Doses from Radiation Exposure

ICRP Symposium on the International System of Radiological Protection

October 24-26, 2011 – Bethesda, MD, USA

Hans Menzel
ICRP Committee 2

SYMPOSIUM
October 24-26
2011

Committee 2
Doses From Radiation Exposure

Committee 2 is concerned with the development of **reference dose coefficients** for the assessment of **internal and external radiation exposure**, and the development of **reference biokinetic and dosimetric** models; and reference data for workers and members of the public.

Committee 2 Members

Hans-Georg Menzel(Chair) (CH)

John Harrison (Vice-chair) (UK)

Mike Bailey (UK)

Mikhail Balonov (RU)

David Bartlett (UK)

Vladimir Berkovski (UKR)

Wesley Bolch(US)

Roger Cox (UK)

Günther Dietze (DE)

Keith Eckerman(US)

Akira Endo (JP)

Nobuhito Ishigure (JP)

Rich Leggett (US)

Joyce Lipsztein (BR)

Jizeng Ma (CHN)

Francois Paquet (FR)

Nina Petoussi Henss (DE)

Sambika Sahai Pradhan (IND)

Recent ICRP Publications prepared by C2 and its Task Groups

- **Publication 89**

Basic Anatomical and Physiological Data for Use in Radiological Protection Reference Values

- **Publication 95**

Doses to Infants from Ingestion of Radionuclides in Mothers' Milk

- **Publication 100**

Human Alimentary Tract Model for Radiological Protection

- **Publication 107**

Nuclear Decay Data for Dosimetric Calculations

- **Publication 110**

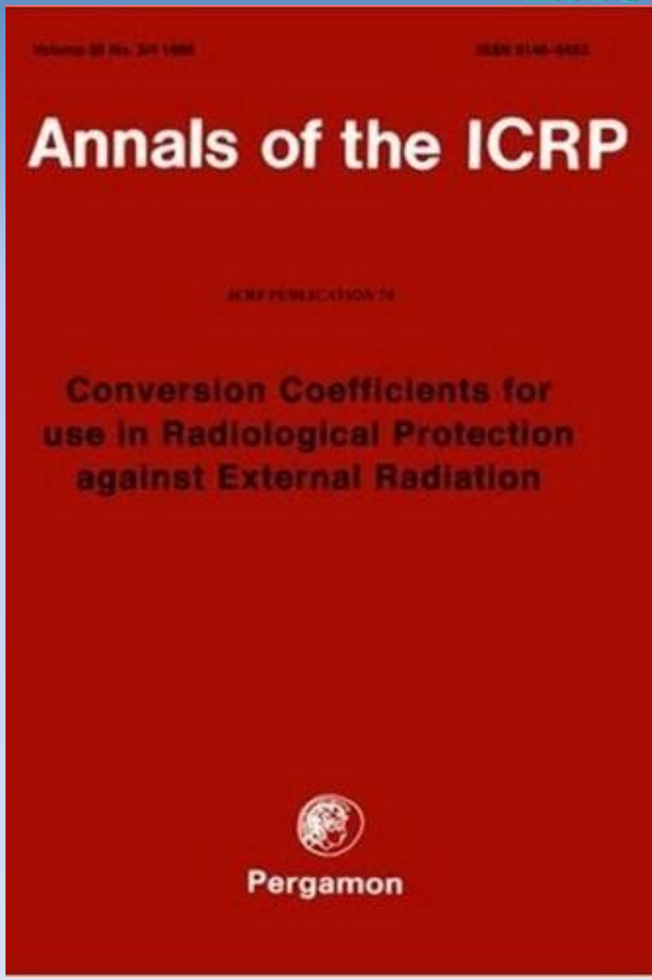
Adult Reference Computational Phantoms

Current Task Groups of Committee 2

- Task Group 4 (DOCAL)
  Dose Calculations
- Task Group 21 (INDOS)
  Internal Dosimetry
- Task Group 67
  Radiation Protection in Space
- Task Group 79 jointly with C 1, C 2, C 4)
  The Use of Effective Dose

Active involvement in TGs of all other Committees

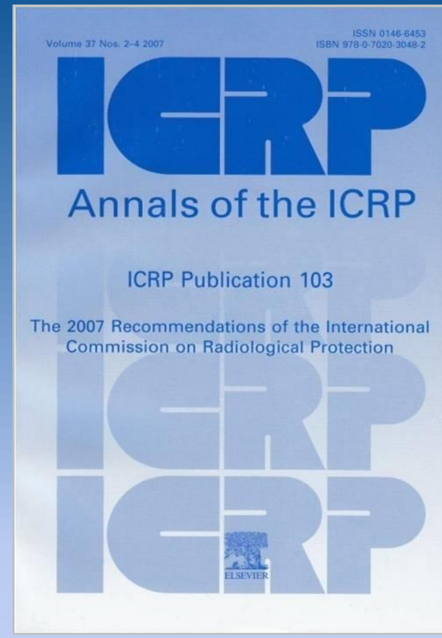
Conversion Coefficients for External Radiation



Conversion from field quantities (fluence, air kerma) to dose quantities (organ absorbed dose, equivalent dose, effective dose)

Why new dose conversion coefficients?

Published in 1997
also published as ICRU report 57


Volume 37 Nos. 2-4 2007
ISSN 0146-6453
ISBN 978-0-7020-3048-2
ICRP
Annals of the ICRP
ICRP Publication 103
The 2007 Recommendations of the International Commission on Radiological Protection
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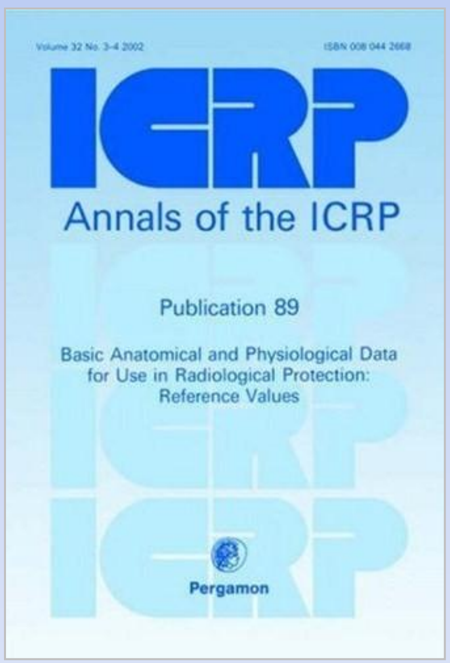
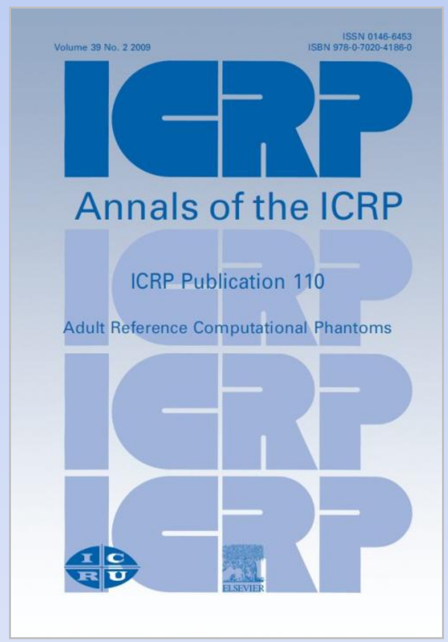

Volume 32 No. 3-4 2002
ISBN 008 044 2668
ICRP
Annals of the ICRP
Publication 89
Basic Anatomical and Physiological Data for Use in Radiological Protection: Reference Values
Pergamon


Volume 39 No. 2 2009
ISSN 0146-6453
ISBN 978-0-7020-4186-0
ICRP
Annals of the ICRP
ICRP Publication 110
Adult Reference Computational Phantoms
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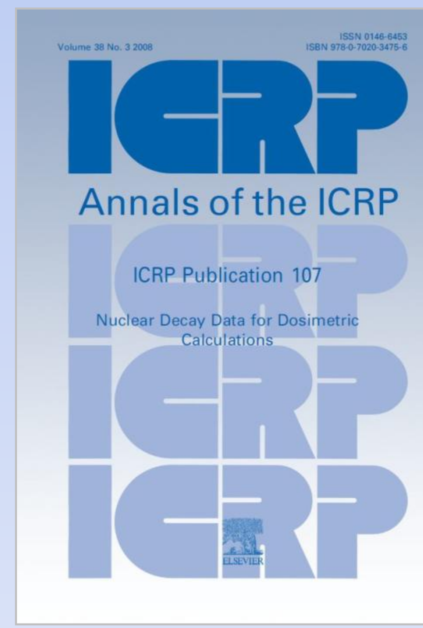
Volume 38 No. 3 2008
ISSN 0146-6453
ISBN 978-0-7020-3475-6
ICRP
Annals of the ICRP
ICRP Publication 107
Nuclear Decay Data for Dosimetric Calculations
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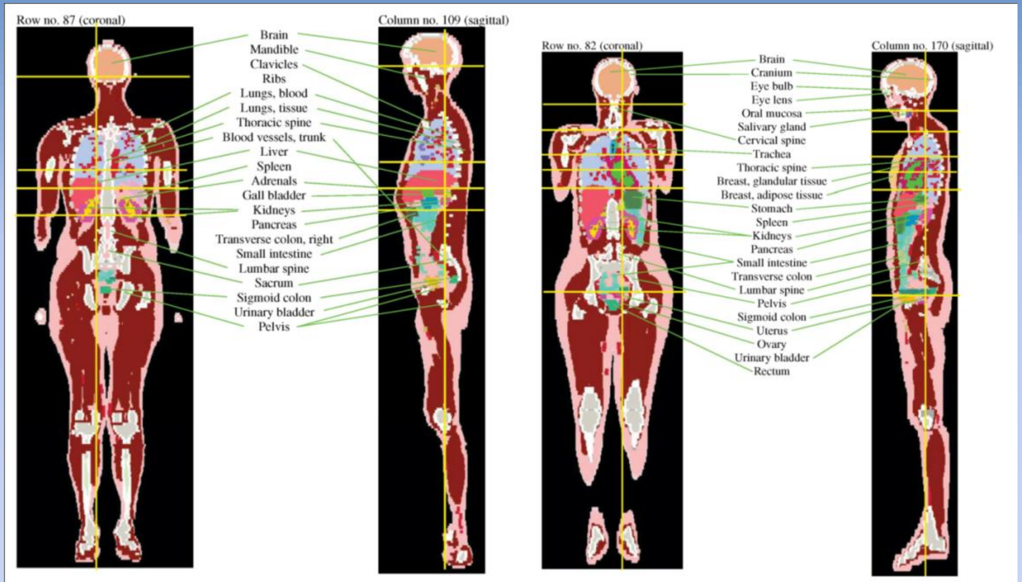
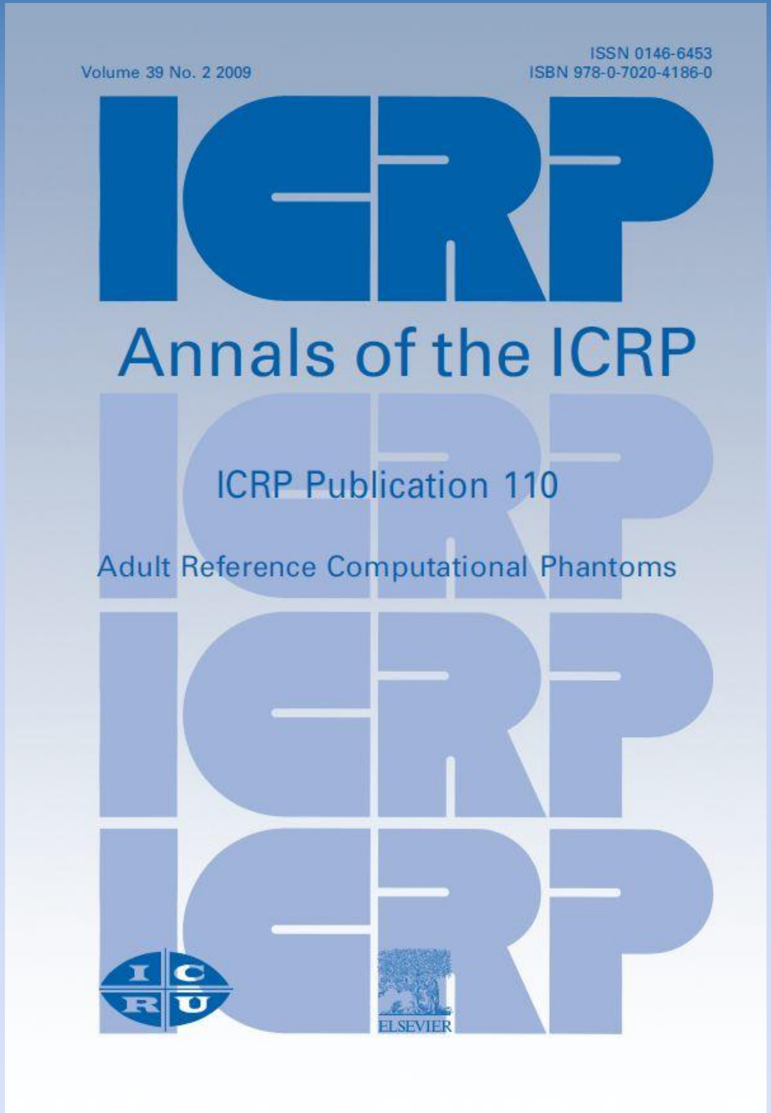
ICRP Publication 110 – Adult Reference Computational Phantoms

Joint Publication with ICRU

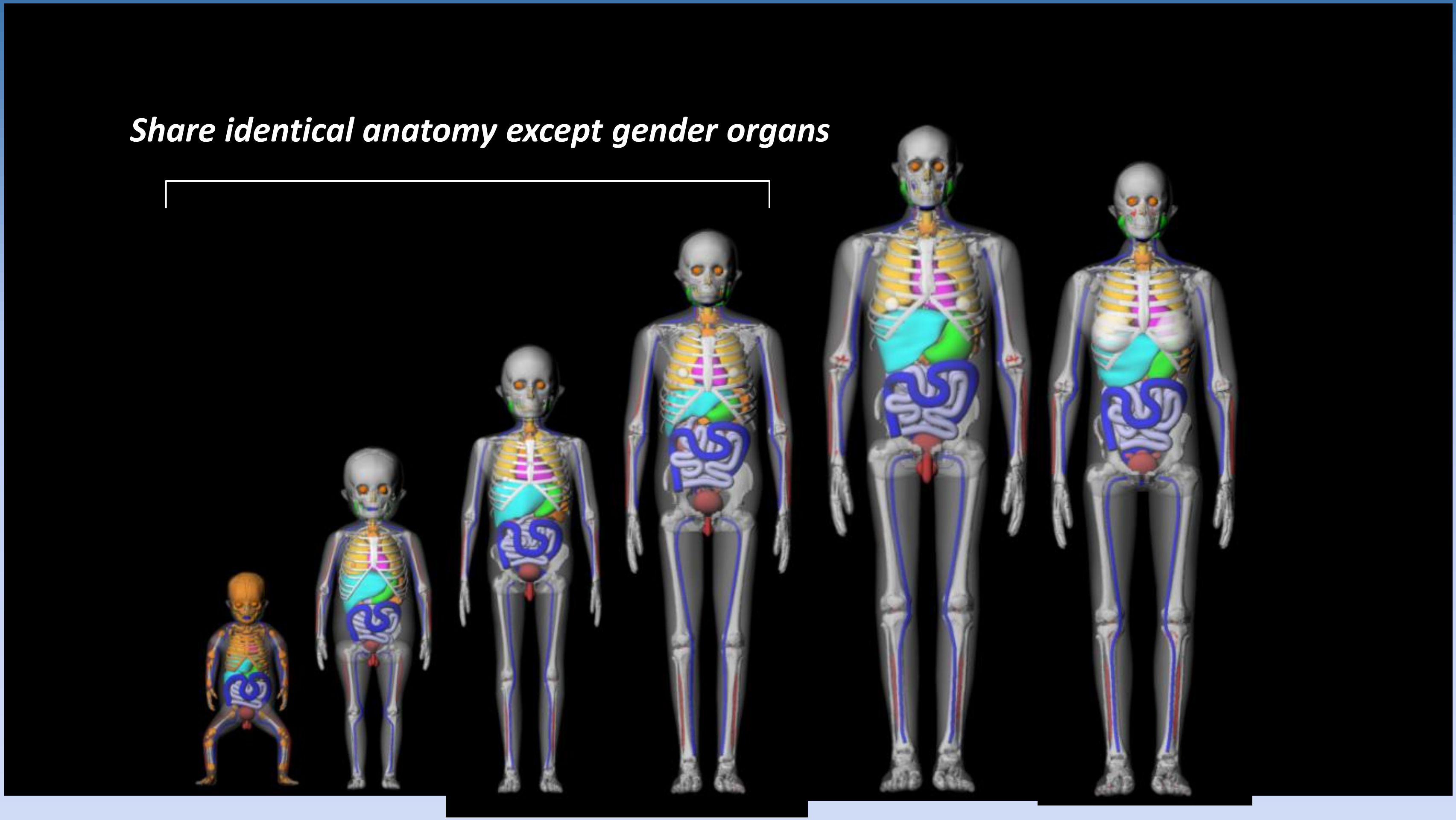


ICRP Reference Adult Male *ICRP Reference Adult Female*



Anatomically detailed voxel models of the ICRP 89 Reference Adult Male and Reference Adult Female – 141 tissue structures for each phantom

Pediatric Hybrid



Newborn 1-year 5-year 10-year 15-year male 15-year female

Likely future ICRP Reference phantoms developed at the University of Florida

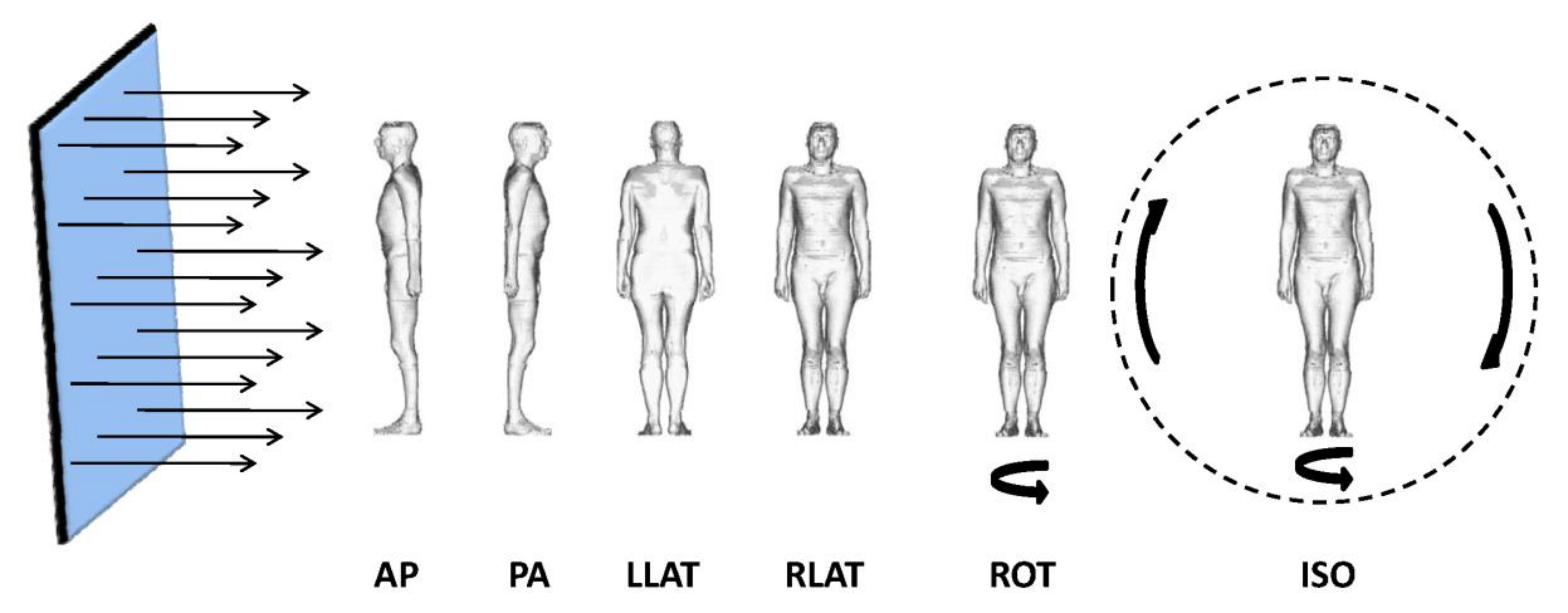
Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures

ICRP Publication 116

Approved by ICRP in October 2010 and adopted by ICRU in November 2010

Joint Publication with ICRU

Dose quantities are evaluated using Monte Carlo simulations of radiation transport in the reference phantoms for reference irradiation geometries



Parameter Matrix

Particles	Energies	Geometries	Primary Calculations	Secondary Calculations	Spot Checks
Photons	10 keV – 10 GeV Radionuclides: 511, 662, 1170, 1330 keV, N-16	AP, PA, LLAT, RLAT, ISO, ROT.	HMGU (Schlattl) – EGSnrc	GTech (Hertel) – MCNPX-CEM	HMGU (Simmer) – GEANT4
Neutrons	1 MeV – 10 GeV	AP, PA, LLAT, RLAT, ISO, ROT	JAEA (Endo) – PHITS	INFN (Pelliccioni) – FLUKA	RPI (Xu) – MCNPX 2.5 GTech (Hertel) – MCNPX-CEM HMGU (Simmer) – GEANT4
Electrons / Positrons	50 keV – 10 GeV	AP, PA, ISO	GTech (Hertel) – MCNPX-CM	HMGU (Schlattl) – EGSnrc	
Protons	1 MeV – 10 GeV	AP, PA, LLAT, RLAT, ISO, ROT	JAEA (Endo) – PHITS	INFN (Pelliccioni) – FLUKA	JAEA (Endo) – MCNPX HMGU (Simmer) – GEANT4
Pions negative/ Pions positive	1 MeV – 200 MeV	AP, PA, ISO	JAEA (Endo) – PHITS and FLUKA	GTech (Hertel) – MCNPX-CEM	
Muons negative/ Muons Positive	1 MeV to 10 GeV	AP, PA, ISO	JAEA (Endo) – FLUKA and MCNP2.6	JAEA (Endo) – PHITS	Muons negative: HMGU (Simmer) – GEANT4 RPI (Xu) – MCNPX 2.5
He Ions	1 MeV/n to 100 GeV/n	AP, PA, ISO	JAEA (Endo) – PHITS	JAEA (Endo) – FLUKA	

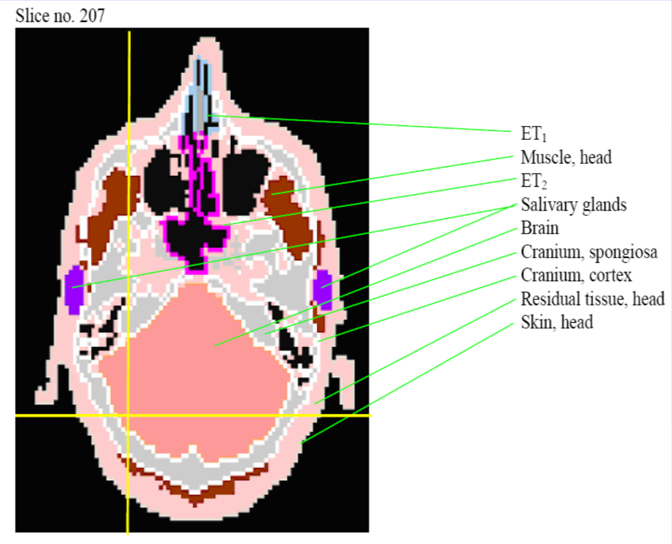
List of tables of conversion coefficients (Male, Female sets will be given separate)

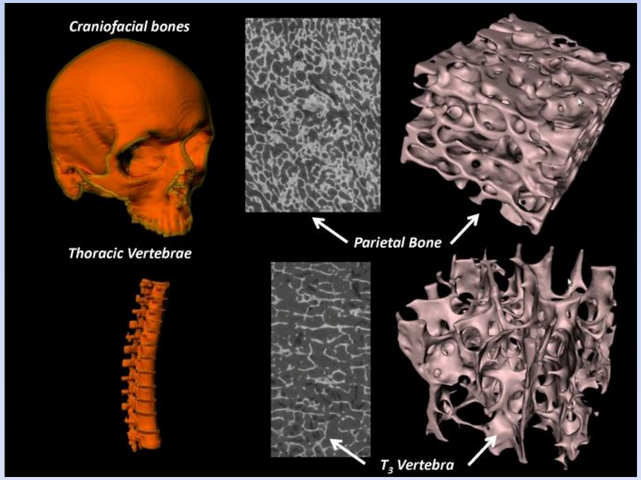
Effective dose	Lens of Eye	Saliver glands
Adrenals	Liver	Skin
Brain	Lungs	Small Intestine wall
Breast	Lymph	Spleen
Colon	Muscle	Stomach wall
Endost-BS	Oesophagus	Thyroid
ET	Oral Mucosa	Thymus
GB-wall	Pancreas	Urinary Blader wall
Gonads	Prostate	Uterus
Heart wall	R-marrow	
Kidneys	Remainder	

Skeletal Dosimetry

- **The skeletal microstructure (bone trabeculae and marrow cavities) is not represented in the ICRP voxel phantoms – only their macroscopic locations (skeletal spongiosa).**
- **In spongiosa, strong elemental and mass density differences present themselves in the tissues of the mineral bone (trabeculae) and the marrow (red and yellow).**

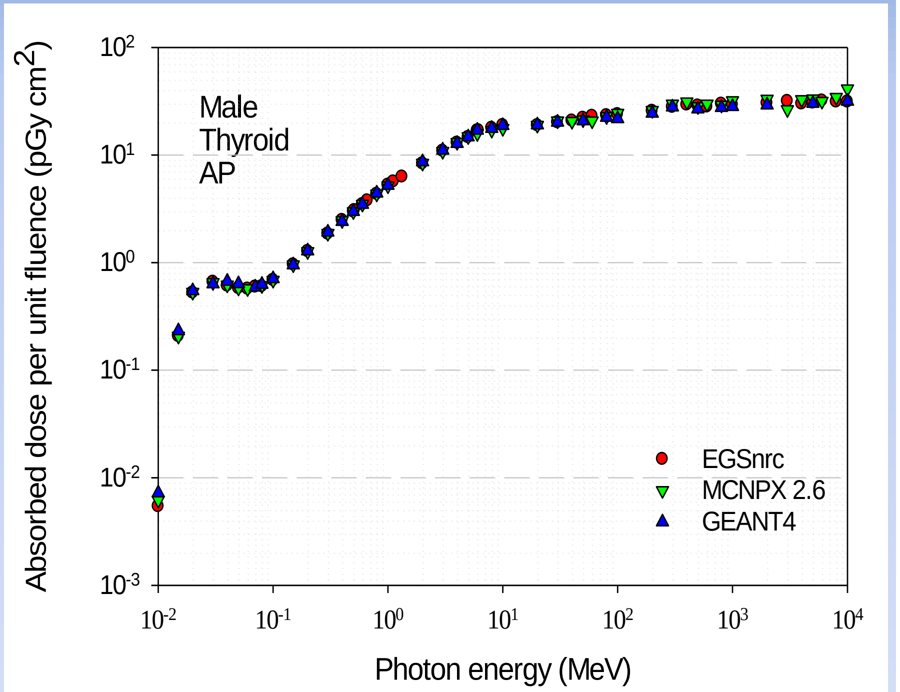
Trabecular Spongiosa in the ReferenceP hantom

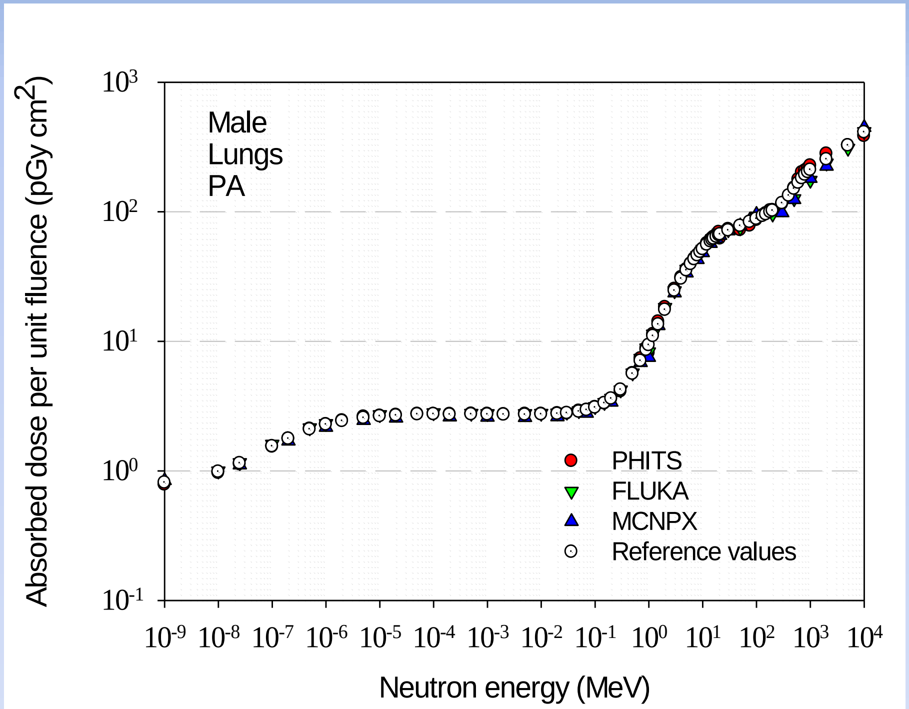




Different Transport Codes

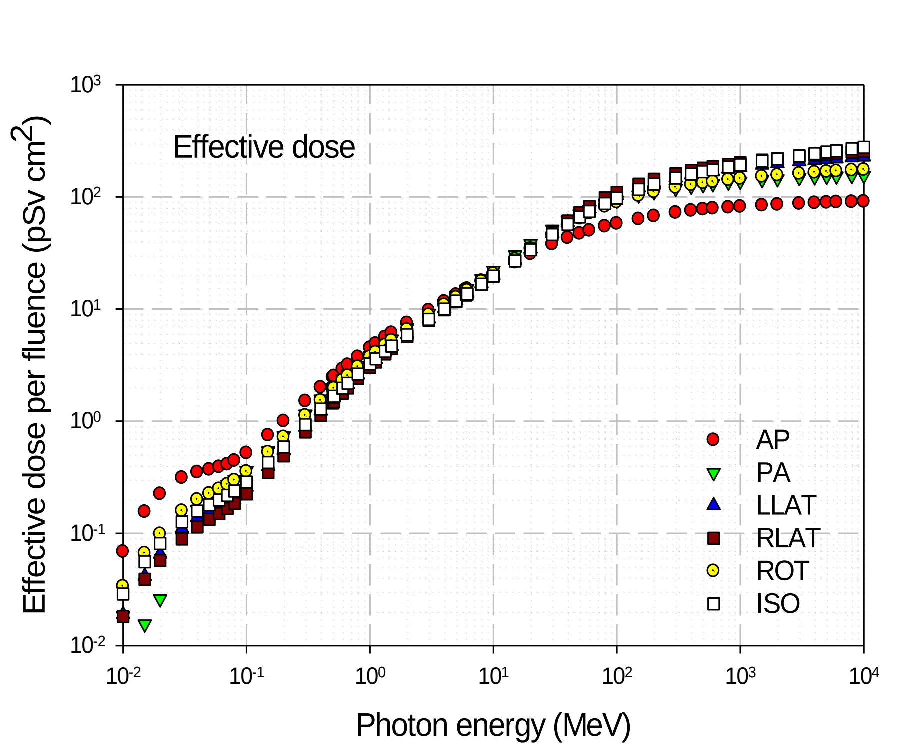
Organ Absorbed Dose

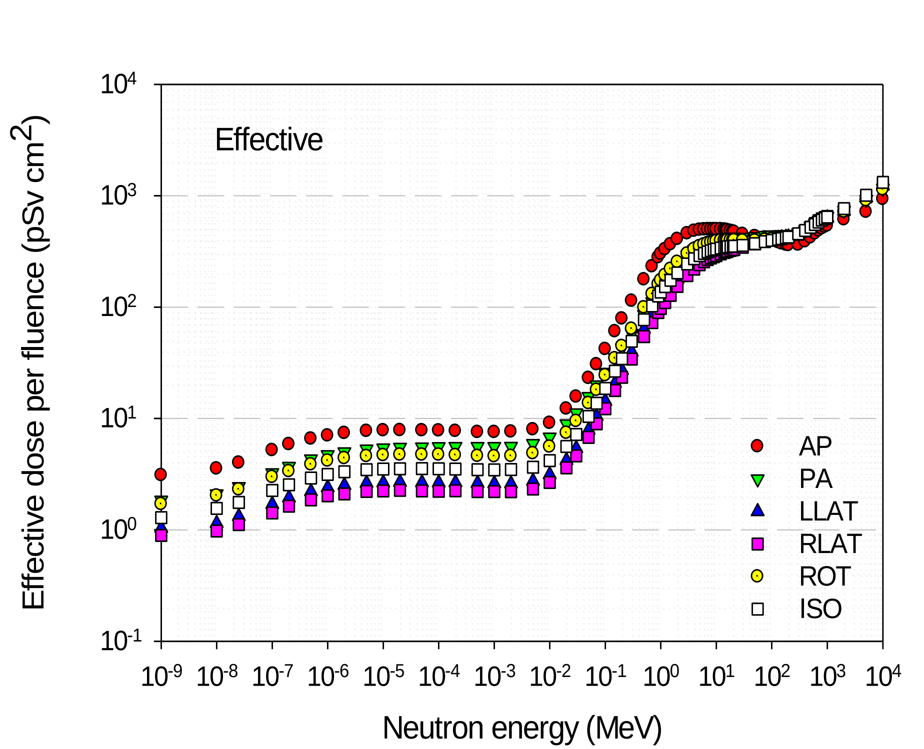




Photons **Neutrons**

Dose Conversion Coefficients – Reference Values

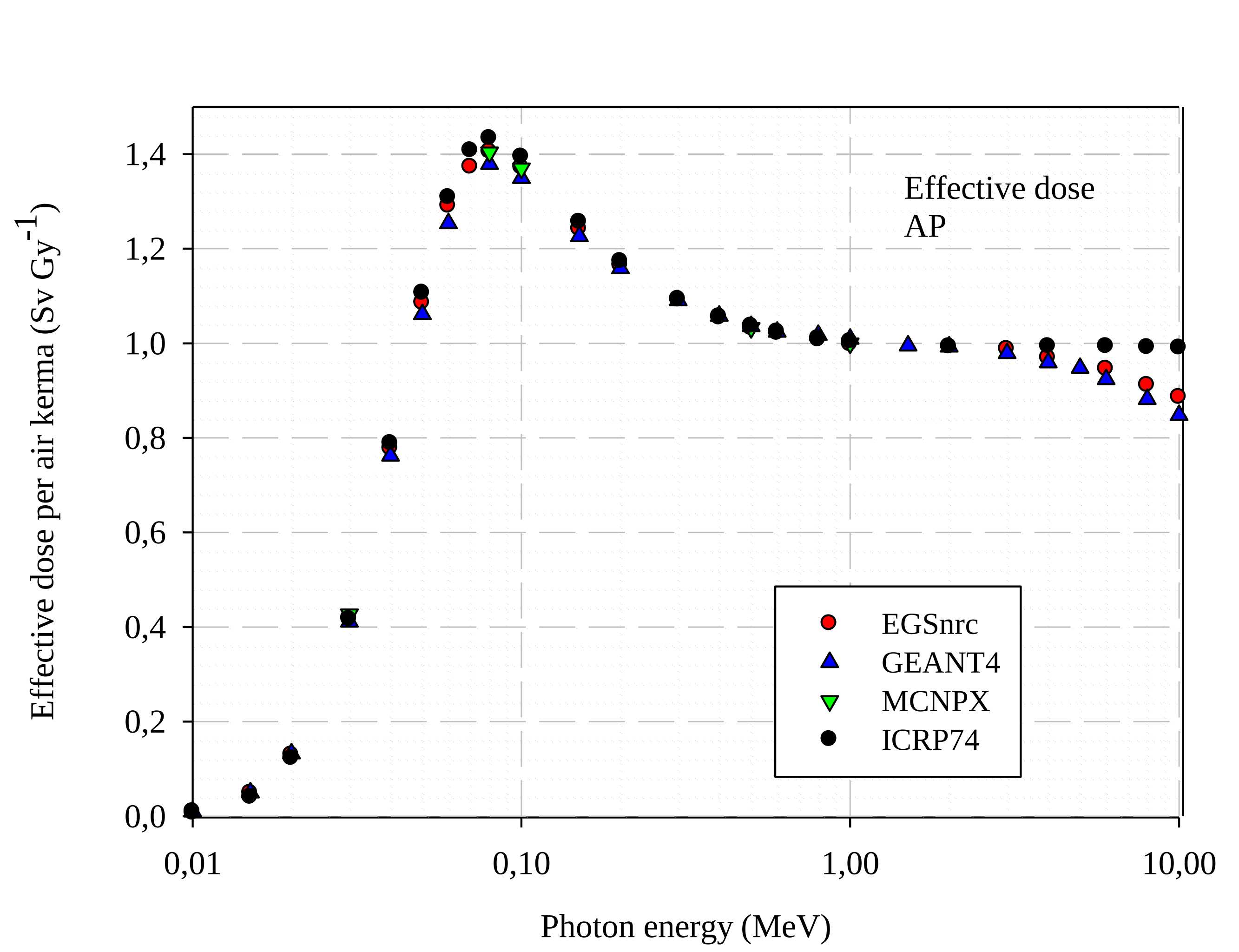




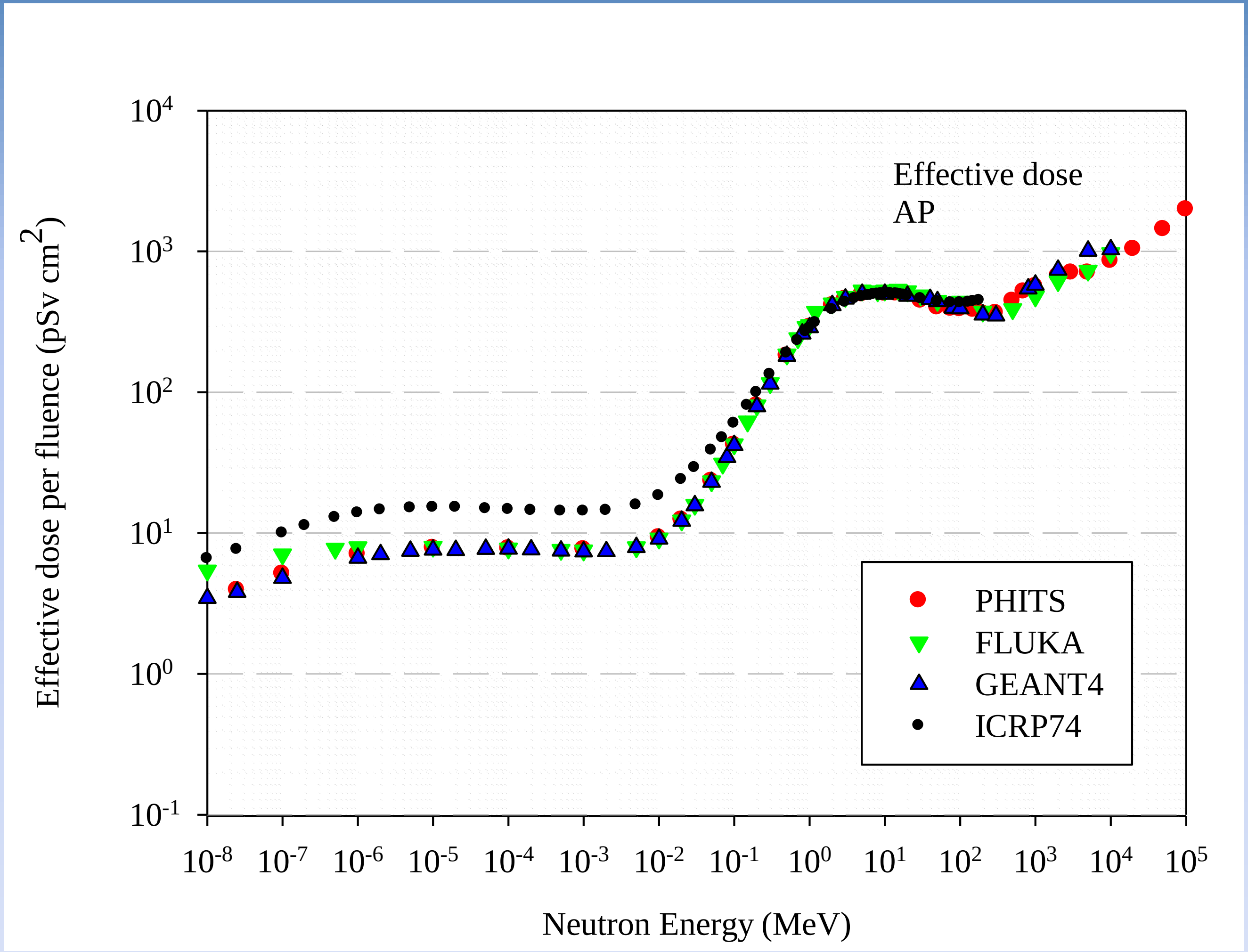
External Photons

External Neutrons

Comparison ICRP 74 ↔ New Coefficients Photons



Comparison ICRP 74 ↔ New Coefficients Neutrons



ICRP Publication 116

The joint ICRP/ ICRU Publication

is composed of a printed copy with explanatory text and examples of results. It includes also data for the lens of the eye.

The 620 tables of data for reference dose conversion coefficients for organ absorbed dose and effective dose and additional information and explanation are given in an accompanying CD.

Dose coefficients for internal emitters

Quantified intake by inhalation or ingestion

↓ ← Biokinetic and Dosimetric Models

Mean absorbed dose, $D_{T,R}$ in an organ or tissue

↓ ← Radiation weighting factors, w_R

Equivalent dose, H_T, in an organ or tissue

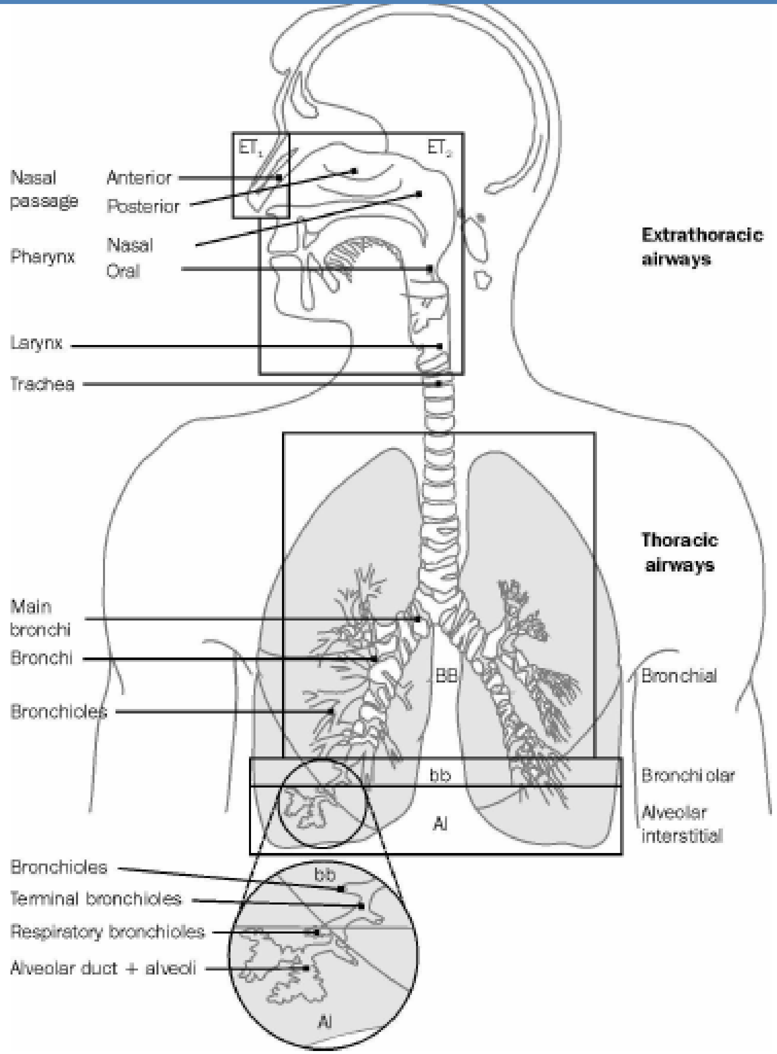
↓ ← Tissue weighting factors, w_T

Effective dose, E

The human respiratory tract model

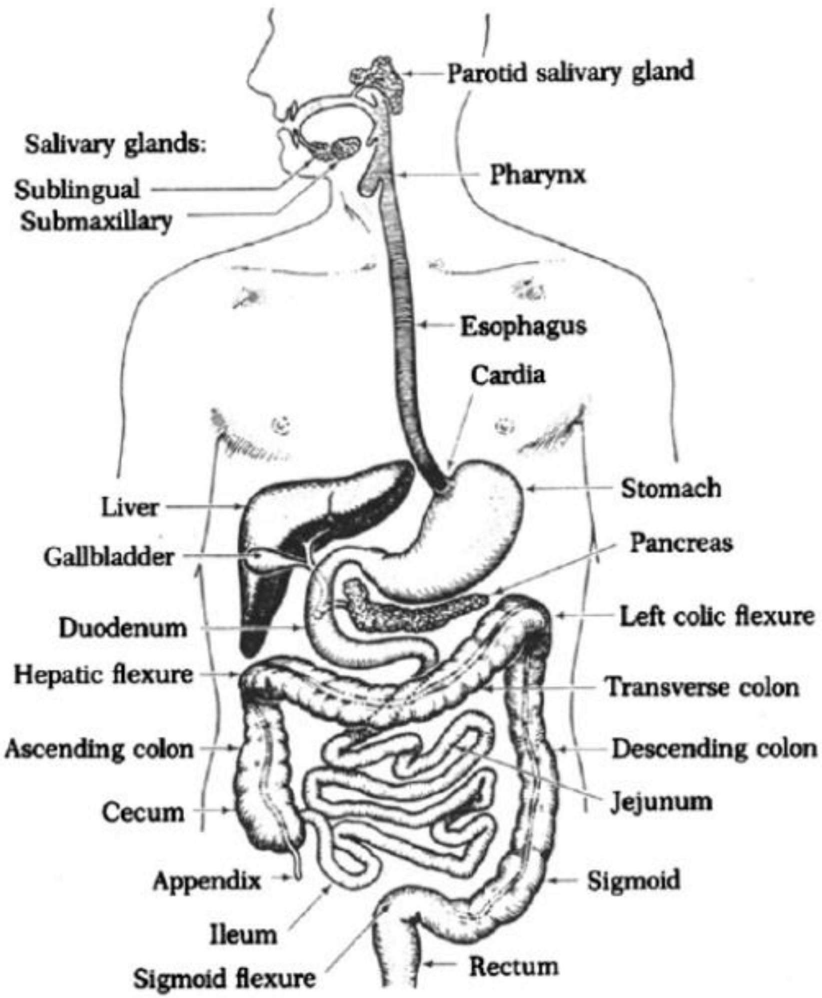
The human respiratory tract model (ICRP publication 66, 1994)

deposition, transport and absorption of particles into blood after inhalation



The Human alimentary tract model

A new alimentary tract model (2006)



Annals of the ICRP

ICRP PUBLICATION 100

Human Alimentary Tract Model for Radiological Protection

Editor
J. VALENTIN

PUBLISHED FOR

The International Commission on Radiological Protection

by

ELSEVIER

Internal Dosimetry (INDOS)

Current tasks

Providing new models to

Update publications 30 (1982), 68 (1995) for <u>occupational intake of radionuclides</u>
- Update reports on <u>bioassay interpretation</u> publications 54 (1988) and 78 (1997)

OIR Document

- Update publications 56, 67,69, 71, 72 (1989-1996) for <u>intakes by members of the public.</u>

The OIR document

Dose coefficients for
Occupational INTAKES of Radionuclides (OIR)
by inhalation and ingestion.

The OIR document

Main features

1. Revision of the Publication 66 Human Respiratory Tract Model (HRTM) which takes account of more recent data.

2. Revisions of models for the systemic biokinetics of radionuclides absorbed to blood for physiologically more realistic representations of uptake and retention in organs and tissues and of excretion.

3. Data for the interpretation of bioassay measurements

4. Dose coefficients for about 40 elements <u>including Radon</u>

The OIR document

will be published in 4 parts

Part 1 : Main text (2012)
Contains chapters on control of occupational exposures, biokinetic and dosimetric models, monitoring methods and programmes, and retrospective dose assessment.

Part 2, 3 and 4 : Element sections (2012-2014)
Contain biokinetic data and models for individual elements and their radioisotopes, dose coefficients and data for bioassay interpretation.
CD-ROMs accompanying this series give extensive additional information.

Contents of OIR Pt. 1 / 2

Introduction

Control of exposure

Models

Monitoring

Elements

H, C, P, S, Ca, Fe, Co, Zn, Zr, Nb, Ru, Sb, Te, Sr, Ir, Y, Cs, I, Ba, Pb, Bi, Po, Rn, Ra, U, Th

Task Group 79 on: The use of Effective Dose as a risk-related radiation-protection quantity

Jointly with Committees 1, 3 and 4

The quantity effective dose has gained widespread acceptance worldwide for regulatory purposes.

The objective of the TG is to clarify the circumstances under which effective dose can be applied and when it should not be used. Alternatives to the use of effective dose will be provided for specific situations including patient exposure in radiological diagnostics.

Come tomorrow at 8:30 to Session

Applications of Effective Dose

Task Group 67
Assessment of Radiation Exposure of Astronauts in Space

- Radiation environment in space
- Radiation fields inside space vehicles and on planetary surfaces
- Radiation fields and absorbed doses in the human body
- Organisation of radiation protection in space

➢ Come tomorrow at 10:40 to Session

Radiation Protection in Space

Some other planned ICRP Publications

- Internal SAF Values for the Reference Adult Male and Female
- Computational Phantoms for the Infant and Children
- Internal SAF Values for the Infant and Children
- Computational Phantoms for the Pregnant Female, Embryo, and Foetus
- Internal SAF Values for Embryo, Foetus, Children and Pregnant Female
- Public Exposures to Radionuclides
- Doses to the Embryo, Foetus, and Nursing Infant

Concluding remark

- Reference dose conversion coefficients for external radiation will be published in the near future.

- In spite of significant changes in weighting factors and introduction of reference phantoms, the differences in conversion coefficients between ICRP 74 and new data is generally small.

► Effective Dose is a robust quantity.

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