SRT Dosimetry Methods

Potential Tools from the ICRP

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NCI Workshop on Dosimetry of Systemic Radiopharmaceutical Therapy

Rockville, MD

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UF UNIVERSITY of FLORIDA

J. Crayton Pruitt Family Department of Biomedical Engineering

ICRP

- ICRP is now 87 years old *90 now!*
- Founded in 1928, International X-ray and Radium Protection Committee
- Renamed International Commission on Radiological Protection ICRP in 1950
- Registered charity UK

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

First Chairman & First Publication

INTERNATIONAL RECOMMENDATIONS FOR X-RAY AND RADIUM PROTECTION

on the proposal of the Radio-Physics Section adopted by the Second International Congress of Radiology in Stockholm, July 27th, 1928

1. The dangers of over-exposure to X-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of X-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are:
(a) Injuries to the superficial tissues;
(b) Derangements of internal organs and changes in the blood.

I. *Working Hours etc.*

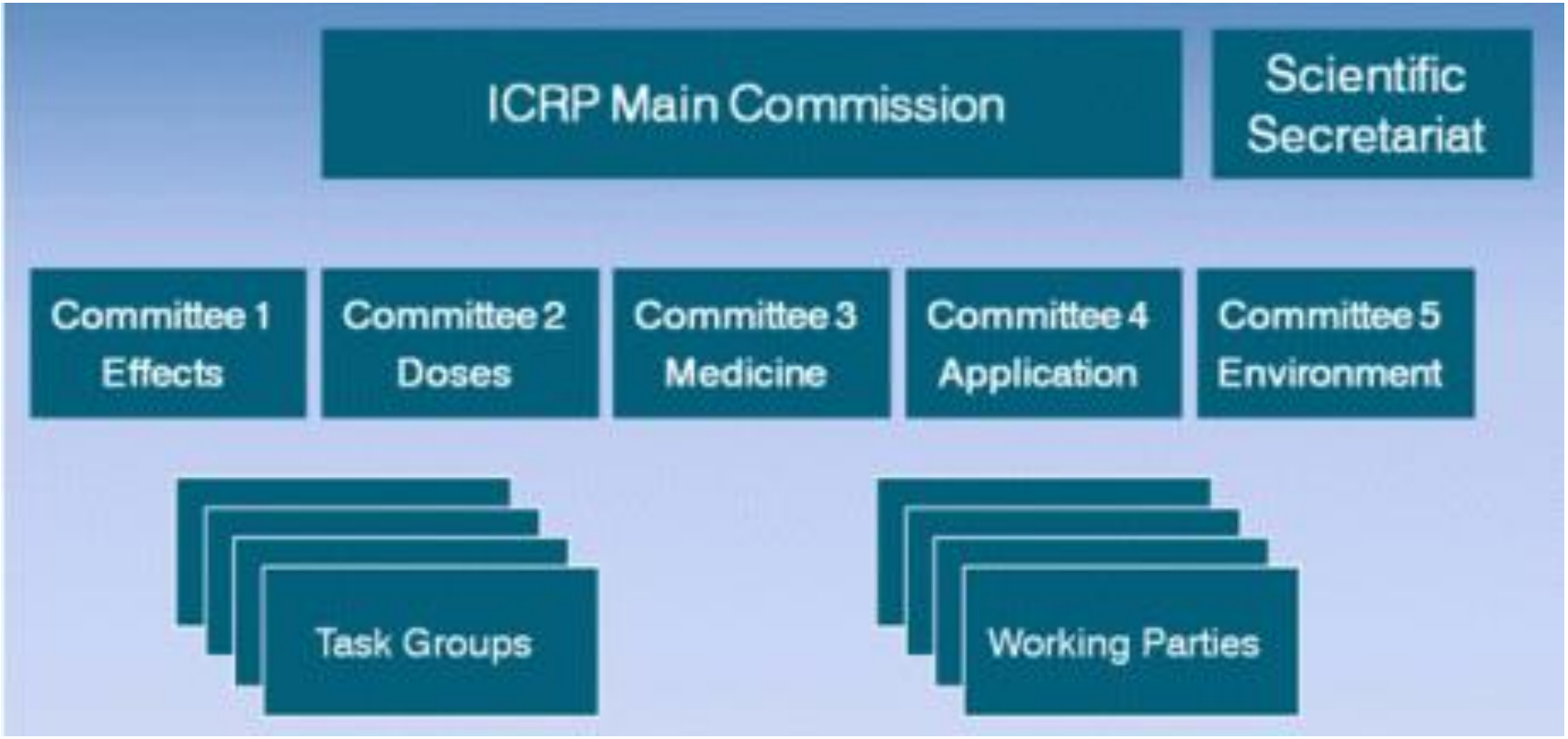
2. The following working hours etc. are recommended for whole-time X-ray and radium workers:
(a) Not more than seven working hours a day.
(b) Not more than five working days a week. The off-days to be spent as much as possible out of doors.
(c) Not less than one month's holiday a year.
(d) Whole-time workers in hospital X-ray and radium departments should not be called upon for other hospital service.

II. *General X-Ray Recommendations.*

3. X-ray departments should not be situated below ground-floor level.
4. All rooms, including dark-rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

Rolf Sievert
Chairman 1928-1931

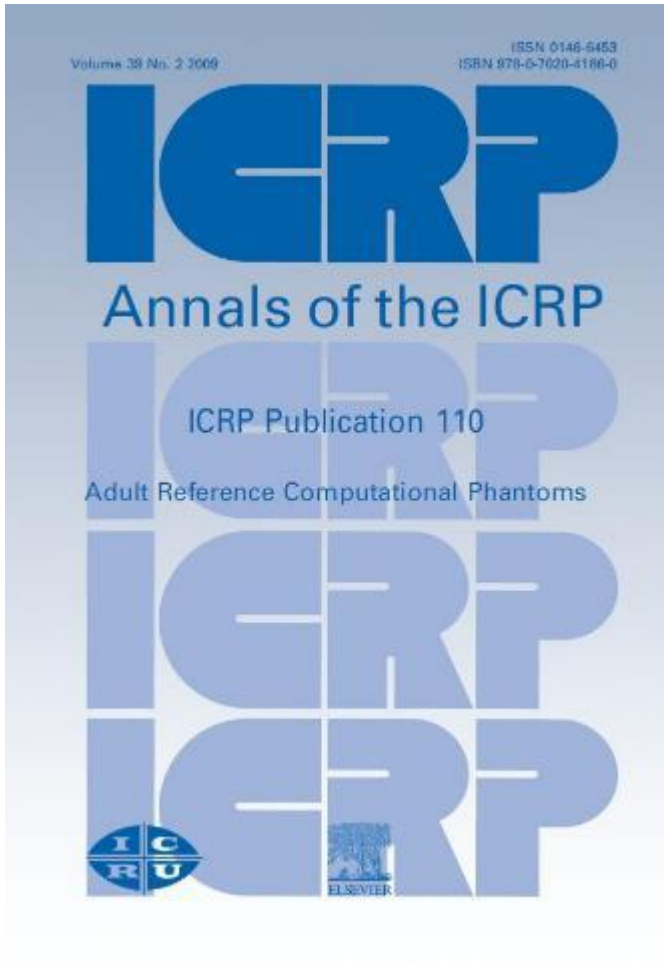
ICRP Structure and Function

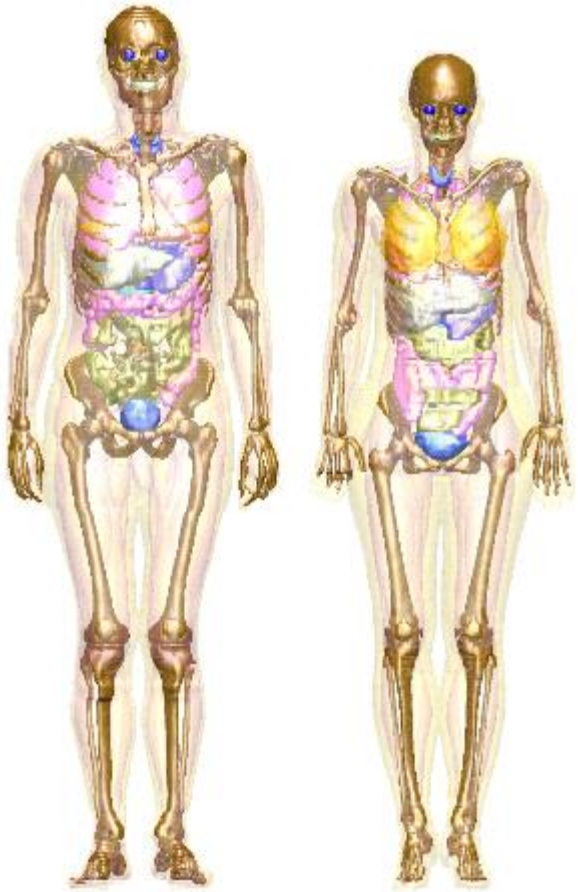


Summary of tools developed by the ICRP that might have applications to SRT

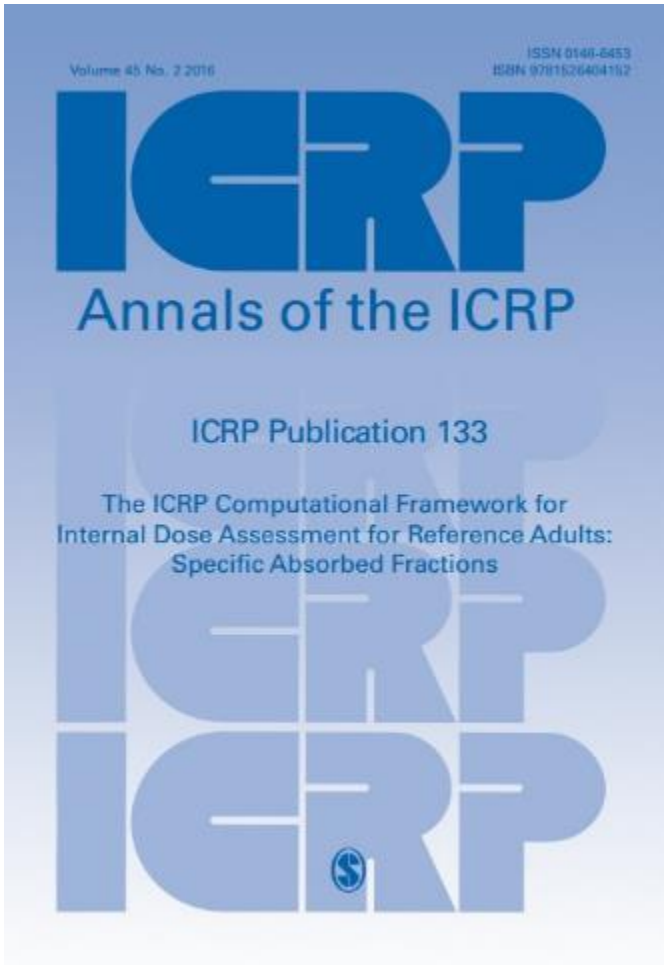
- ***Standardized computational phantoms***
- ***Radionuclide S values from these standardized phantoms***
- ***Intake models for inhalation and ingestion***
- ***Biokinetic models for single elements***
- ***Techniques for modeling radionuclide daughter in-growth with independent (not shared) biokinetics***

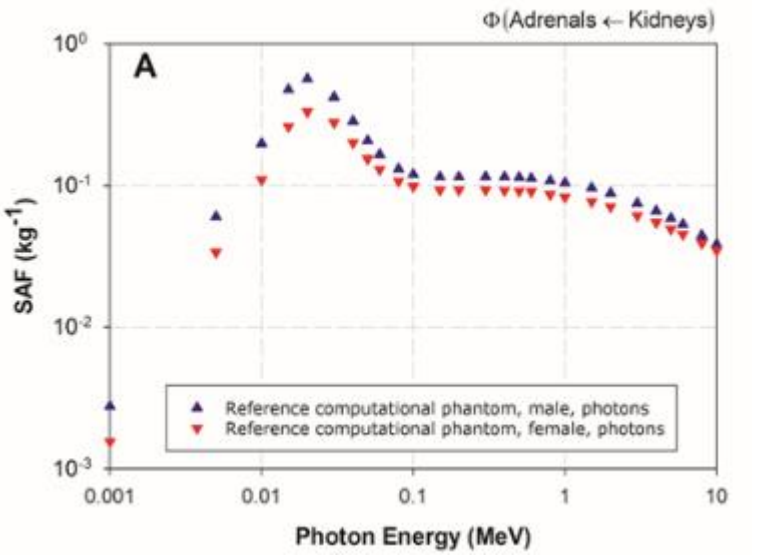
Adult Male and Female Reference Phantoms

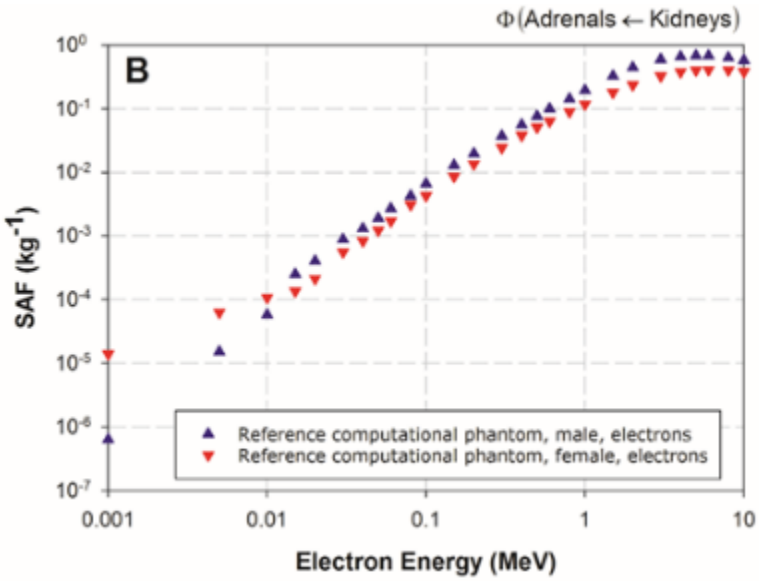




Reference Adult Specific Absorbed Fractions (SAFs)







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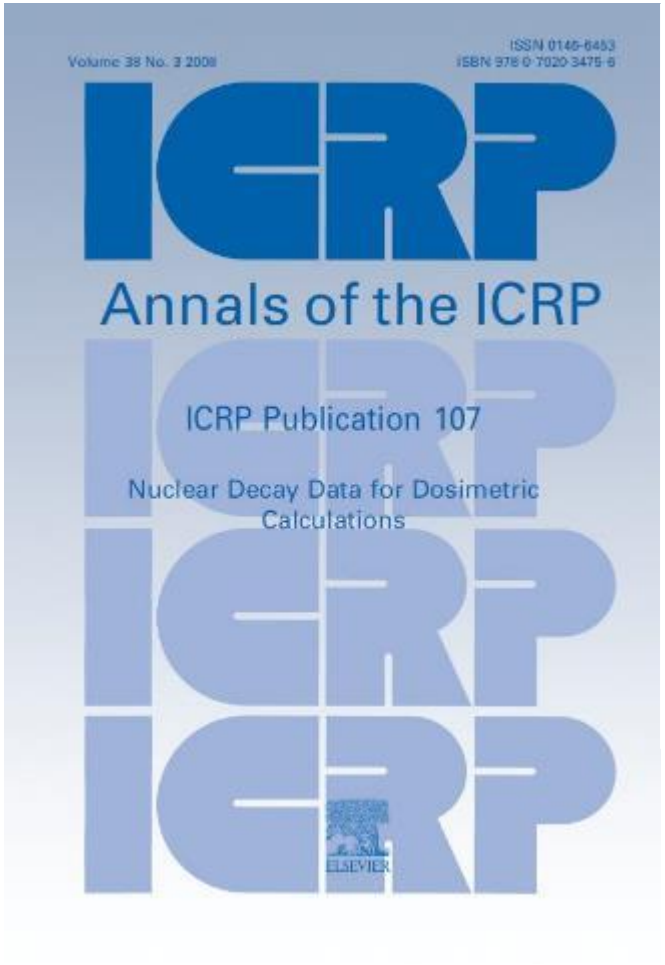
Radionuclide Decay Schemes / Radionuclide S Values



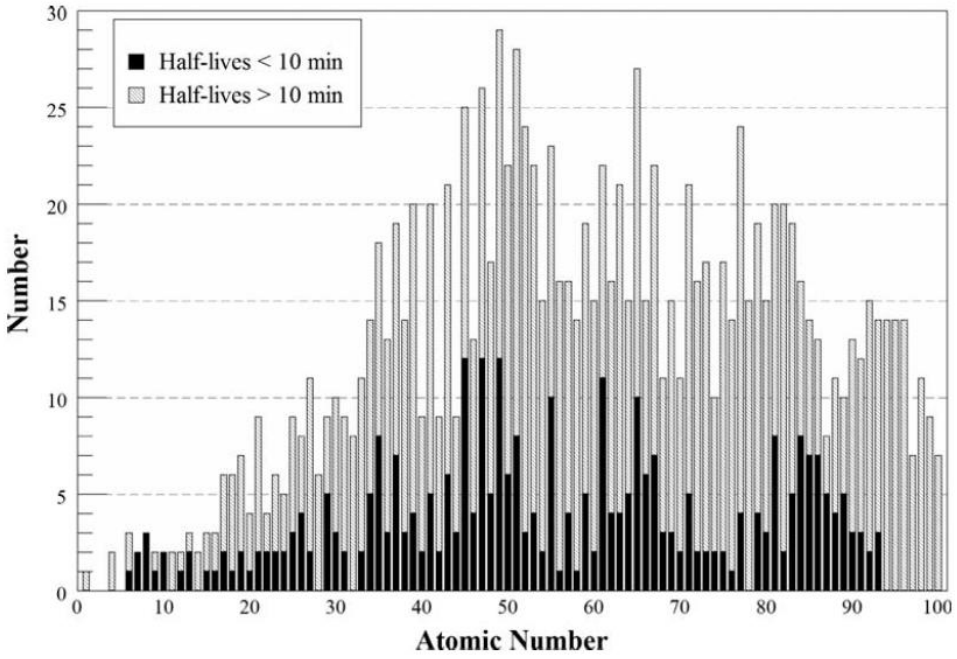


Fig. 1. Number of radioisotopes of the elements in this compilation.

Patient-Specific Adjustments - Radionuclide S Values

Phys. Med. Biol. **63** (2018) 085006 (20pp)

Individualized adjustments to reference phantom internal organ dosimetry—scaling factors given knowledge of patient internal anatomy

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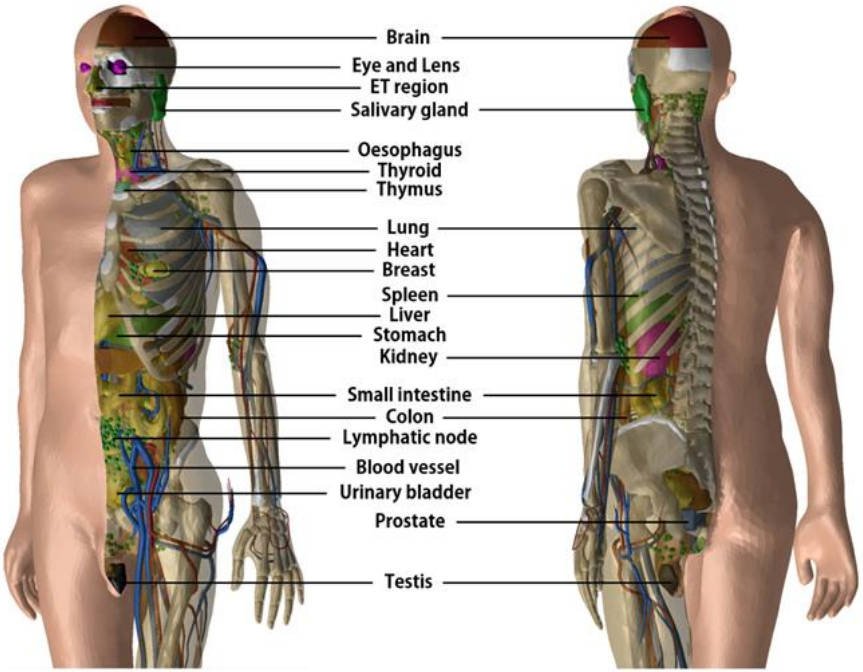
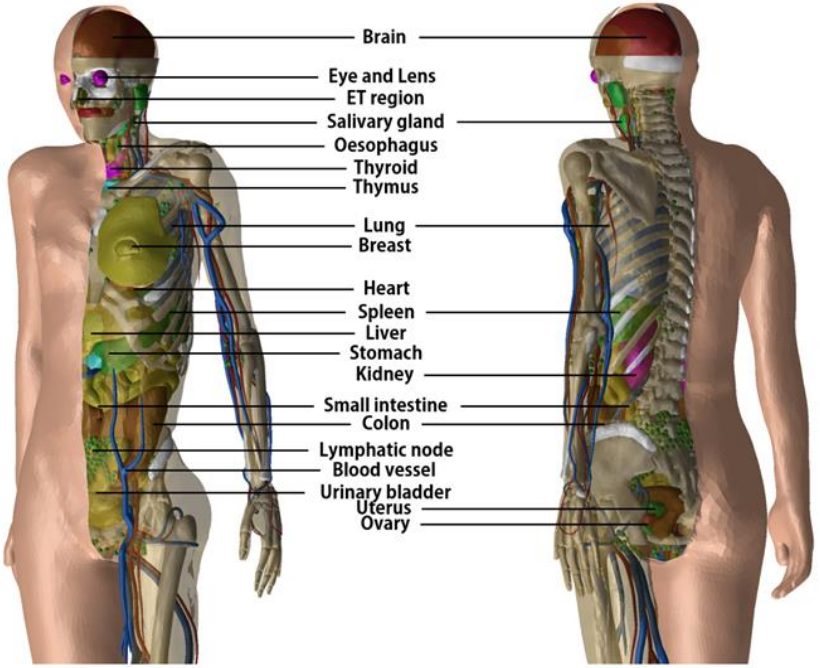
Current ICRP Work – Conversion to Mesh Format



Adult Male Phantom



Adult Female Phantom

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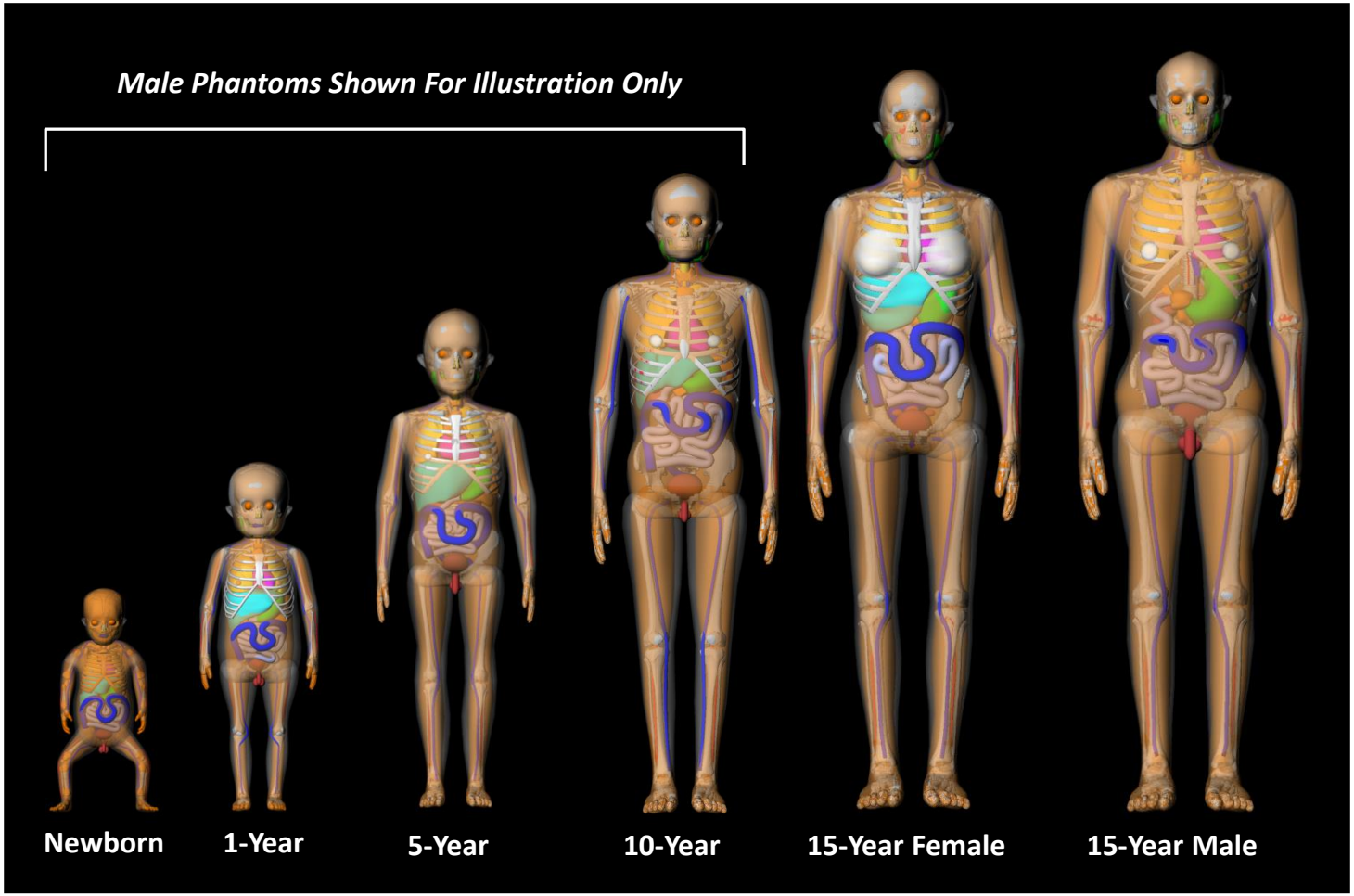
Pediatric Series of Reference Phantoms



UF/NCI Series of Hybrid Phantoms

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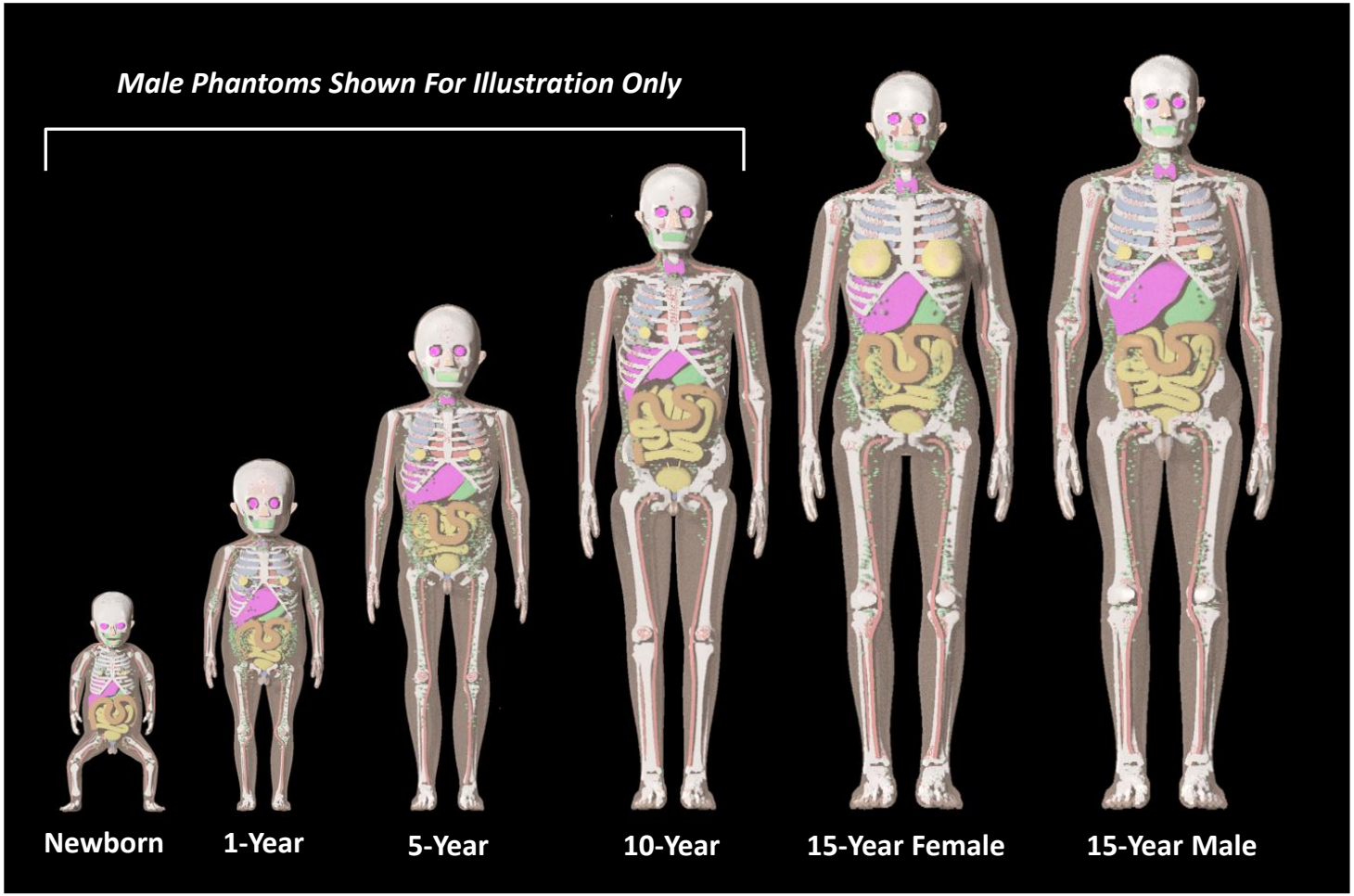
Pediatric Series of Reference Phantoms



ICRP Series of Reference Voxel Phantoms

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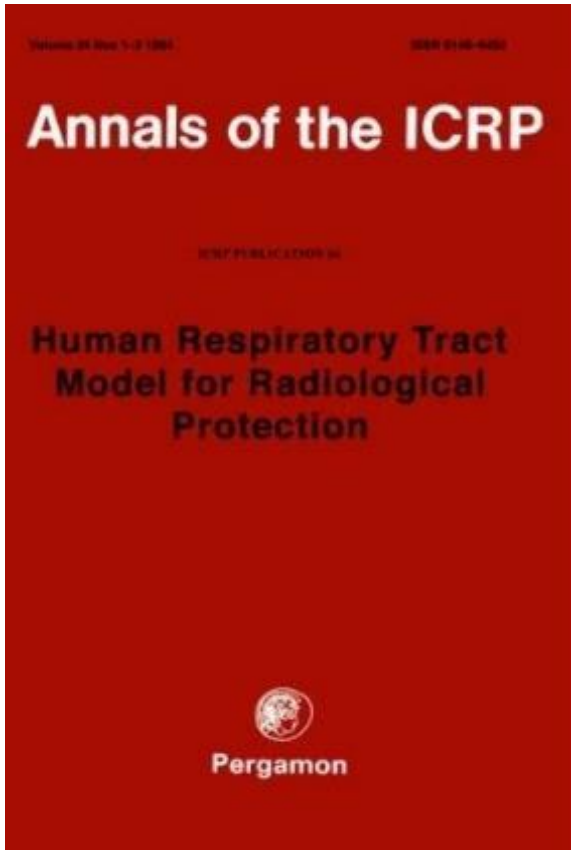
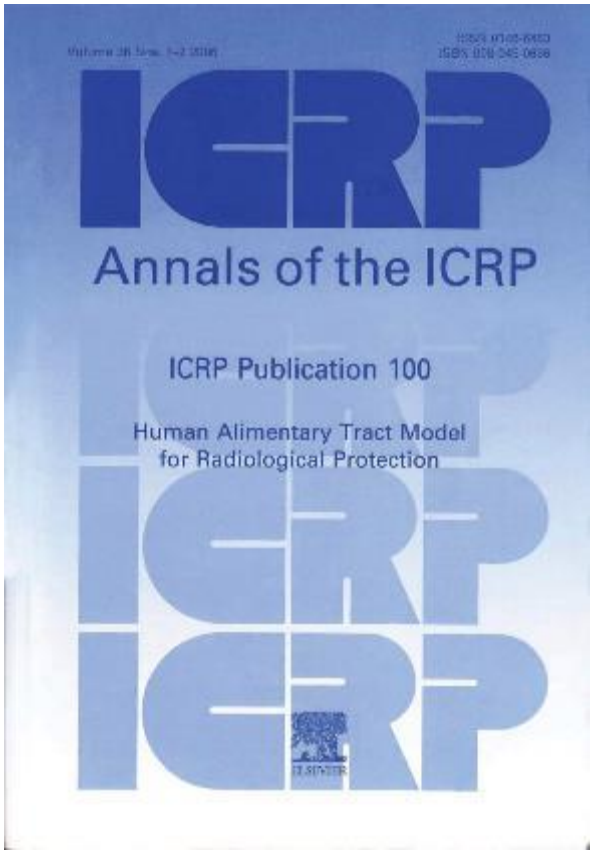
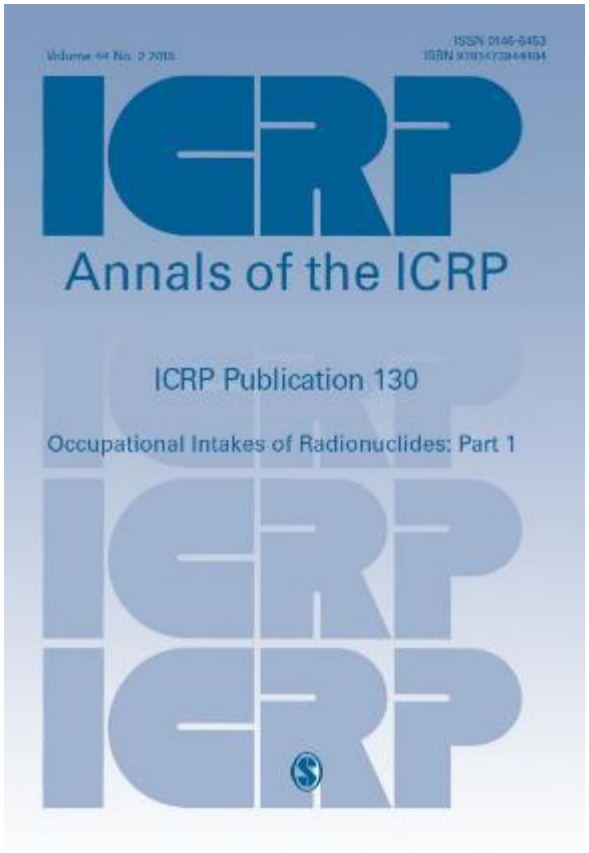
ICRP Intake and Systemic Biokinetic Models







ICRP 66
Human Respiratory Tract Model

ICRP 100
Human Alimentary Tract Model

ICRP 130
Systemic Biokinetic Models

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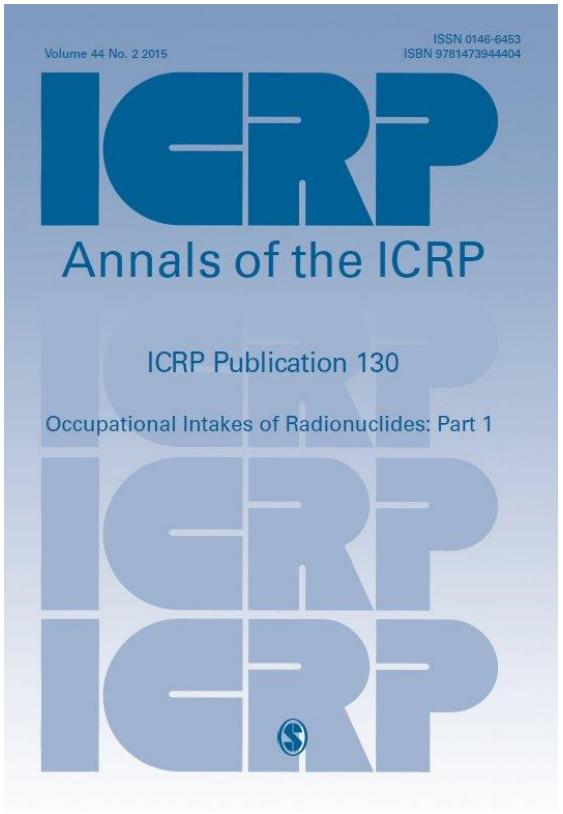
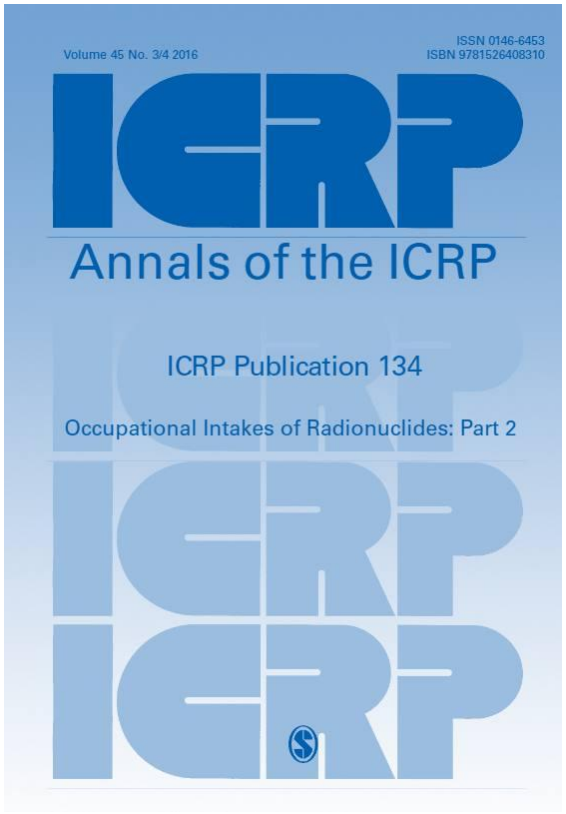
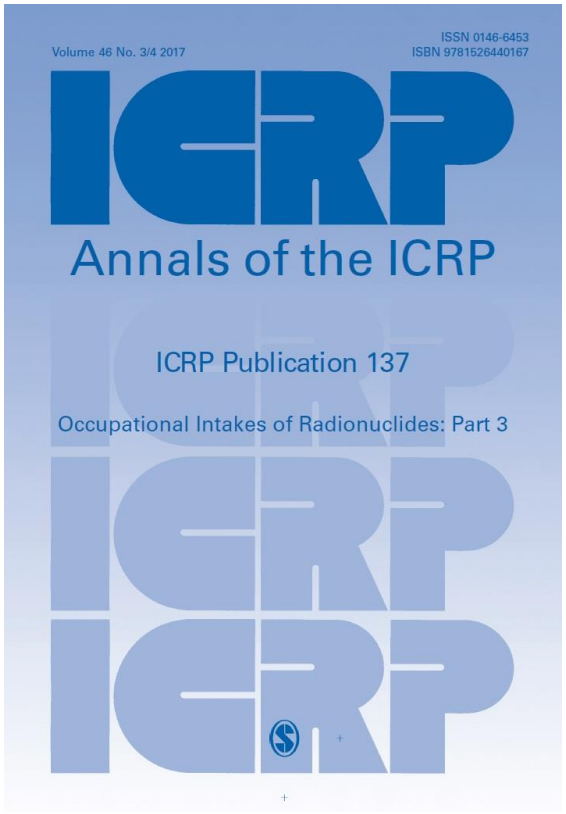
Occupational Intakes of Radionuclides (OIR) Series







OIR Part 1 *– General framework (update to ICRP 130)*

OIR Part 2 *– H, C, P, S, Ca, Fe, Co, Zn, Sr, Y, Zr, Nb, Mo, and Tc*

OIR Part 3 *– Ru, Sb, Te, I, Cs, Ba, Ir, Pb, Bi, Po, Rn, Ra, Th, and U*

OIR Part 4 *– Lanthanides and remaining actinides (in review)*

OIR Part 5 *– everything else (in development)*

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Following decay recoil and release of daughter nuclides…

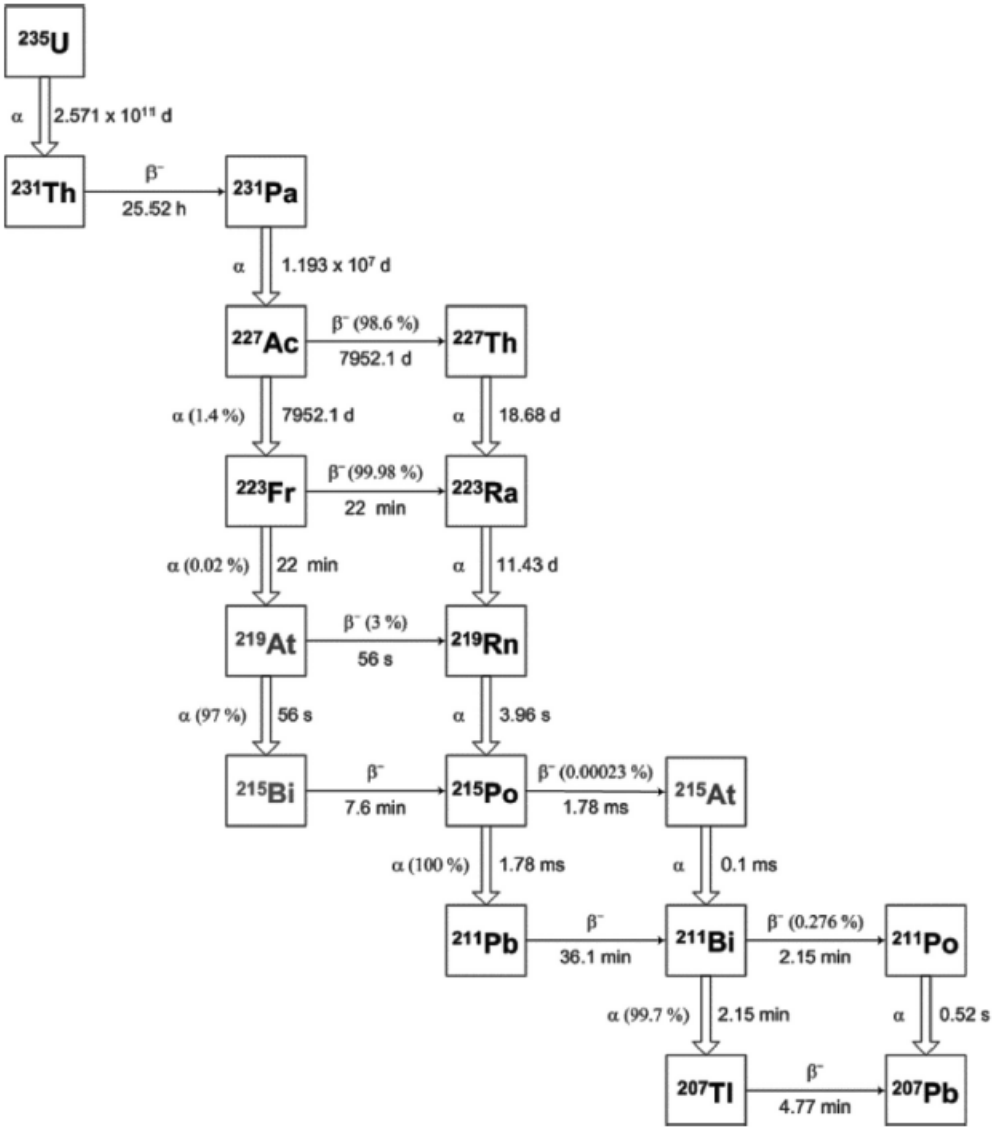

Fig. 1. The decay series of ^{235}U.

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OIR Biokinetic Model for Polonium

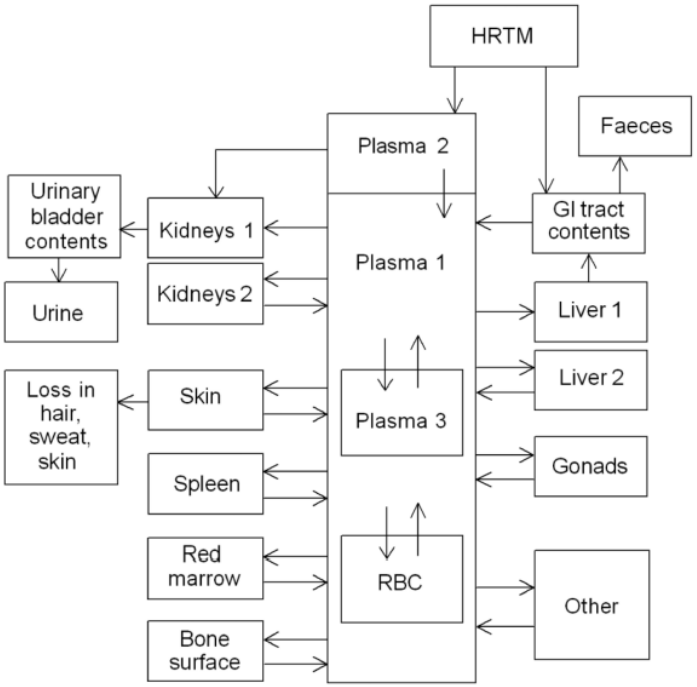

Fig. 11.1. Structure of the biokinetic model for systemic polonium. HRTM, Human Respiratory Tract Model; RBC, red blood cells; GI, gastrointestinal.

Table 11.3. Transfer coefficients in the model for systemic polonium.

From	To	Transfer coefficient (d^{-1})
Plasma 2	Plasma 1	800
Plasma 2	Kidneys 1	200
Plasma 1	Plasma 3	4
Plasma 1	RBC	6
Plasma 1	Liver 1	17.5
Plasma 1	Liver 2	17.5
Plasma 1	Kidneys 1	5
Plasma 1	Kidneys 2	5
Plasma 1	Skin	5
Plasma 1	Red marrow	4
Plasma 1	Bone surface	1.5
Plasma 1	Spleen	2
Plasma 1	Testes	0.1
Plasma 1	Ovaries	0.05
Plasma 1	Other	32.35
Plasma 3	Plasma 1	0.099
RBC	Plasma 1	0.099
Liver 1	Small intestine contents	0.139
Liver 2	Plasma 1	0.099
Kidneys 1	Urinary bladder contents	0.173
Kidneys 2	Plasma 1	0.099
Skin	Plasma 1	0.00693
Skin	Excreta	0.00693
Red marrow	Plasma 1	0.099
Bone surface	Plasma 1	0.0231
Spleen	Plasma 1	0.099
Testes	Plasma 1	0.0139
Ovaries	Plasma 1	0.0139
Other	Plasma 1	0.099

RBC, red blood cells.

Independent Biokinetics

(175) The assumption of independent kinetics is generally applied in this series of reports to progeny radionuclides produced in systemic compartments other than bone volume compartments, or absorbed into blood after production in the respiratory or alimentary tract. The basic assumption is that a progeny radionuclide follows its characteristic behaviour from its time of production in, or absorption into, the systemic pool. The implementation of this assumption is not always straightforward due to structural differences in the systemic models for many parent and progeny combinations. For example, a radionuclide may be born in an explicitly designated tissue in the parent's model that is not an explicitly designated tissue in the progeny radionuclide's characteristic model. When this happens, the rate of removal of the progeny radionuclide and the destination of the removed activity must be defined before the model can be solved.

Thank you for your attention

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