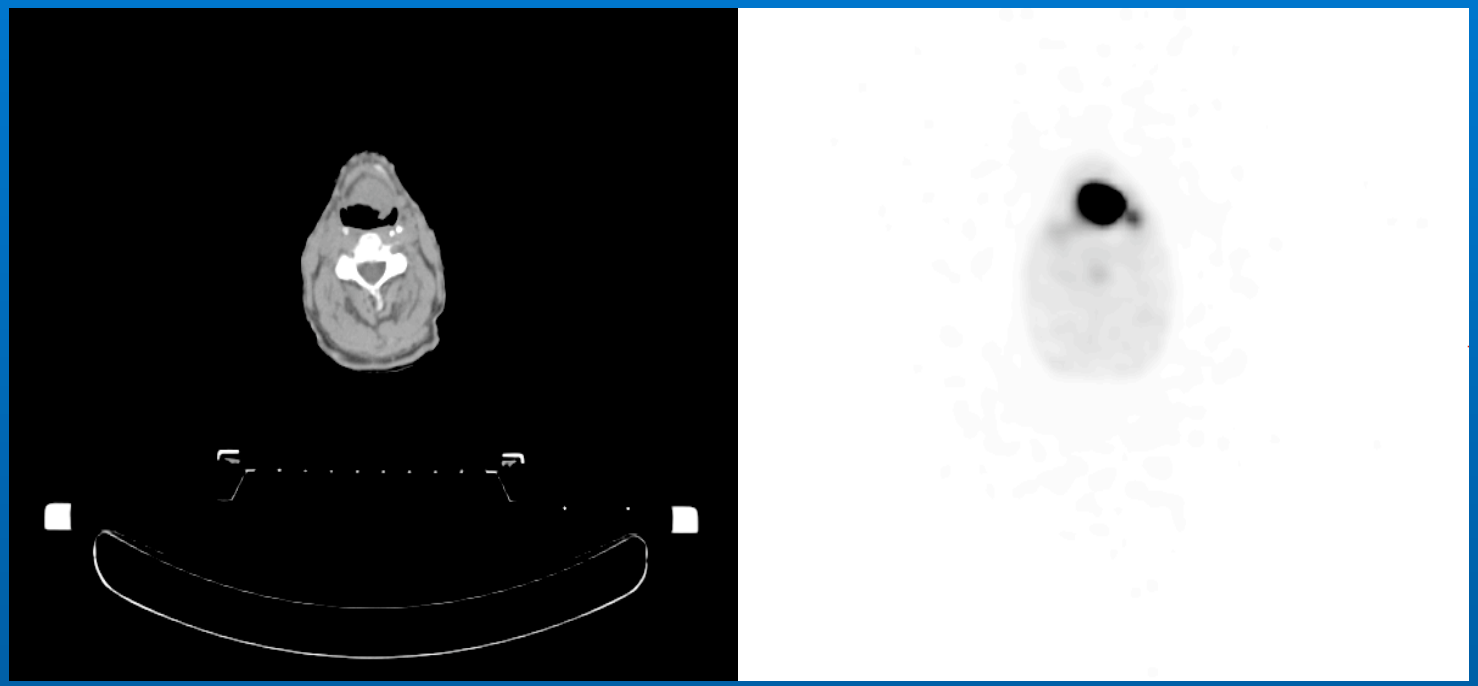


Lung tumor

TARGET DEFINITION

CT

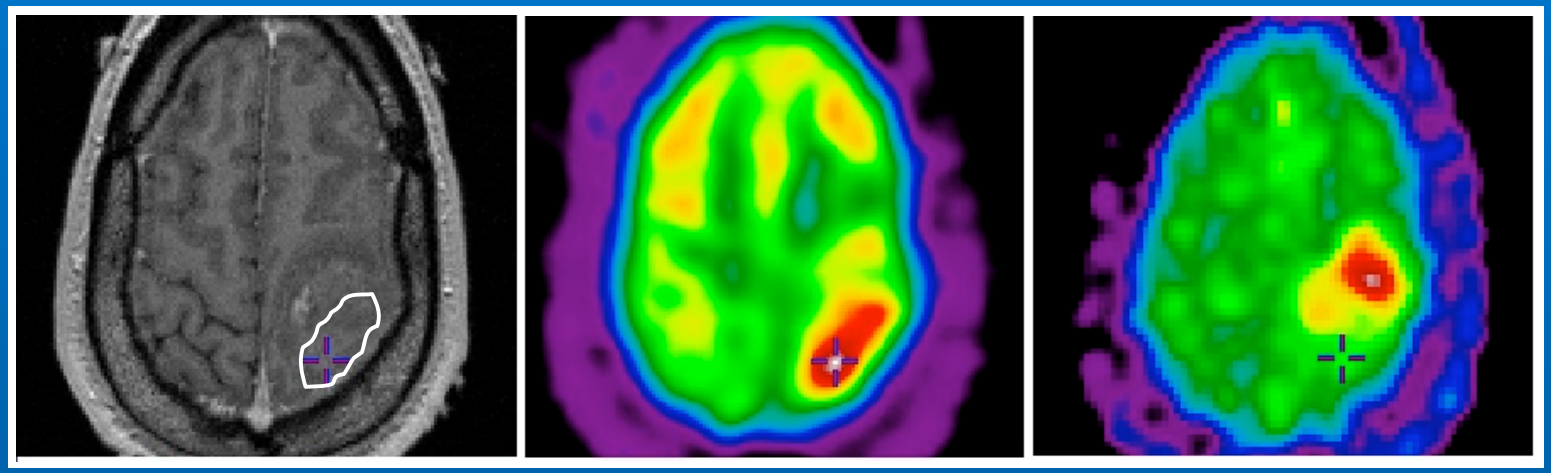
FDG



Head & neck tumor

TARGET DEFINITION

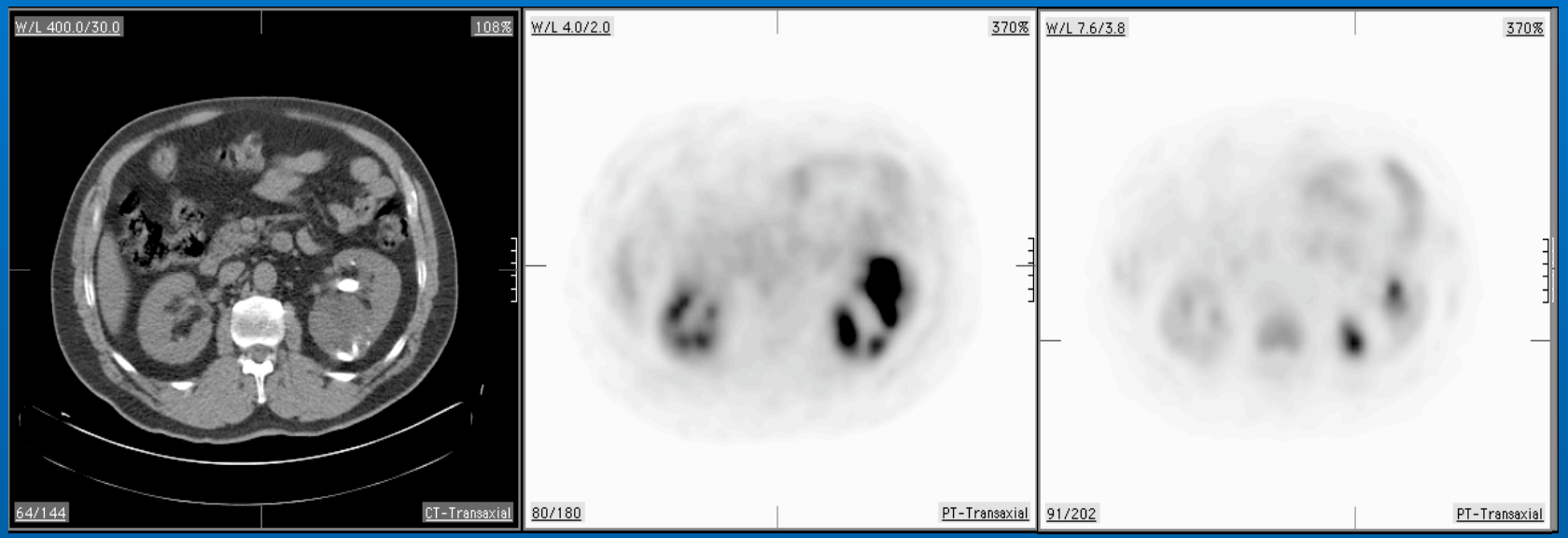
MRI FDG FMISO



Brain Glioma

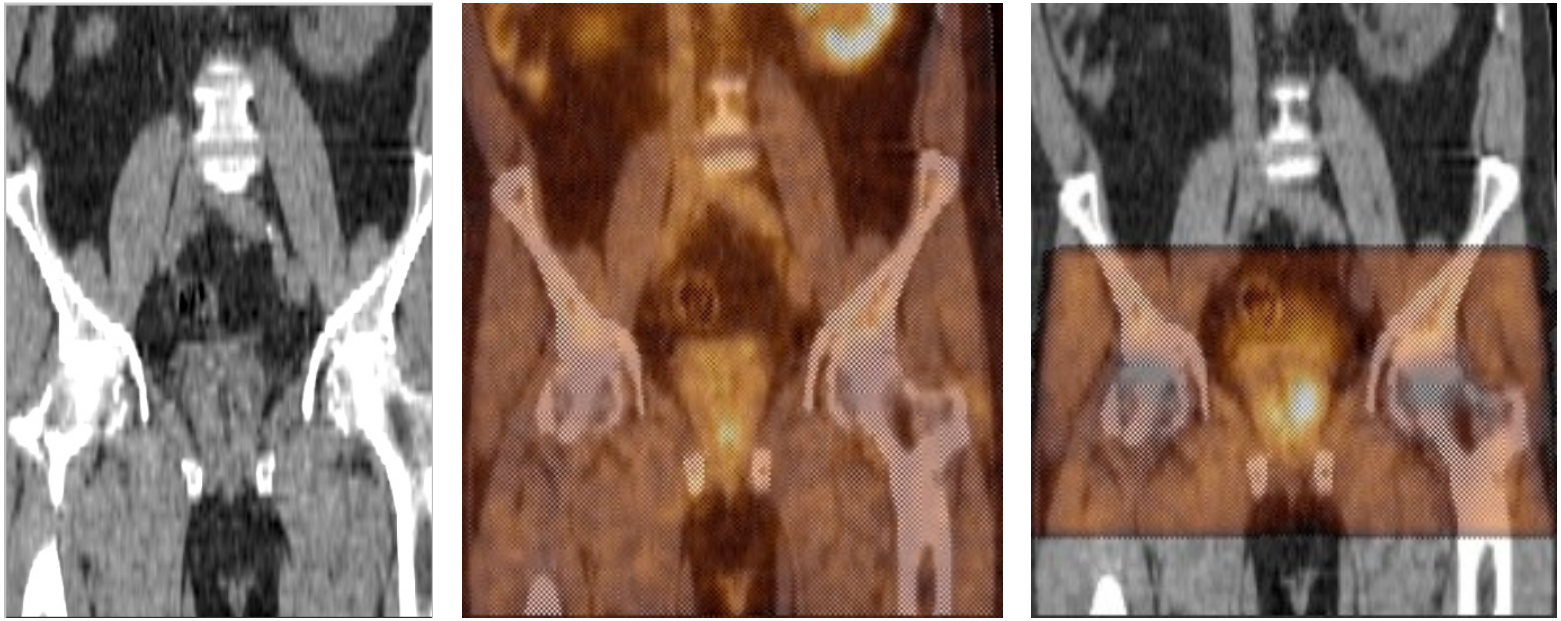
TARGET DEFINITION

CT FDG FLT



TARGET DEFINITION

CT | FDG PET | CHOLINE PET



Prostate cancer

CONCLUSION

The use of PET or SPECT for imaging cell proliferation and hypoxia leads to the identification of different areas of a biologically heterogeneous tumor mass.

This new biological target volume is significantly different from CT or MRI morphological target volume.

However future clinical studies still need to be conducted to confirm the suggested superiority of biological strategies for radiotherapy treatment planning (RTP).

Acknowledgements

Centre for PET
Austin Hospital
John Sachinidis
Sylvia Gong
Kunthi Pathmaraj
Graeme O'Keefe
Sam Berlangieri
Andrew Scott