Update on ICRP Internal Dosimetry Task Group 95

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ICRP C2

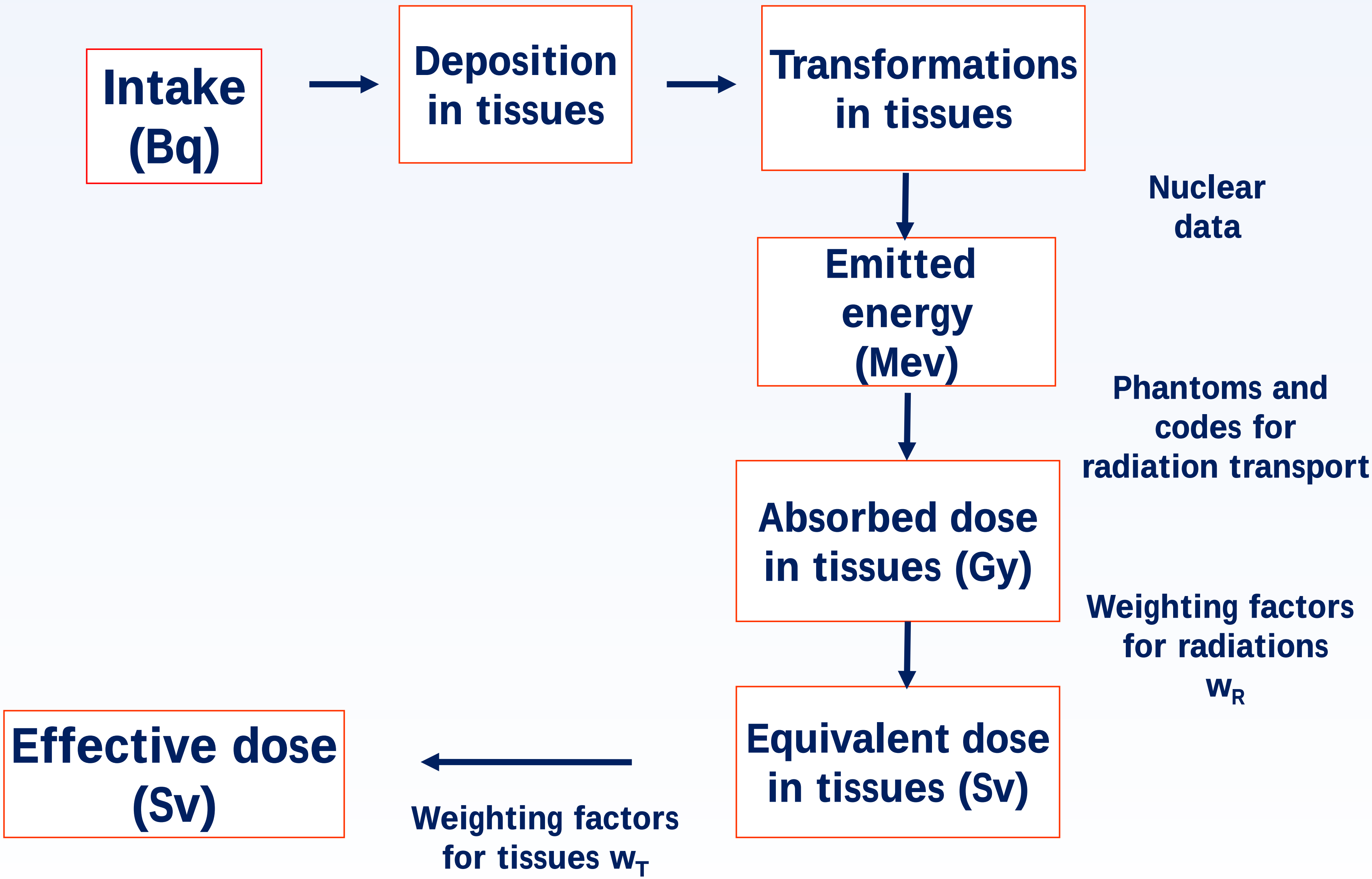
This presentation has neither been approved nor endorsed by the Main Commission of ICRP

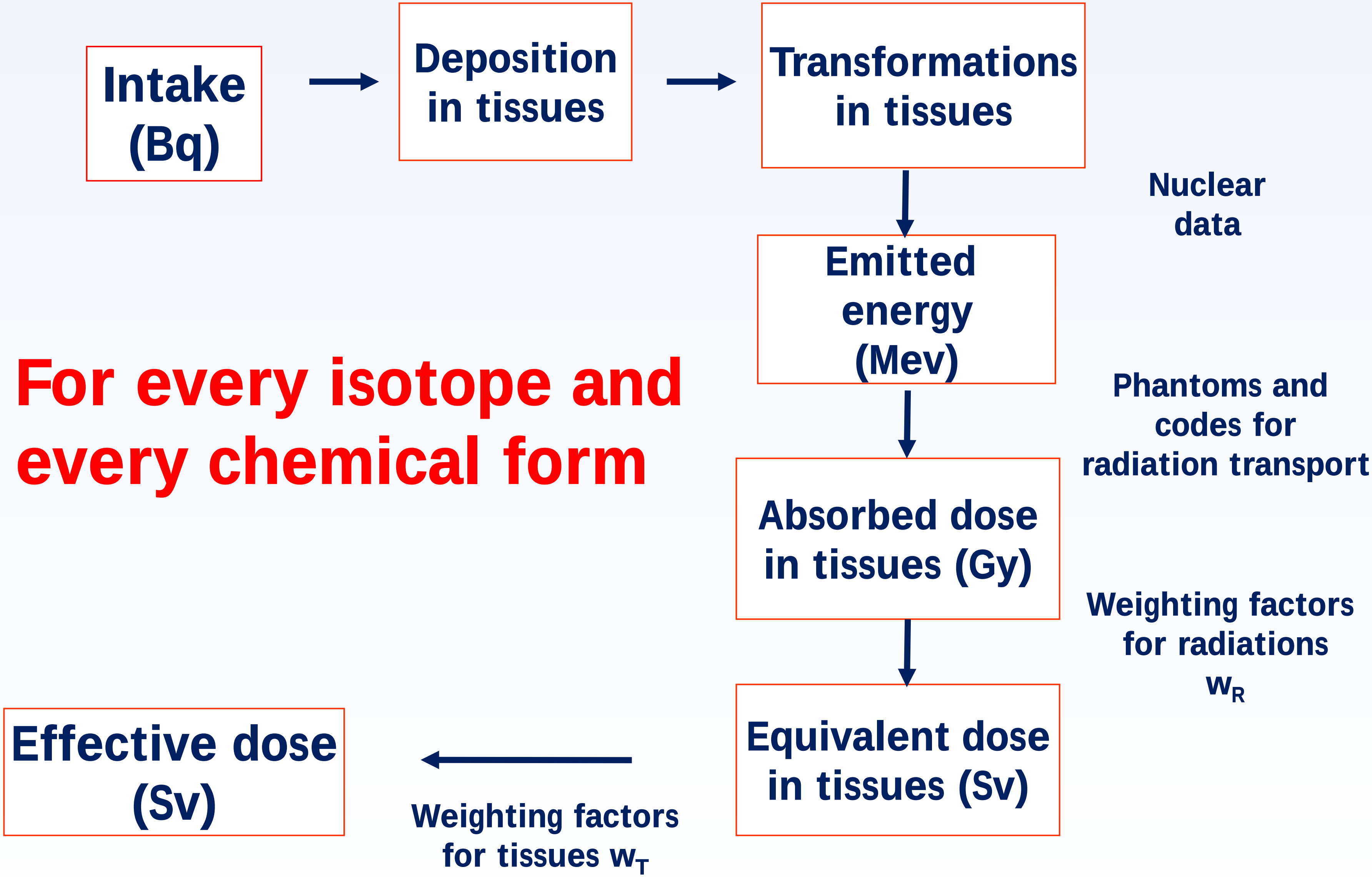
Internal exposures to radiations are managed by the use of the committed effective dose

$$e(\tau) = \sum_T w_T \left[\frac{h_T^M(\tau) + h_T^F(\tau)}{2} \right]$$

Cannot be measured !!

Calculating committed effective dose after internal contamination is a complex procedure


Intake (Bq)
Deposition in tissues
Transformations in tissues
Nuclear data
Emitted energy (Mev)
Phantoms and codes for radiation transport
Absorbed dose in tissues (Gy)
Weighting factors for radiations w_R
Equivalent dose in tissues (Sv)
Weighting factors for tissues w_T
Effective dose (Sv)



For every isotope and every chemical form

Complex procedure, limited to experts

ICRP proposes tools, to allow non-specialist to perform dose assessment

1. **Biokinetic models**
2. **Dose coefficients**
3. **Bioassays functions**

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2. Dose coefficients
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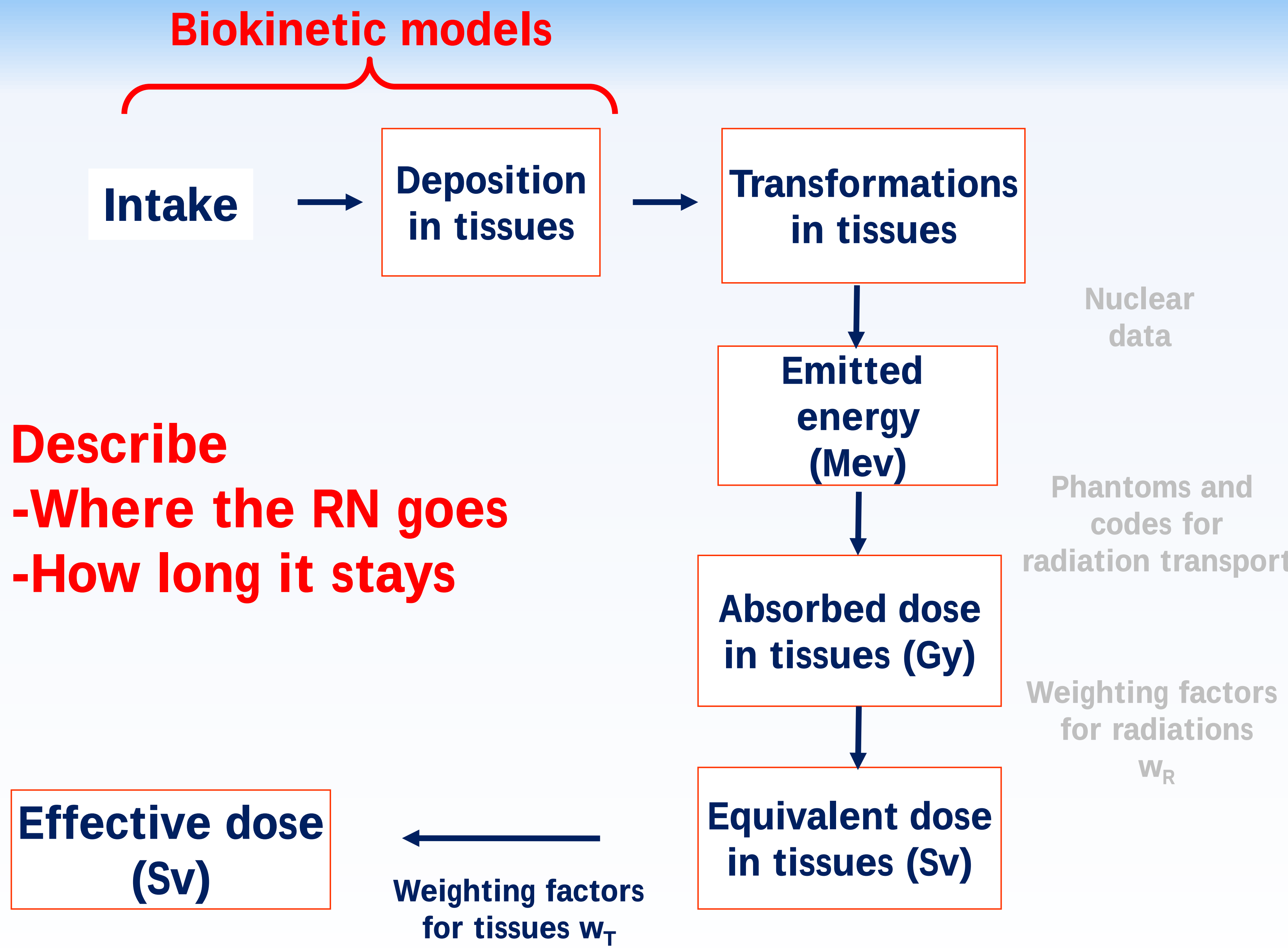
Biokinetic models
Intake
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Nuclear data
Emitted energy (Mev)
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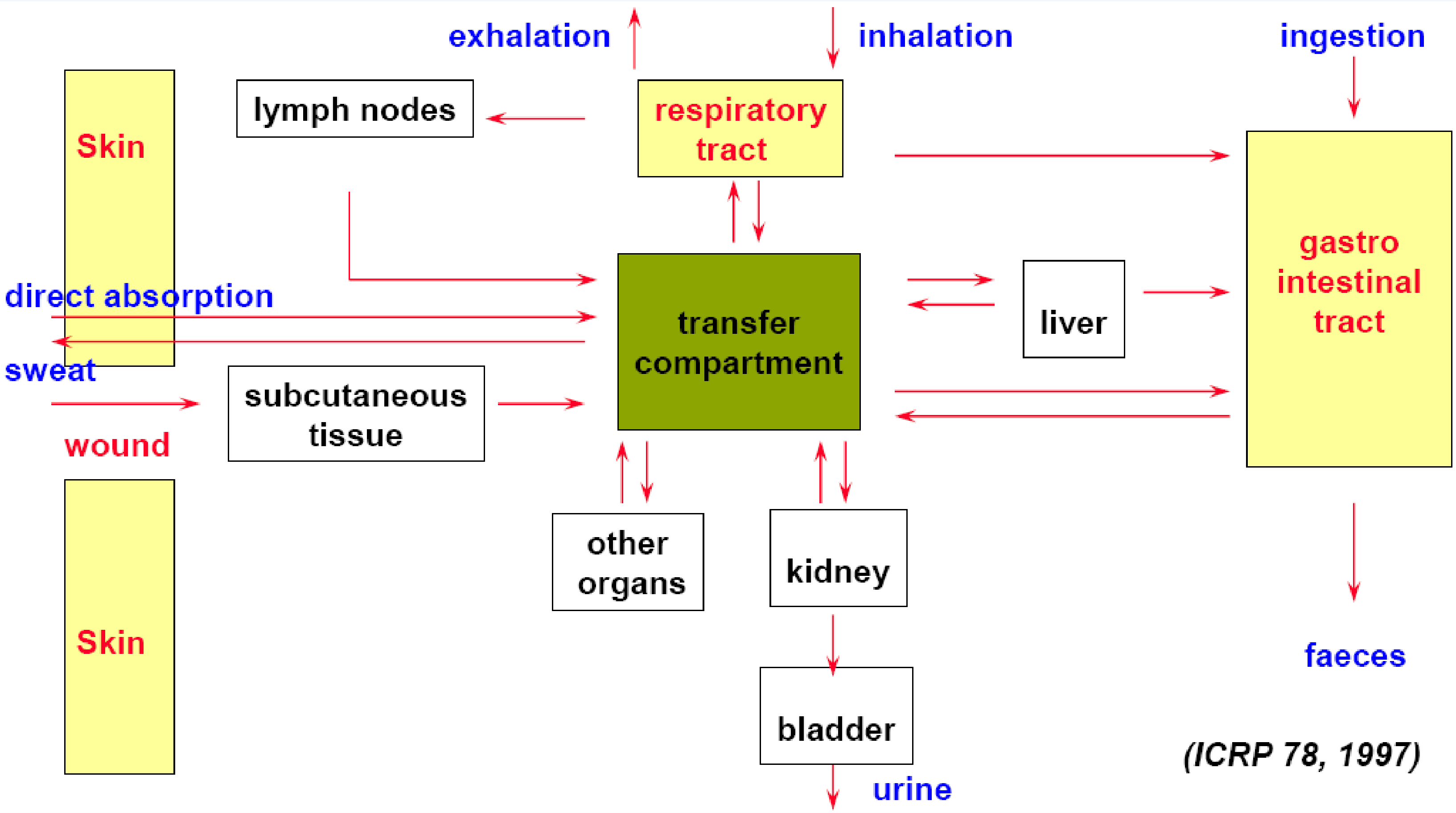
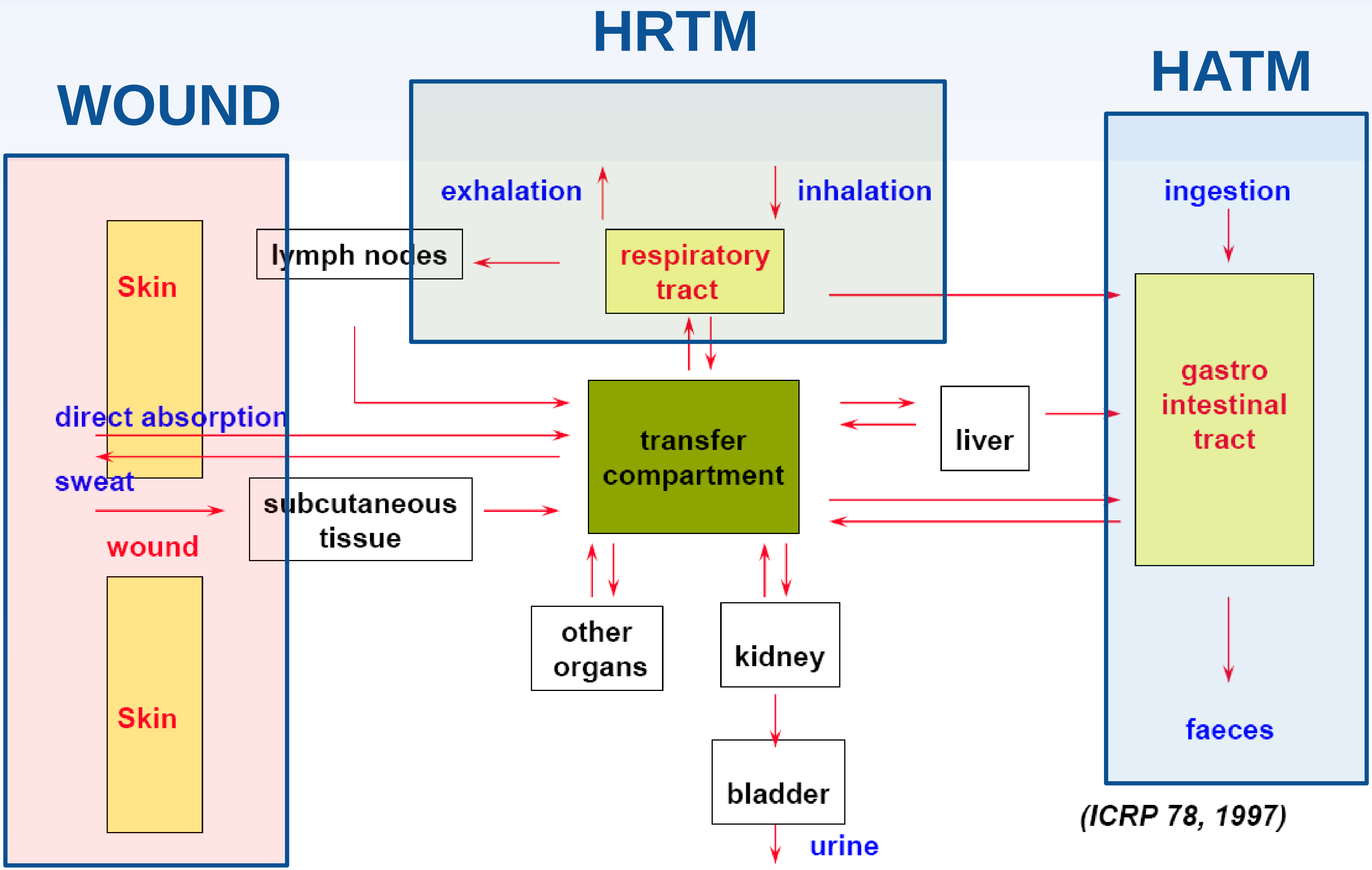
Weighting factors for radiations w_R
Equivalent dose in tissues (Sv)
Weighting factors for tissues w_T
Effective dose (Sv)
Describe
-Where the RN goes
-How long it stays

Generic biokinetic model



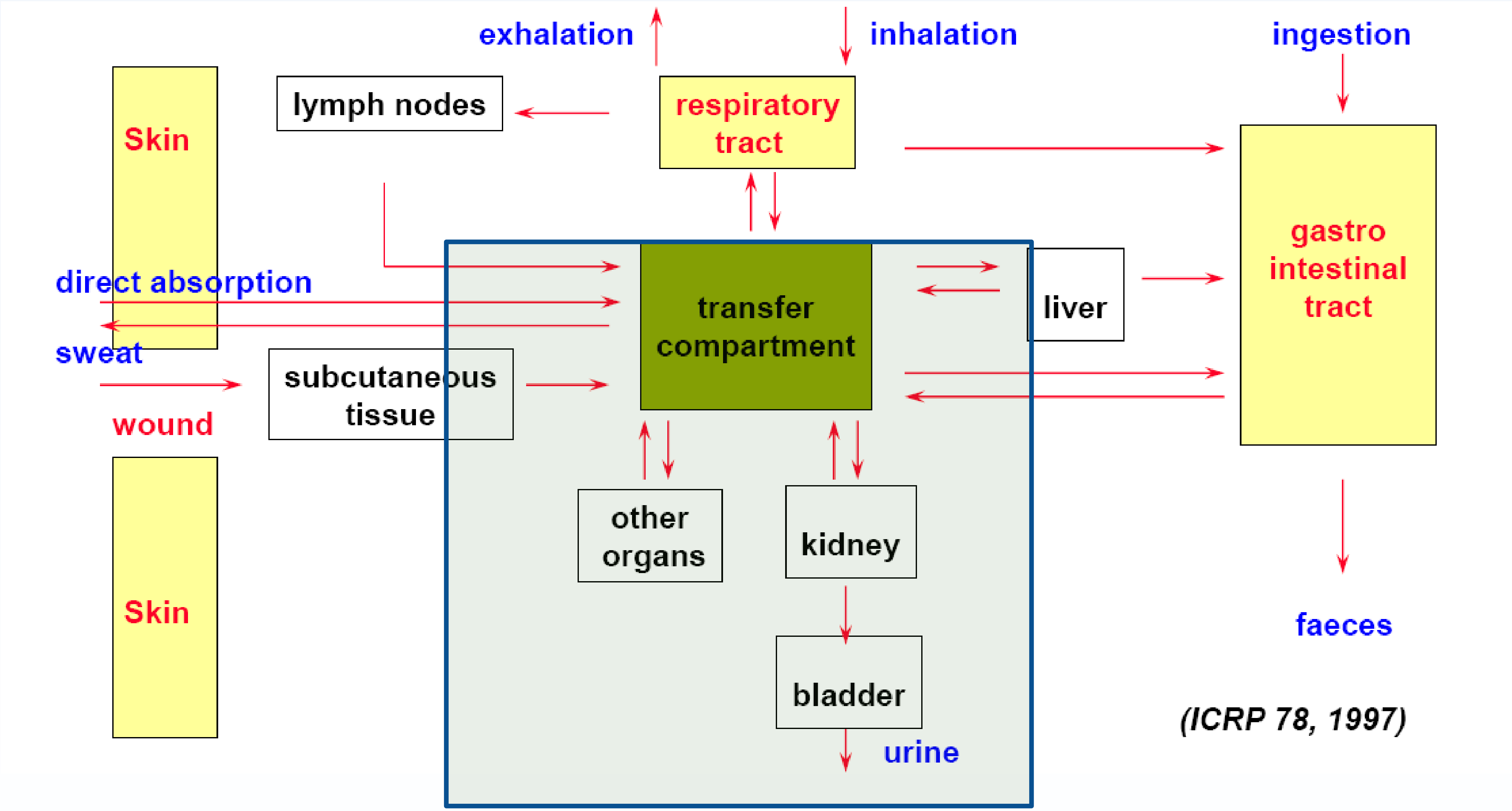
(ICRP 78, 1997)

Depend on chemical forms



(ICRP 78, 1997)

Element specific



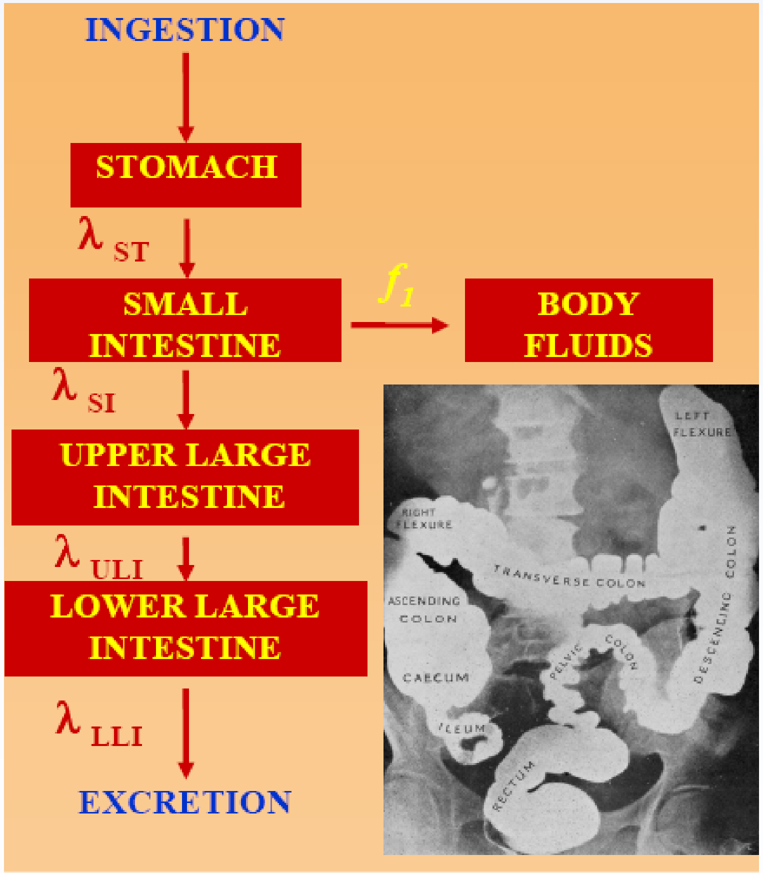
(ICRP 78, 1997)

Systemic

What's new on these models ?

The Human alimentary tract model

The former model



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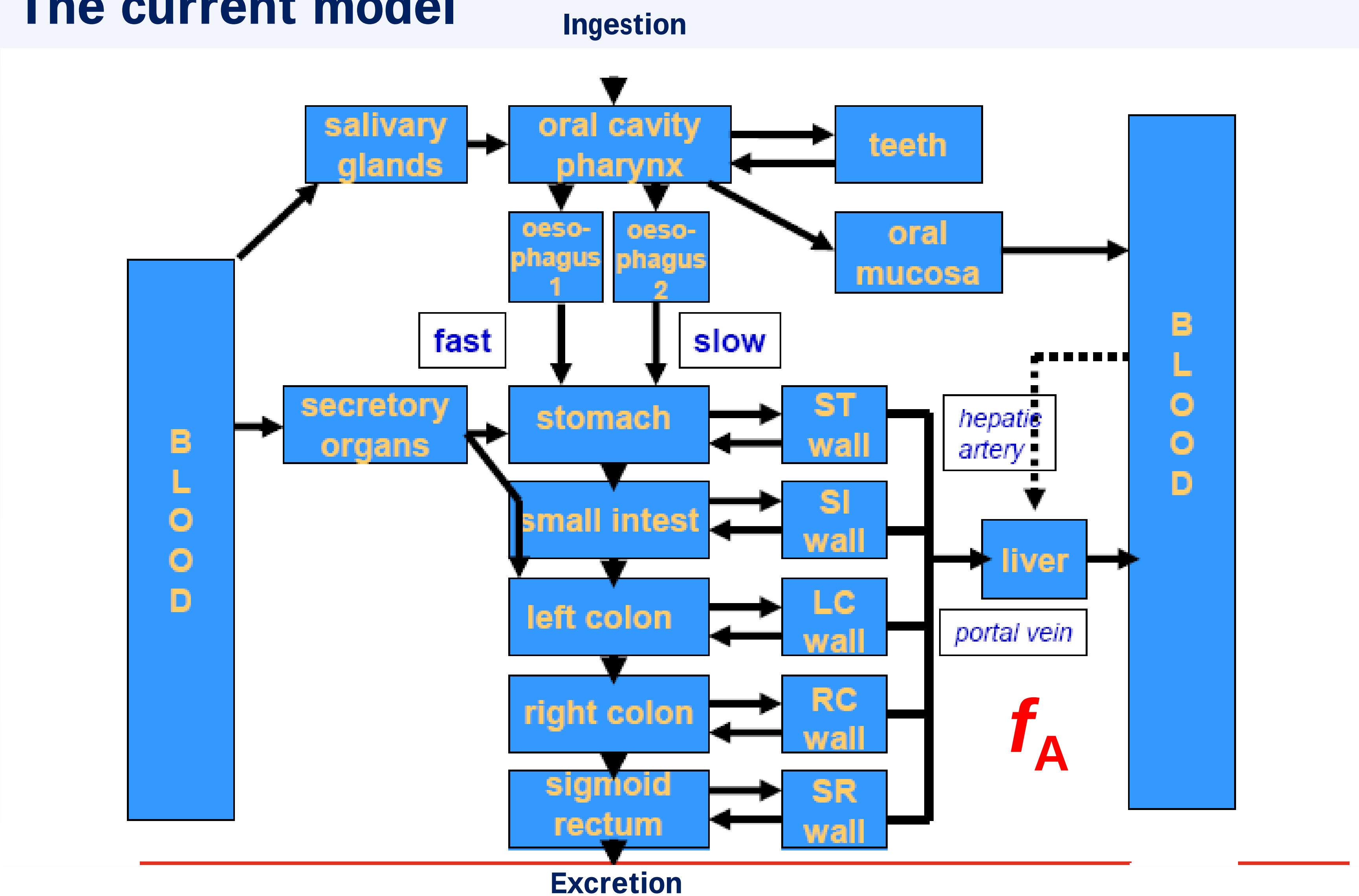
ICRP Publication 30 (1979)

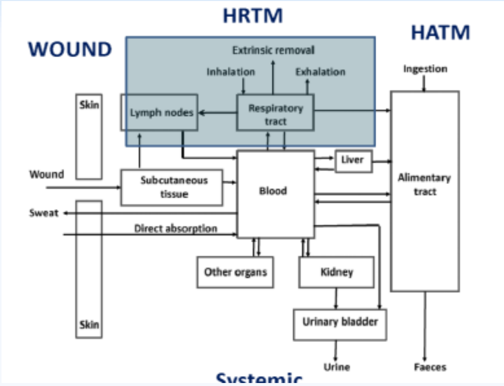
The Human alimentary tract model

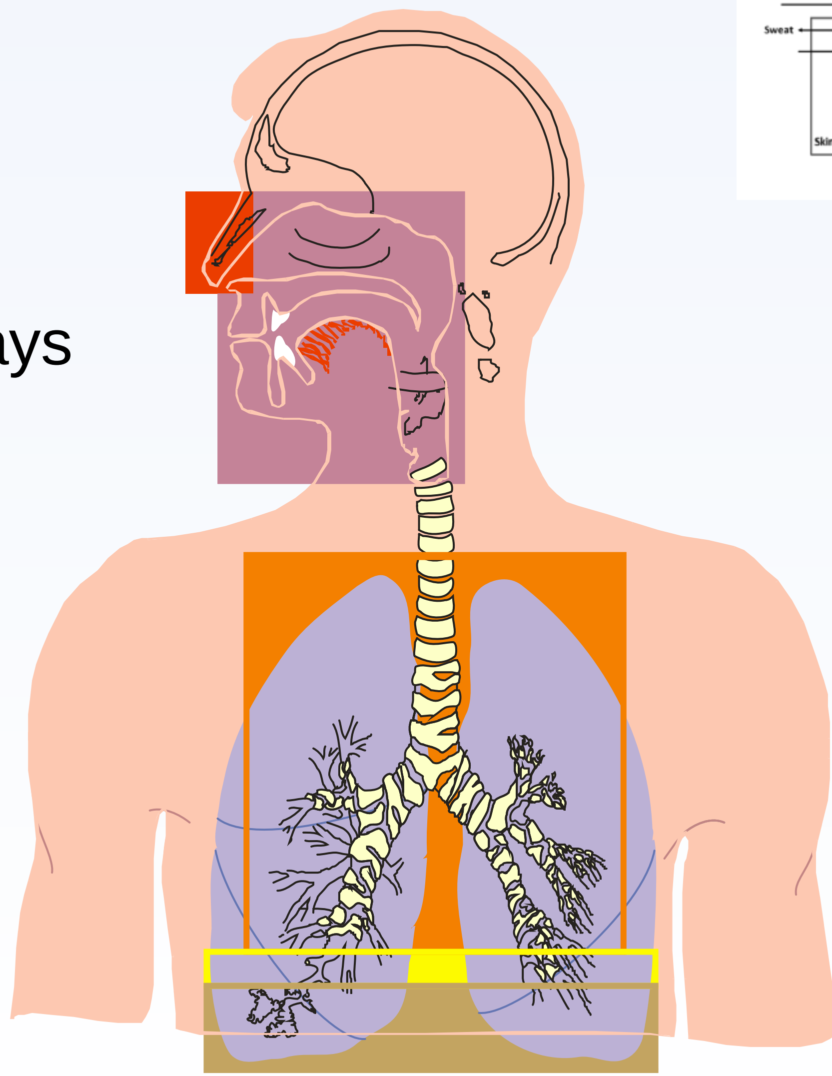
The current model



ICRP Publication 100 (2006)

The Human Respiratory Tract model





Extrathoracic airways — ET_1, ET_2

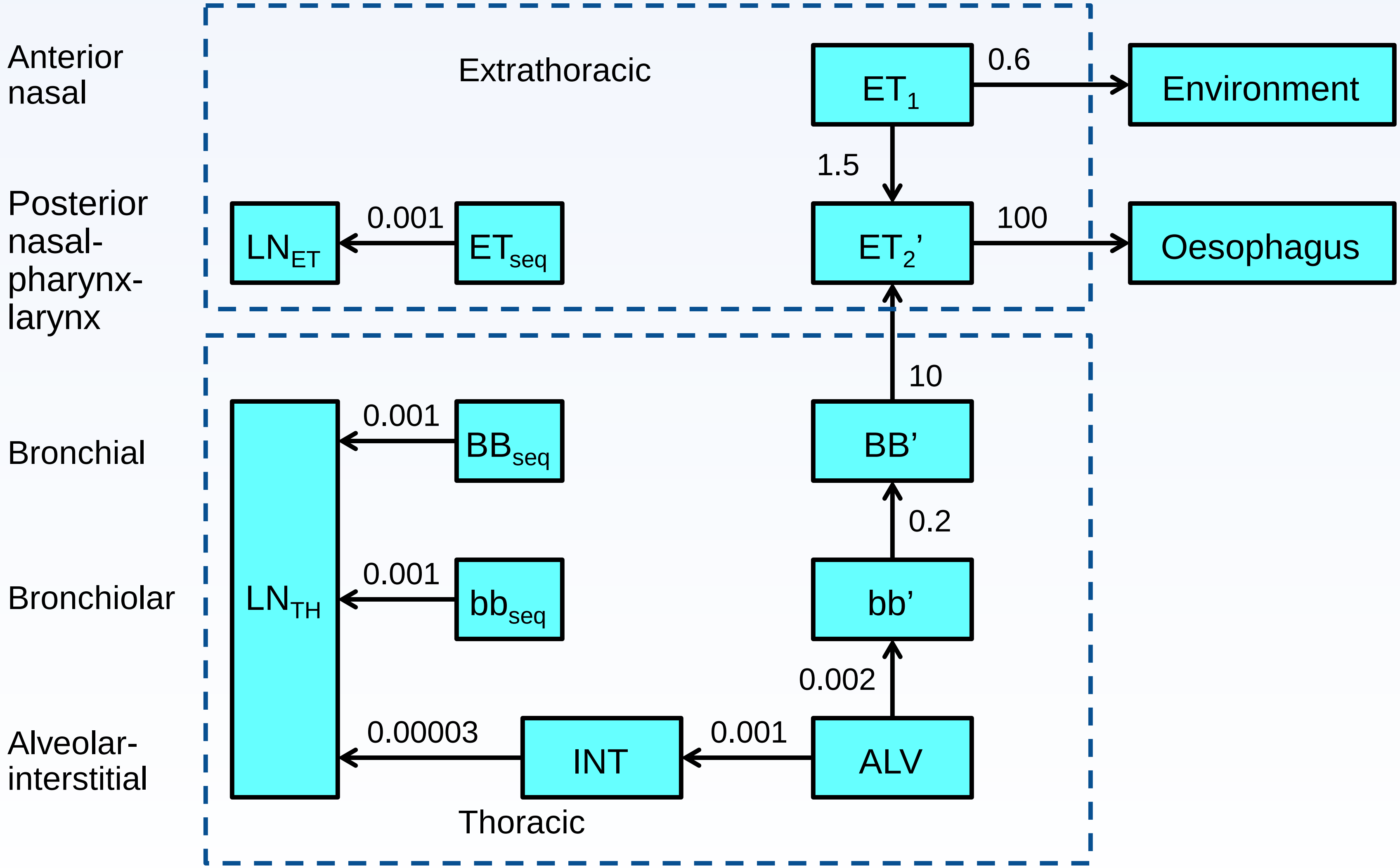
Bronchial — BB

Bronchiolar — bb

Alveolar interstitial — AI

ICRP Publication 66 (1994)

New particle transport model



Default parameter values for Type F, M, S materials

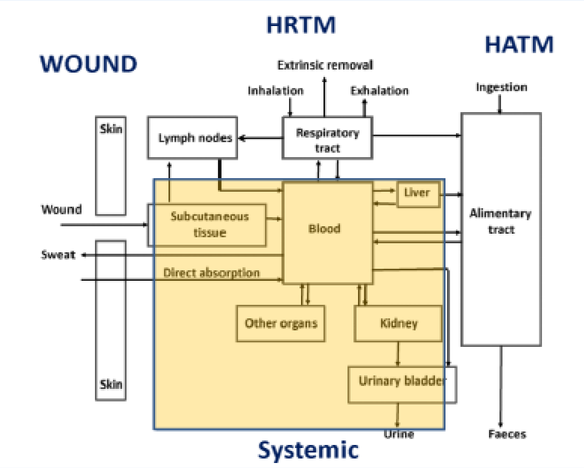
	Fraction	Dissolution rates	
	f_r	s_r (d^{-1})	s_s (d^{-1})
Type F (fast)	*1*	*30*	
Type M (moderate)	*0.2*	*3*	*0.005*
Type S (slow)	*0.01*	*3*	*0.0001*

Material specific values for f_r, s_r and s_s
Element-specific values for s_r. Range from 0.4 to 100 d^{-1}

Example of Uranium absorption

Compound	Absorption parameter values			Type
	f_r	s_r (d^{-1})	s_s (d^{-1})	
Default Type F (UF6, U-TBP)	***1.0***	***10***		
Uranyl nitrate, $UO_2(NO_3)_2$	0.8	1	0.01	(F/M)
Uranium peroxide hydrate	0.8	1	0.01	(F/M)
Ammonium diuranate, ADU	0.8	1	0.01	(F/M)
Default Type M (UF4)	***0.2***	***3***	***0.005***	
Uranium Octoxide U_3O_8; Uranium dioxide	0.03	1	0.0005	(M/S)
Default Type S	***0.01***	***3***	***0.0001***	

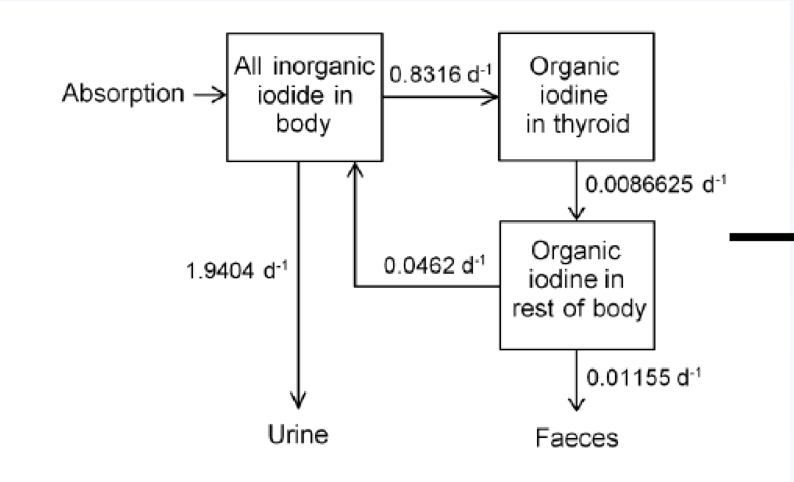
The systemic models

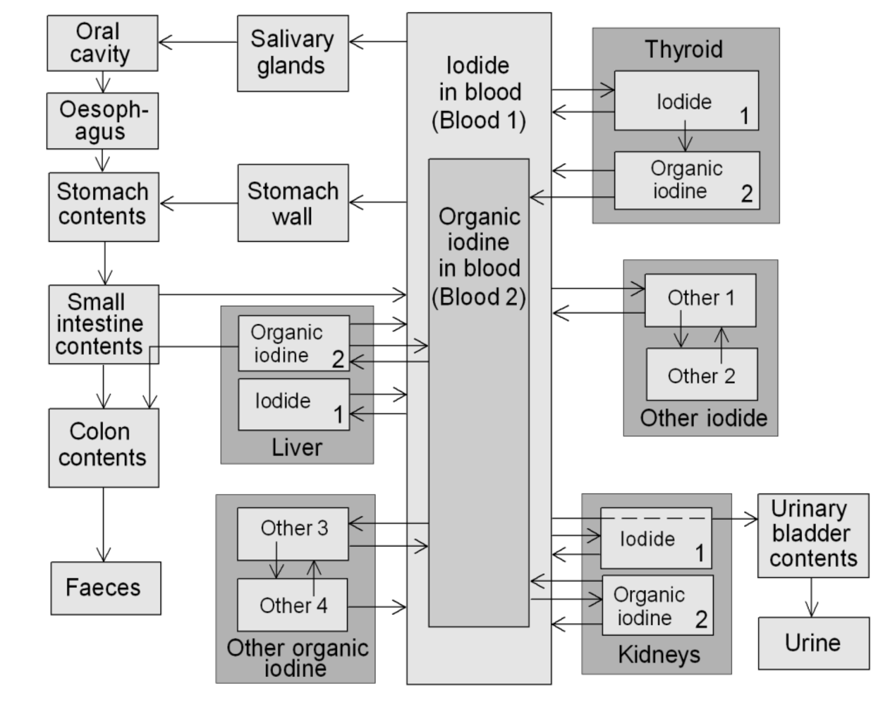


Describes the time-dependent distribution and retention of a radionuclide in the body after absorption to blood, and its excretion from the body.

New models are physiologically realistic with recycling of elements

Systemic model for Iodine





The former model (ICRP 1994, 1997)

The new model
ICRP Publication 137 (2017)

Three subsystems:

- **circulating inorganic iodide;**
- **thyroidal organic iodine**
- **extrathyroidal organic iodine.**

Systemic model for Strontium

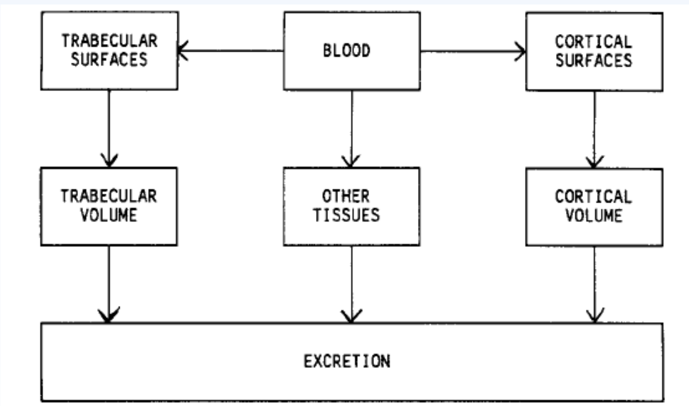
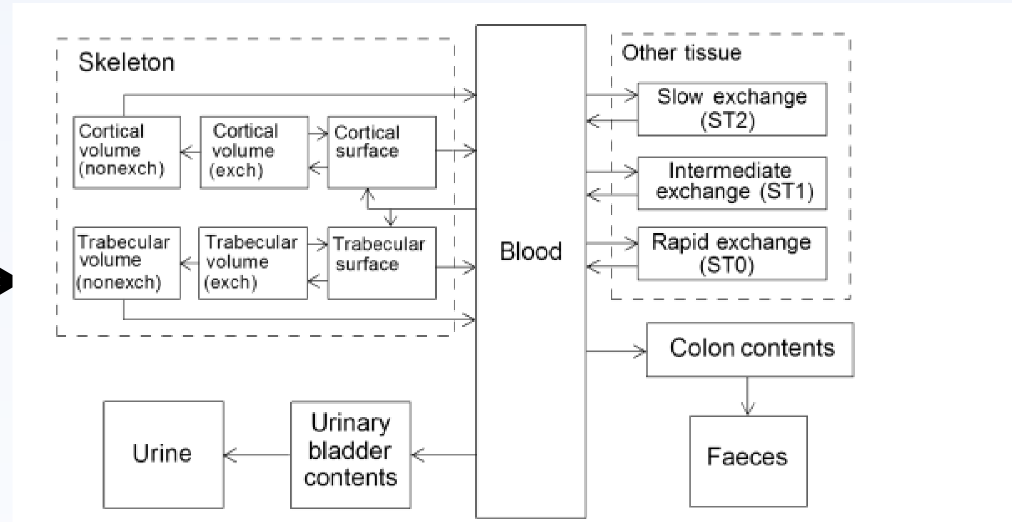


Fig. 2. Diagram of the biokinetic model for strontium.



Structure of the biokinetic model for systemic strontium. ST, soft tissue; exch, exchangeable; nonexch, non-exchangeable.

The former model (ICRP 1989)

The new model
ICRP Publication 134, 2016

Complex procedure, limited to experts

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2. Dose coefficients

3. Bioassays functions

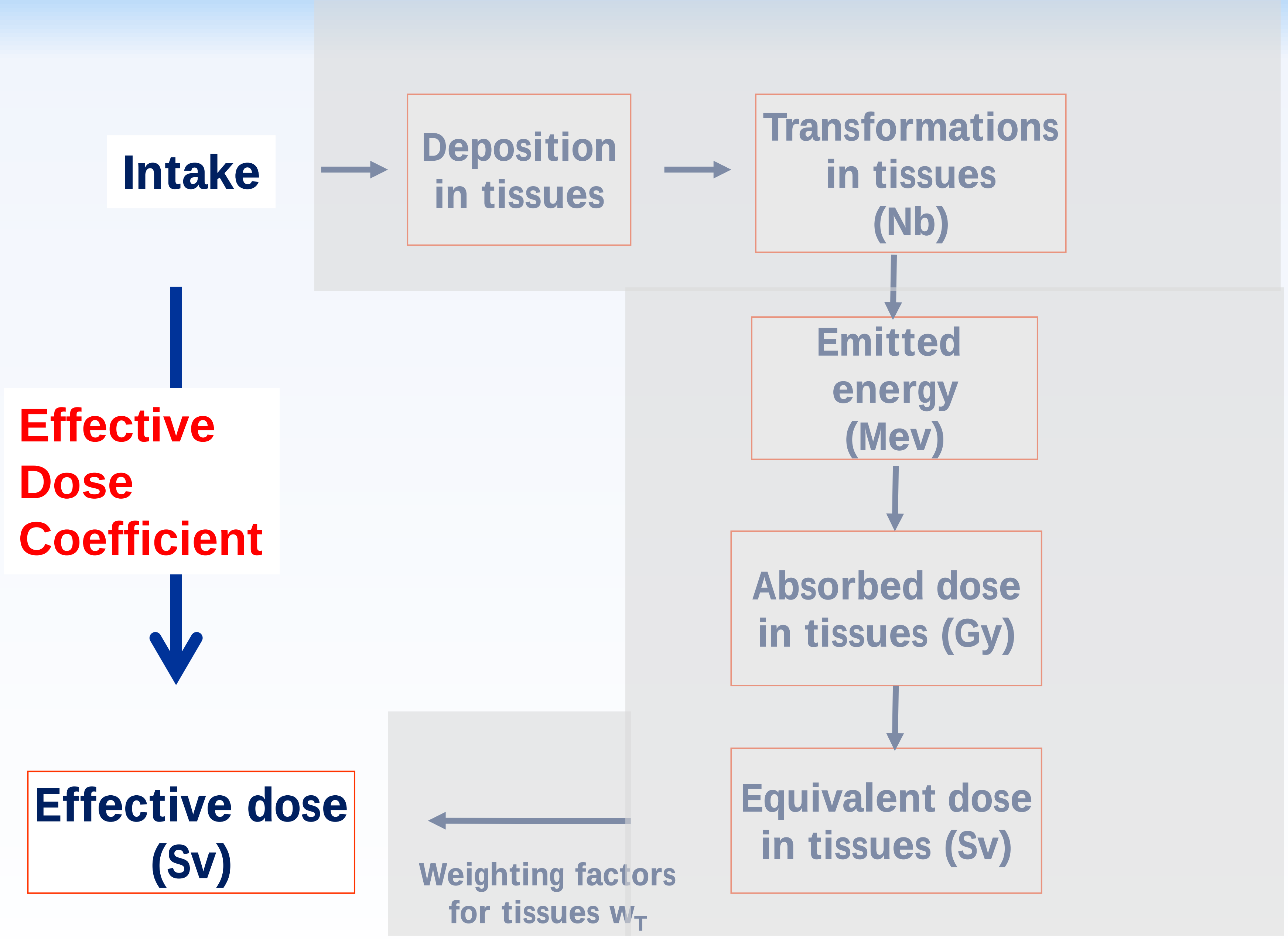
Intake
Deposition in tissues
Transformations in tissues (Nb)
Emitted energy (Mev)
Absorbed dose in tissues (Gy)
Equivalent dose in tissues (Sv)
Weighting factors for tissues w_T
Effective Dose Coefficient
Effective dose (Sv)

Table B.1.—(*continued*)

Nuclide	$t_{1/2}$	Type	f_1	Inhalation, $e_{inh}(50)$ 1 µm AMAD	Inhalation, $e_{inh}(50)$ 5 µm AMAD	Ingestion f_1	Ingestion $e_{ing}(50)$
				Effective dose coefficients (Sv Bq^{-1})			
Ca-47	4.53d	M	0.300	1.8E-09	2.1E-09	0.300	1.6E-09
Scandium							
Sc-43	3.89h	S	1.0E-04	1.2E-10	1.8E-10	1.0E-04	1.9E-10
Sc-44	3.93h	S	1.0E-04	1.9E-10	3.0E-10	1.0E-04	3.5E-10
Sc-44m	2.44d	S	1.0E-04	1.5E-09	2.0E-09	1.0E-04	2.4E-09
Sc-46	83.8d	S	1.0E-04	6.4E-09	4.8E-09	1.0E-04	1.5E-09
Sc-47	3.35d	S	1.0E-04	7.0E-10	7.3E-10	1.0E-04	5.4E-10
Sc-48	1.82d	S	1.0E-04	1.1E-09	1.6E-09	1.0E-04	1.7E-09
Sc-49	0.956h	S	1.0E-04	4.1E-11	6.1E-11	1.0E-04	8.2E-11
Titanium							
Ti-44	47.3y	F	0.010	6.1E-08	7.2E-08	0.010	5.8E-09
		M	0.010	4.0E-08	2.7E-08		
		S	0.010	1.2E-07	6.2E-08		
Ti-45	3.08h	F	0.010	4.6E-11	8.3E-11	0.010	1.5E-10
		M	0.010	9.1E-11	1.4E-10		
		S	0.010	9.6E-11	1.5E-10		

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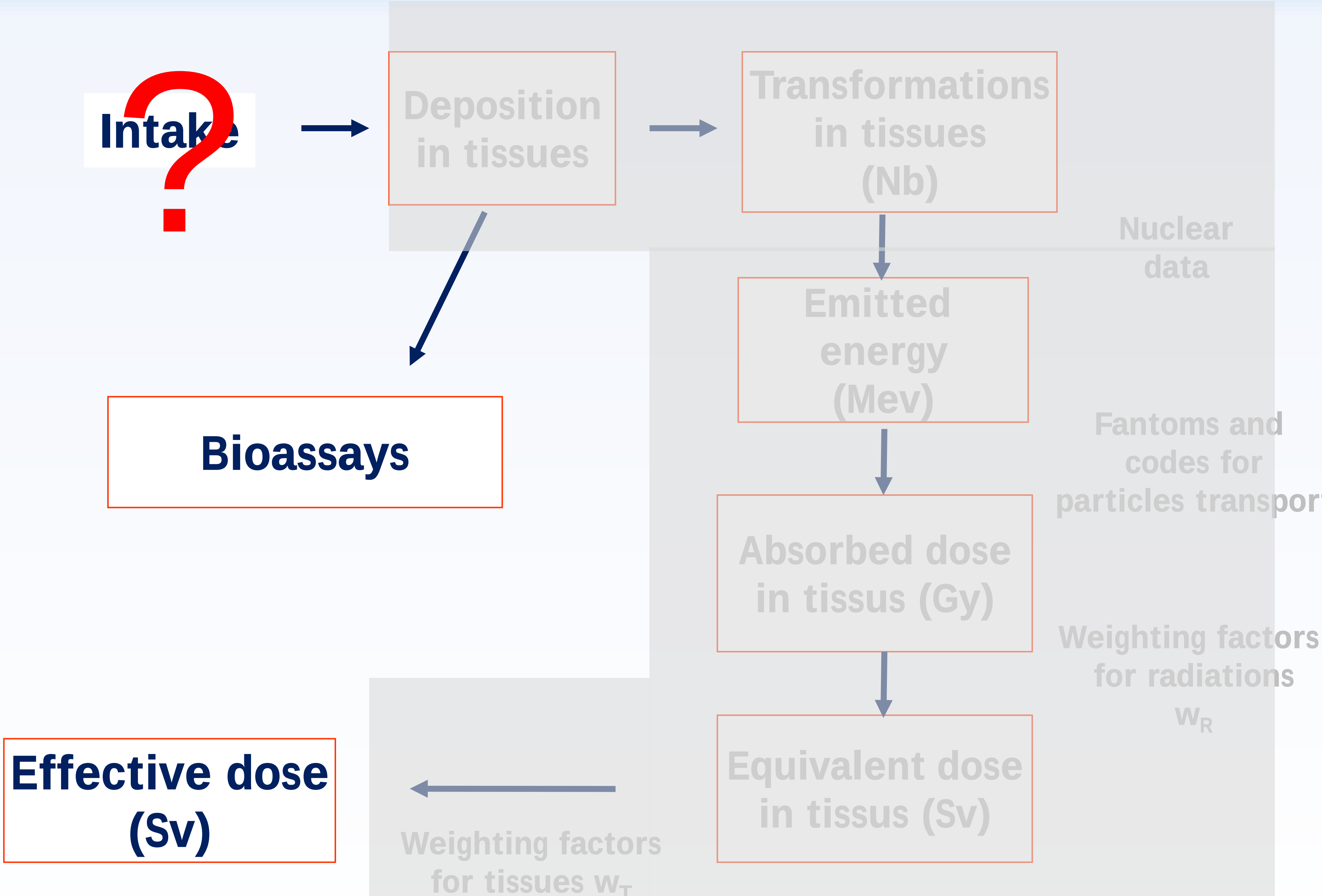
Dose = Intake x EDC

From ICRP 68, 1994


Intake
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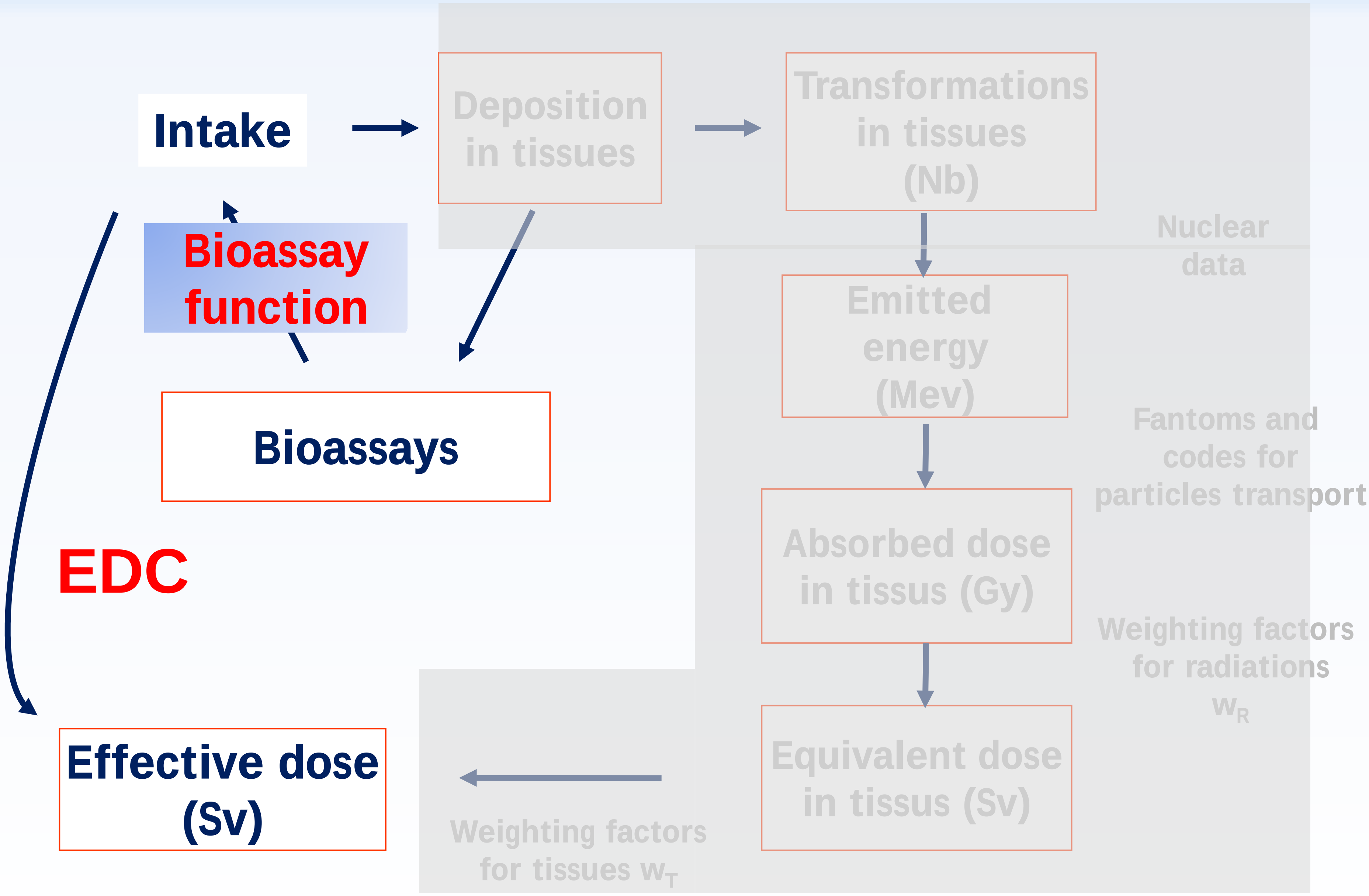
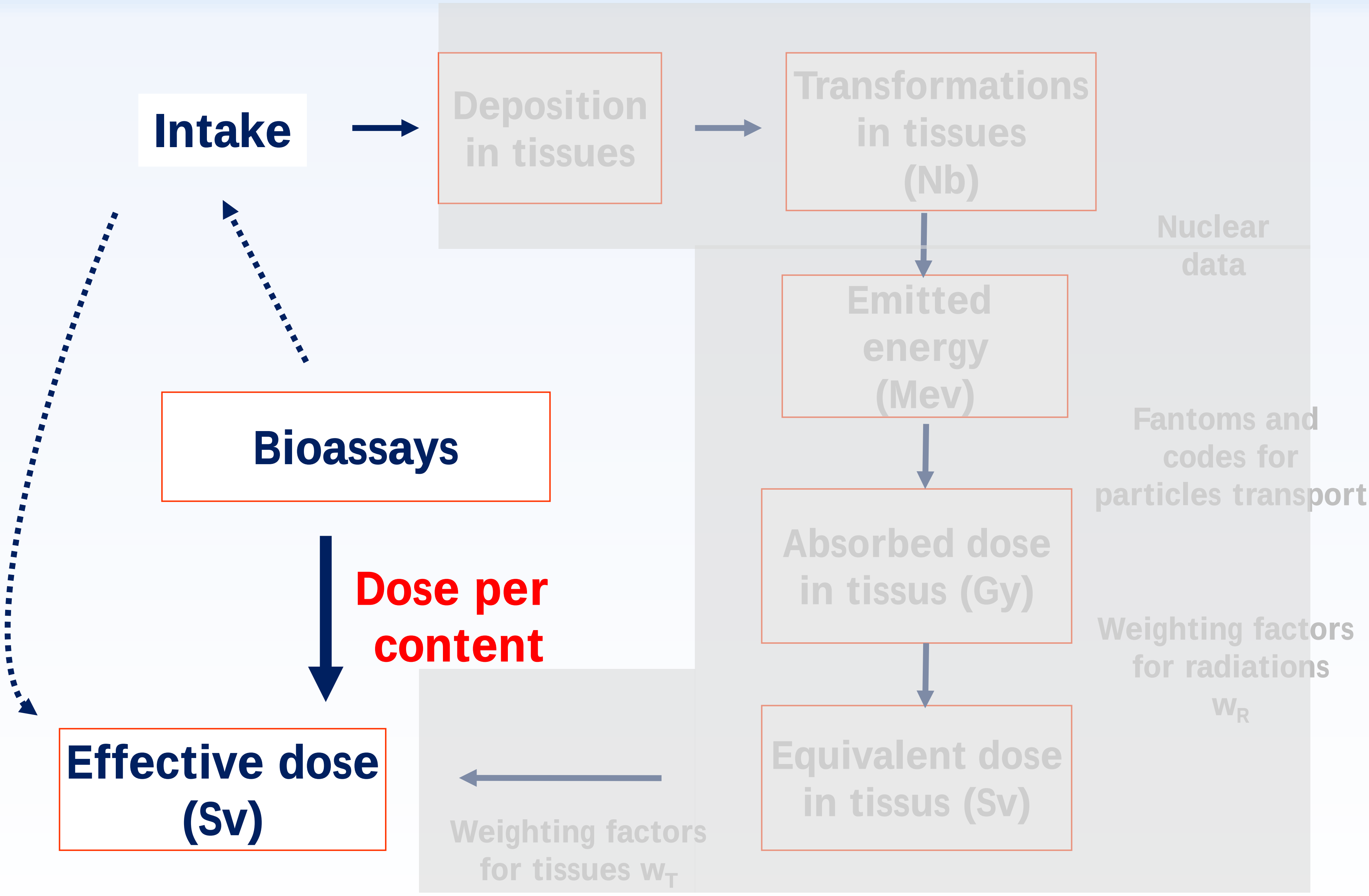
Bioassays
Effective dose (Sv)



Intake
Deposition in tissues
Transformations in tissues (Nb)
Nuclear data
Bioassay function
Emitted energy (Mev)
Bioassays
Fantoms and codes for particles transport
EDC
Absorbed dose in tissus (Gy)
Weighting factors for radiations w_R
Equivalent dose in tissus (Sv)
Effective dose (Sv)
Weighting factors for tissues w_T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Equivalent dose in tissus (Sv)
Weighting factors for tissues w_T
Bioassays
Dose per content
Effective dose (Sv)

Many models, dose coefficients and bioassay functions have been issued since the 70s

For the workers

Publication 30 series **(ICRP, 1979, 1980, 1981, 1988)**
Publication 68 **(ICRP, 1994)**

For the members of the public

Publications 56, 67, 69, 71 and 72 **(ICRP, 1989, 1993, 1995)**
age-specific models

Publications 88 and 95 **(2001,2004)**
transfers to embryo/fetus and infants

Update of the reports on internal exposure

Division of the work in two parts :

- **Revision of models and dose coefficients for workers** ***(OIR series)***

- **Revision of models and dose coefficients for members of the public** ***(Age dependant series, Embryo and fetus, maternal transfer,..)***

The OIR series

OIR Part 1 *ICRP Publication 130, 2015*

Models and methods for monitoring

OIR Part 2 *ICRP Publication 134, 2016*

Hydrogen (H), Carbon (C), Phosphorus (P), Sulphur (S), Calcium (Ca), Iron (Fe), Cobalt (Co), Zinc (Zn), Strontium (Sr), Yttrium (Y), Zirconium (Zr), Niobium (Nb), Molybdenum (Mo) and Technetium (Tc).

OIR Part 3 *ICRP Publication 137, 2017*

Ruthenium (Ru), Antimony (Sb), Tellurium (Te), Iodine (I), Caesium (Cs), Barium (Ba), Iridium (Ir), Lead (Pb), Bismuth (Bi), Polonium (Po), Radon (Rn), Radium (Ra), Thorium (Th) and Uranium (U).

OIR Part 4, *ICRP Publication 141, 2019*

Lanthanides series, actinium (Ac), protactinium (Pa) and transuranic elements

OIR Part 5, *Public consultation on ICRP website*

Most of the remaining elements

The « Public » series; 5 volumes

Public Part 1, *scheduled 2021*
Dose coefficients for 28 elements

Public Part 2, *scheduled 2022*
Dose coefficients for actinides and lanthanides

Public Part 3, *scheduled 2023*
Dose coefficients for every other elements

Public Part 4, > 2024
Breast-feeding Infant Internal Dose Coefficients from Maternal Intakes

Public Part 5, > 2024
In utero Internal Dose Coefficients from Maternal Intakes

The end

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