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ICRP Publication XXX



107PAEDIATRIC MESH-TYPE REFERENCE108COMPUTATIONAL PHANTOMS

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111 ABSTRACT

Abstract- Following the issuance of the 2007 Recommendations in Publication 103, the 112 113 Commission released the adult (male and female) and paediatric (newborn, 1-, 5-, 10- and 15-114 year-old male and female) reference computational phantoms in Publications 110 and 143, 115 respectively, for use in effective dose calculations. These phantoms are voxel models 116 represented in the form of a 3D array of cuboidal voxels, which were constructed from computed tomography images of people and adjusted to be consistent with the reference 117 118 anatomical parameters given in Publication 89. The voxel phantoms provide anatomical 119 improvements over the mathematical equation-based stylised phantoms used for the previous 120 dose coefficient (DC) calculations prior to the 2007 Recommendations. Nevertheless, the voxel phantoms, due to the nature of voxel geometry and finite voxel resolutions, have limitations in 121 122 representing small and thin organs and tissues, necessitating additional supplementary stylised 123 models such as those defined for the respiratory tract airways, the alimentary tract organ walls 124 and stem cell layers, lens of the eye and the skin basal layer.

- 125 To address the limitations of the voxel phantoms, Task Group 103 was charged with developing 126 mesh-type reference computational phantoms (MRCPs) by converting the voxel phantoms into 127 a high-quality/fidelity mesh format with anatomical improvements for the complex organs and tissues which were not fully represented in the voxel phantoms. The MRCPs for adult male 128 129 and female were then developed and recently released in Publication 145. Following the 130 release of the adult MRCPs, the current publication describes the construction of the paediatric 131 MRCPs, the counterparts of the Publication 143 voxel phantoms. The paediatric MRCPs, like the adult MRCPs, were developed to have all the source and target tissues required for 132 133 calculation of effective dose, including the micrometre-scale regions, assimilating the supplementary stylised models. These phantoms can be directly used in general-purpose Monte 134 135 Carlo codes such as Geant4, PHITS and MCNP6, fully maintaining the high fidelity of the 136 mesh geometry in Monte Carlo dose calculations.
- 137 To investigate the impact of the paediatric MRCPs, the DCs of organ dose and effective dose
- 138 and specific absorbed fractions (SAFs) for some selected external and internal exposures were
- 139 calculated and compared with the values calculated using the *Publication 143* phantoms and
- 140 the *Publications* 66 and 100 mathematical models for the respiratory and alimentary tracts and



141 the reference values of Publication 1XX. While some differences in the DCs and SAFs were 142 observed for anatomically improved organs and weakly penetrating radiations, they were found not to be much different, indicating that the reference DCs obtained from the Publication 143 143 144 voxel phantoms for both external and internal exposures remain valid in the current ICRP 145 dosimetry system. The Publication 143 voxel phantoms remain the primary ICRP/ICRU reference models for the calculation of reference DCs based on Publication 103 methodology. 146 147 The paediatric MRCPs will be used for all calculations of reference DCs following the next set 148 of general recommendations and provide a resource for wider use in radiological protection 149 applications.

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- 151 *Keywords:* Phantoms; Tetrahedral mesh; Polygon mesh; Dose coefficients; Internal and 152 external exposures



MAIN POINTS

- This publication presents paediatric mesh-type reference computational phantoms (MRCPs) representing the Reference Male and Female at 0 year (i.e. newborn), 1 year, 5 years, 10 years and 15 years of age, which are counterparts of the paediatric voxel-type reference computational phantoms in *Publication 143* (ICRP, 2020a) developed based on computed tomography images of real people.
- The paediatric MRCPs were constructed by converting the *Publication 143* voxel phantoms to a high-quality mesh format, assimilating the supplementary stylised models used in conjunction with the voxel phantoms to overcome limitations of voxel geometry and adding tissue layers that are considered to contain cells at risk of radiogenic cancer.
- The paediatric MRCPs include all the necessary source and target tissues defined
 by the ICRP system for effective dose calculations, including the micrometre-thick
 source and target layers of the alimentary and respiratory tracts, skin and urinary
 bladder, as well as lens dose calculations.
- The paediatric MRCPs were found to provide dose coefficients and specific absorbed fractions that are generally not much different from those of the *Publication 143* voxel phantoms for both external and internal exposures, while some differences were observed for anatomically improved organs and weakly penetrating radiations (e.g. photons <50 keV and electrons).
- The *Publication 143* voxel phantoms remain the primary ICRP/ICRU reference models for the calculation of reference dose coefficients based on *Publication 103* methodology (ICRP, 2007), but the paediatric MRCPs will be used for all calculations of reference dose coefficients following the next set of general recommendations and also serve as a resource for wider use in radiological protection applications.

180



1. INTRODUCTION

182 (1) A system of radiological protection requires appropriate dose quantities for use in the 183 control of radiation exposures to individuals, including workers and members of the public, to prevent tissue reactions and to optimise protection from stochastic effects. For these purposes, 184 185 the latest ICRP recommendations published in Publication 103 (ICRP, 2007) described two 186 protection quantities: equivalent dose (H_T) and effective dose (E), both given in sievert (Sv). 187 These protection quantities are derived from absorbed dose (D_T) , which is the basic physical dose quantity in the unit of gray (Gy; joule per kilogram). H_T is calculated from D_T averaged 188 over an organ/tissue (hereafter 'organ') considering the relative effectiveness of different 189 190 radiation types in causing stochastic effects. E is defined as the weighted sum of the values of 191 H_T (i.e. weighted by the tissue weighting factors (w_T) over all organs considered to be sensitive 192 to the induction of stochastic effects) (ICRP, 1991a). In accordance with the definition in 193 Publication 103 (ICRP, 2007), E is computed from the gender-averaged H_T values of the 194 Reference Male and Female at specified ages as defined in *Publication 89* (ICRP, 2002). *E* is 195 the risk-related quantity in radiation protection and is used as the central protection quantity in 196 the optimisation of protection for workers and members of the public, the setting of control 197 criteria (dose limits, dose constraints and reference levels) and the demonstration of regulatory 198 compliance.

199 (2) For the calculation of the above dose quantities, the Commission adopted adult male and 200 female reference computational phantoms as described in *Publication 110* (ICRP, 2009). The 201 Publication 110 phantoms, to be referred in this report as P110 phantoms, were constructed 202 from computed tomography (CT) data of two subjects anatomically similar to the Reference 203 Persons and adjusted to be consistent with the reference adult anatomical parameters given in 204 Publication 89 (ICRP, 2002). These phantoms, coupled with Monte Carlo radiation transport 205 codes, were used to calculate the dose coefficients (DCs) for external idealised exposures in Publication 116 (ICRP, 2010), external environmental exposures in Publication 144 (ICRP, 206 207 2020b) and specific absorbed fractions (SAFs) in Publication 133 (ICRP, 2016). The SAFs in Publication 133 were subsequently used in the computation of the DCs for internal exposures 208 209 due to occupational intakes of radionuclides in a series of publications (ICRP, 2015, 2016, 210 2017a,b, 2019).

211 (3) The Commission also adopted ten paediatric male and female reference computational 212 phantoms representing for ages of 0 year (i.e. newborn), 1 year, 5 years, 10 years and 15 years 213 in Publication 143 (ICRP, 2020a). The Publication 143 phantoms, to be referred in this report 214 as P143 phantoms, were also constructed from CT data and adjusted taking into account the 215 reference paediatric anatomical parameters from *Publication 89* (ICRP, 2002). The P143 216 phantoms were used to calculate the DCs for external environmental exposures in Publication 217 144 (ICRP, 2020b) and are currently being used by a joint Task Group of ICRP Committees 2 218 and 3 to estimate the DCs for common diagnostic x-ray imaging examinations. In addition, 219 these phantoms were employed to calculate the paediatric SAFs in Publication 1XX (ICRP, 220 2022). The SAFs listed in Publication 133 and 1XX are currently being used for the 221 computation of the DCs for internal exposures due to environmental intakes of radionuclides 222 by the public and to patients from radiopharmaceuticals administered in diagnostic nuclear 223 medicine.

224 (4) The P110 and P143 phantoms are voxel models represented in the form of a 3D array of 225 cuboidal voxels. Such voxel phantoms, based on CT images of human bodies, provide higher 226 realism of human anatomy than previous stylised (or mathematical) phantoms in which 227 external body and internal organ shapes are modelled using mathematical equations such as 228 spheres, cylinders and ellipsoids. Prior to the 2007 Recommendations, the Commission relied



on various stylised phantoms (Snyder et al., 1969, 1978; Cristy, 1980; Kramer et al., 1982;
Cristy and Eckerman, 1987; Stabin et al., 1995) for the calculation of the ICRP reference DCs
for external and internal exposures issued in *Publications 30*, *53*, *56*, *60*, *61*, *66*, *67*, *68*, *69*, *71*, *72*, *74*, *80* and *100* (ICRP, 1979, 1988, 1990, 1991a,b, 1994a, 1993, 1994b, 1995a,b, 1996a,b,
1998, 2006).

234 (5) While providing anatomical improvements over the stylised phantoms, the ICRP voxel 235 phantoms have limitations in the representation of small organ structures and very thin tissue 236 layers. The voxel phantoms, composed of millimetre-scale voxels, cannot explicitly represent 237 the micrometre-scale radiosensitive target regions and source regions in the respiratory and 238 alimentary tracts, skin, lens of the eye and urinary bladder (the source regions here indicate the 239 organs, tissues and body regions where radionuclides reside or pass that could thus irradiate target regions). With the limitations of these phantoms acknowledged in *Publications 133* and 240 241 1XX (ICRP, 2016, 2022), the SAFs for electrons and alpha particles emitted from the source 242 regions in the respiratory and alimentary tracts were computed by employing supplementary 243 organ-specific stylised models. For the same reason, in Publication 116 (ICRP, 2010), the DCs 244 from external idealised exposures for lens of the eye and local skin were computed by 245 additional simulations with supplementary stylised models.

246 (6) In order to overcome the limitations of the ICRP voxel phantoms associated with their 247 intrinsic limitations of using voxels, to avoid the use of supplementary stylised models and to 248 provide therefore all-in-one anatomical computational phantoms, the Commission started to 249 develop mesh-type reference computational phantoms (MRCPs) by converting the voxel 250 phantoms to high-quality/fidelity mesh-based phantoms. Note that the mesh geometry, either 251 polygonal mesh (PM) or tetrahedral mesh (TM), is considered at the time of writing this report 252 as the most advanced geometry used to construct computational phantoms beyond voxel 253 geometry (Kainz et al., 2019).

254 (7) Recently, many researchers have been motivated to develop computational phantoms in 255 the PM geometry [or sometimes combined with non-uniform rational B-spline (NURBS) 256 geometry] for both adults (Christ et al., 2009; Zhang et al., 2009; Cassola et al., 2010; Lee et al., 2010; Segars et al., 2010; Hurtado et al., 2012; Gosselin et al., 2014; Dong et al., 2015; 257 258 Lombardo et al., 2018; Pi et al., 2018) and children and adolescents (Lee et al., 2007, 2008, 259 2010; Christ et al., 2009; de Melo Lima et al., 2011; Cassola et al., 2013; Gosselin et al., 2014; 260 Norris et al., 2014; Ma et al., 2017; Pi et al., 2018), providing more realistic representations of the human bodies than the voxel phantoms. These phantoms, however, need to be voxelised to 261 be used in Monte Carlo codes, which leads to the recurrence of the limitations of the voxel 262 263 phantoms. The aim of this Task Group, therefore, is to develop ICRP reference computational phantoms in the advanced mesh geometry which can be directly used in Monte Carlo codes, 264 265 fully maintaining the advantages of the mesh geometry in Monte Carlo dose calculations.

266 (8) Publication 145 (ICRP, 2020c) was the first report of this Task Group, which describes 267 the development of adult male and female MRCPs constructed as the mesh counterparts of the P110 phantoms (ICRP, 2009). The current report, as the second report of the Task Group, 268 269 describes the development of the paediatric series of MRCPs for newborn, 1 year, 5 years, 10 270 years and 15 years, depicting (1) the conversion of the P143 phantoms to the mesh format, 271 including the remodelling or modification of complex organs; (2) the addition of some tissue 272 structures such as the target cell layers for the respiratory and alimentary tracts, skin, urinary 273 bladder, eyes and teeth; and (3) the impact of the paediatric MRCPs in the estimation of DCs 274 within the ICRP system.

(9) The MRCPs, while closely preserving the original topology and shape of most of the
 organs of the voxel phantoms, present substantial improvements in the anatomy of small organs
 and include all the necessary source and target tissues defined by the ICRP system, assimilating



the supplementary stylised models such as those defined for the respiratory tract airways, the alimentary tract organ walls and stem cell layers, the lens of the eye and the skin basal layer. The MRCPs, which are in the TM format, are no longer bounded by the limitations of voxel geometry for the representation of very small and/or thin structures. These phantoms can also be used directly in the general-purpose Monte Carlo codes (e.g. Geant4, PHITS and MCNP6) without any additional processing (i.e. voxelisation) as needed for earlier work with mesh phantoms (Yeom et al., 2019b, 2020).

285 (10) For the calculation of reference equivalent and effective DCs based on Publication 286 103 (ICRP, 2007) methodology, the P110 and P143 voxel phantoms (ICRP, 2009, 2020a) 287 remain the primary ICRP/ICRU reference anatomical models. The MRCPs will replace the voxel phantoms for all calculations of reference DCs following the next set of general 288 289 recommendations. The MRCPs have applications beyond the calculation of reference DCs. The 290 new mesh phantoms are highly deformable and can be used to create phantoms of various body 291 sizes and postures for use in retrospective emergency or accidental dose reconstruction (Lee et 292 al., 2019; Yeom et al., 2019a; Choi et al., 2020). The deformation capability of the phantoms 293 can also facilitate the virtual calibration of whole-body counters to account for the body size 294 of individuals in efficiency calibration. The mesh phantoms can also be used directly to produce 295 physical phantoms with 3D printing technology (Kim et al., 2022). In addition, it is relatively 296 easy to model detailed structures in the phantoms and, therefore, the new phantoms could find 297 applications in medicine and other areas requiring sophisticated organ models. One of the aims 298 of this report is to assist those who wish to implement the phantoms for their own applications; 299 therefore, detailed data on the phantoms in the PM format as well as the TM format are 300 provided in the supplementary electronic data that accompany the printed publication, together 301 with some input examples of the Monte Carlo codes.

302 (11) Chapter 1 explains the main background for the construction of the paediatric MRCPs. Chapter 2 focuses on the organs of the P143 phantoms for which the anatomical description 303 304 has been significantly improved in the paediatric MRCPs. Chapter 3 describes the general 305 procedure for the conversion of the P143 phantoms to the mesh format, including the 306 remodelling or modification of complex organs. Chapter 4 describes the adjustment of the 307 converted mesh models to the reference values for the mass, density and elemental composition 308 of organs inclusive of blood content. Chapter 5 describes the inclusion of the thin target and 309 source regions in the skin, alimentary tract, respiratory tract and urinary bladder. Chapter 6 310 describes the general characteristics of the paediatric MRCPs. Finally, Chapter 7 investigates the impact of the improved morphology of the paediatric MRCPs on the calculation of DCs for 311 312 external and internal exposures.

(12) A detailed description of the paediatric MRCPs is given in Annexes A-F. Annex A 313 314 presents a list of the organs/structures [identification number (ID) list], together with the 315 assigned media, densities and masses. Annex B presents a list of the phantom media and their 316 elemental compositions. Annexes C and D list the source and target regions, respectively, together with their acronyms and IDs. Annex E provides depth distributions for selected organs 317 318 from the front, back, left, right, top and bottom, along with the respective data for the P143 319 phantoms. Annex F provides chord-length distributions between selected pairs of source and target organs, along with the data for the P143 phantoms. Annex G presents selected transverse, 320 321 sagittal and coronal slice images of the paediatric MRCPs. In Annexes H and I, the DCs and 322 SAFs calculated with the paediatric MRCPs for some selected idealised external and internal 323 exposure cases are compared with the values calculated with the P143 phantoms and the 324 Publication 1XX values (ICRP, 2022). Annex J describes the contents of the supplementary 325 electronic data that accompany the printed publication, including the detailed phantom data



and examples of input files for three general-purpose Monte Carlo codes (i.e. Geant4, PHITSand MCNP6) which are widely used for dose calculation in the field of radiation protection.



329 330 2. IMPROVEMENTS IN PAEDIATRIC MESH-TYPE REFERENCE COMPUTATIONAL PHANTOMS

331 (13) Following the development of the P110 adult voxel phantoms (ICRP, 2009), the 332 Commission released the P143 paediatric voxel phantoms (see Fig. 2.1) for computation of the 333 protection quantities for children and adolescents. The P143 phantoms comprise ten phantoms 334 representing the reference male and female at the five different ages defined for the Reference 335 Person-newborn, 1 year, 5 years, 10 years and 15 years. These phantoms were derived from 336 a corresponding series of boundary representation (BREP) paediatric phantoms with 337 NURBS/PM surfaces based on human CT images developed in collaboration between the University of Florida (UF) and the National Cancer Institute (NCI) (Lee et al., 2010), which 338 339 were adjusted to conform with Publication 89 reference data on the paediatric anatomical 340 parameters (ICRP, 2002) and then voxelised to be used with Monte Carlo simulation codes. The male and female phantoms of newborn, 1-, 5- and 10-year-old are anatomically identical, 341 342 except for the reproductive system organs (e.g. gonads). Their voxel resolution (for the x, y 343 and z axes) ranges from $0.0663 \times 0.0663 \times 0.0663$ cm³ for the newborn to $0.1250 \times 0.1250 \times 0.12500 \times 0.1250 \times 0.12500 \times 0.12500 \times 0.12500 \times 0.12500 \times 0$ 344 0.2832 cm^3 for the 15-year-old male (ICRP, 2020a).



Fig. 2.1. P143 paediatric voxel phantoms (ICRP, 2020a). The figure shows only male phantoms
for 10 years and younger and does not display muscle and adipose tissue for better visualisation
of internal organs.

345

(14) While providing significant anatomical improvements over the previous stylised models, the P143 phantoms have limitations, mainly resulting from the inherent nature of voxel geometry and finite voxel resolutions. Small organ structures (e.g. lens of the eye) and very thin tissue layers (e.g. stem cell targets in alimentary and respiratory tract organs) are not fully modelled and for calculations of dose coefficients, some organs are represented by supplementary stylised models. These limitations and some phantom characteristics were addressed in the paediatric MRCPs, as summarised in the following paragraphs.



356 (15) In the P143 phantoms, the skin is represented by the outermost single voxel layer of 357 each transverse slice, resulting in many spaces between adjacent transverse slices. Through these spaces, radiation incident at nonzero angles relative to the transverse slices can directly 358 359 reach some radiosensitive organs (such as breasts, spongiosa and testes), leading to a significant 360 overestimation of DCs for those tissues for weakly penetrating radiations. Furthermore, the 361 skin masses of the P143 phantoms do not conform ideally with their reference values; the skin 362 masses of the newborn, 1-year-old and 15-year-old phantoms are smaller by up to ~33%, 363 whereas those of the 5-year-old and 10-year-old phantoms are larger by up to $\sim 20\%$, than the reference skin masses in Publication 89. In the paediatric MRCPs developed in the present 364 365 work as in the adult MRCPs of Publication 145 (ICRP, 2020c), the skin is modelled as a 366 continuous layer and the mass exactly matches the reference value. Similarly, the limitations of other thin structures (e.g. cortical bone and alimentary tract organs) were also addressed in 367 368 the same way.

369 (16) For the skin, the basal cell layer of the epidermis is assumed to be the target for 370 radiogenic risk (ICRP, 1977, 2010, 2015). This skin target layer, however, could not be 371 separately represented in the P143 phantoms due to their voxel resolutions being limited to 372 hundreds of micrometres to several millimetres. Consequently, the entire skin (= epidermis 373 plus dermis) is defined as a single voxel layer and used to approximate dose to the skin target 374 layer. Considering the small w_T of the skin (= 0.01), this approximation is acceptable for calculation of the effective dose for most penetrating radiations. For external exposures to 375 376 weakly penetrating radiations (e.g. alpha and beta particles and low-energy photons), however, 377 this approximation could lead to significant errors in both skin dose and effective dose 378 calculations (Yeom et al., 2016, 2017). In the paediatric MRCPs as in the adult MRCPs, this 379 problem was addressed by defining the target layer in the skin.

380 (17) The computation of specific absorbed fractions (SAFs) for the respiratory and 381 alimentary tracts (ICRP, 1994a, 2006) requires the modelling of the cell layers of radiosensitive tissues and similarly scaled source regions (ICRP, 1994a, 2006). However, these target and 382 383 source regions were not modelled in the P143 phantoms due to the finite voxel resolutions. For 384 computation of the paediatric SAFs in Publication 1XX (ICRP, 2022), therefore, a number of 385 mathematical equations-based stylised models used in Publications 66 and 100 to describe the respiratory and alimentary tract organs, respectively, were separately employed for charged 386 387 particles. In the paediatric MRCPs as in the adult MRCPs, the target and source regions in the 388 respiratory and alimentary tracts were defined (Choi et al., 2022a,b), allowing the calculation 389 of SAFs directly using the reference phantoms without using separate supplementary models.

(18) Similarly, for the urinary bladder, the basal cells of the lining epithelium are assumed
to be the relevant target cells for radiogenic risk (Colin et al., 2009) and taken as the target
region for calculation of the SAFs for non-penetrating radiations (i.e. alpha and beta particles),
emitted from the bladder contents (Eckerman and Veinot, 2018). In the paediatric MRCPs as
in the adult MRCPs, therefore, the target layer in the urinary bladder wall was explicitly defined
to conform with following the age-dependent target depth and thickness data.

396 (19) The complex structure of the eye was not represented in the P143 phantoms due to the 397 finite voxel resolutions. In the adult MRCPs (ICRP, 2020c), this issue was addressed by 398 incorporating the detailed eye model of Behrens et al. (2009) which had been adopted in 399 Publication 116 (ICRP, 2010) for calculation of the lens DCs of adults for idealised external 400 radiation fields. The direct use of scaled versions of the adult eye model for children and 401 adolescents, however, would not adequately represent age-related changes in the dimensions 402 of the eye and the lens. In the present work, therefore, a set of paediatric eye models were first developed following the approach used for the development of the Behrens' eye model and 403 404 then incorporated into the paediatric MRCPs (Han et al., 2021).



405 (20) The teeth of the P143 phantoms consist of a single homogeneous region with a 406 simplified geometry (i.e. ellipsoid). In the paediatric MRCPs, detailed tooth models were 407 incorporated based on existing high-quality tooth models (Shin et al., 2021). The tooth models 408 of the paediatric MRCPs include four inner tooth structures (i.e. enamel, dentin, pulp and 409 cementum) and reflect the anatomical changes with age. These revised models are well suited 410 for retrospective dosimetry based on electron paramagnetic resonance (EPR) (IAEA, 2002; 411 Shin et al., 2021).

412 (21) The shapes and/or topologies of some organs (i.e. the thyroid, extrathoracic (ET) 413 region, sacrum, muscle and exterior body contour of all phantoms; the liver of the newborn 414 phantoms; the crania of the newborn and 1-year-old phantoms; and the spine and hand/foot bones of 1-year-old and older phantoms) were modified to achieve better anatomical realism. 415 The mass and density of the colon contents were adjusted to the reference values of *Publication* 416 417 89 (ICRP, 2002), and the position of the colon was also altered to provide a better 418 representation of typical anatomy. The mass of the blood in the large vessels was significantly 419 increased, improving the anatomical representations.

420 (22) The organ masses of the P143 phantoms are based on the reference masses listed in 421 Table 2.8 of *Publication* 89 (ICRP, 2002), which represent only the organ parenchymal masses 422 (i.e. excluding the intra-organ blood masses). Note that in a living person, a significant portion 423 of the total blood is situated in the small vessels and capillaries in the organs, which should be 424 considered in phantom construction. In the paediatric MRCPs as in the adult MRCPs, therefore, 425 the organs were adjusted to the reference masses including the intra-organ blood content based 426 on the blood distribution in Wayson et al. (2018) adopted in the calculation of the paediatric 427 SAFs (ICRP, 2021). In the SAF calculations using the P110 (ICRP, 2009) and P143 (ICRP, 428 2020a) voxel phantoms, scaling of SAFs for self-irradiation geometries was performed (ICRP, 429 2016, 2022). Such scaling will not be necessary with the MRCPs, the organ masses of which 430 are consistent with the reference masses inclusive of blood content.



432 3. CONVERSION OF THE PAEDIATRIC VOXEL-TYPE REFERENCE 433 COMPUTATIONAL PHANTOMS TO MESH FORMAT

434 (23) Fig. 3.1 shows how the paediatric MRCPs were developed from the P143 phantoms.
435 Detailed explanations for each step will be given in the following chapters.



436

Fig. 3.1. Schematic for constructing the paediatric MRCPs from the P143 phantoms (ICRP,2020a).

439 **3.1. Simple organs and tissues**

440 (24) Most of the organs of the paediatric MRCPs [i.e. adrenal glands, trachea, main bronchi 441 (= generation 1), brain, breasts, gall bladder, stomach, small intestine, heart, kidneys, liver, 442 lungs, oesophagus, gonads (testes or ovaries), pancreas, pituitary gland, prostate, salivary 443 glands, spinal cord, spleen, tongue, thymus, tonsils, ureters, urinary bladder and uterus], which 444 have an easily recognisable and anatomically reasonable shape, were reproduced using both 445 the P143 phantoms (ICRP, 2020a) and the UF/NCI paediatric phantom series (Lee et al., 2010) 446 which are the source of the P143 phantoms. First, the UF/NCI phantoms were used to produce



initial polygonal mesh (PM) models of the simple organs, which were then refined using the
approaches employed for the adult MRCPs (ICRP, 2020c). The refined models were then
matched to the organs of the P143 phantoms, which are consistent with the reference values in *Publication 89* (ICRP, 2002), to faithfully preserve the original organ topology. Subsequently,
the models were further adjusted to allow for the intra-organ blood content. The PM models
were converted to the TM format at the final stage of phantom construction with the other
organ models.

454 (25) During the conversion process, the PM models were matched to the P143 phantoms 455 by monitoring two indices which show the geometric similarity of two models: Dice index (DI), 456 the overlapping volume fraction of two objects and centroid distance (CD), the distance 457 between the centroids of two objects. The matching criteria were set for the DI value to be 458 higher than 0.9 of the maximum achievable Dice index (MADI) and for the CD values to be 459 less than 2 mm. Note that the MADI was introduced to account for the intrinsic difference in 460 the geometry format (i.e. voxel vs. PM) of the two models (ICRP, 2020c).

(26) Publication 89 (ICRP, 2002) provides sex-averaged reference masses for most of the 461 462 organs for the ages up to and including 10 years, i.e. the same reference masses for the same 463 age regardless of sex. Only for two organs (i.e. brain for 5 and 10 years and thymus for 10 464 years), it provides sex-specific reference masses, i.e. the different reference masses depending 465 on sex. However, the P143 phantoms of these ages were developed using sex-averaged masses 466 for all the organs, except for the reproductive system organs (e.g. gonads). In the present work, the paediatric MRCPs were developed using sex-specific reference organ masses where 467 468 available. Therefore, the refined PM models of the brain and thymus were additionally adjusted 469 to match the sex-specific reference organ masses.

(27) In the P143 phantoms, some organs and contents (e.g. brain and heart contents for newborn, thymus for 1 year and gastro-intestinal contents for all ages) have masses significantly different from the reference values given in *Publication 89*, mainly due to the small space allowed for these organs and contents (Lee et al., 2010). In the paediatric MRCPs, these organs and contents were adjusted to match the reference values. During the adjustment process, these tissues were isotropically enlarged, preserving their original shapes and centroids, with slight adjustment of the adjacent organs.

477 (28) In the P143 phantoms, the oesophagus contents are not defined, and in principle 478 estimation of the SAFs of the oesophagus wall for radiations from the oesophagus contents is 479 not possible. This limitation was addressed in the paediatric MRCPs following the same 480 approach used for the adult MRCPs (ICRP, 2020c); that is, the oesophagus contents were defined in the middle of the oesophagus with the volume derived from the morphological 481 482 information (i.e. length and diameter) given in Publication 100 (ICRP, 2006). To maintain the 483 oesophagus wall volume, the outer diameter of the oesophagus wall was slightly increased (i.e. 484 by 3-7 mm).

485 (29) The liver of the P143 newborn phantoms is somewhat unrealistically long in the vertical direction, as a result of extending the liver model downwards to match the reference 486 487 mass of Publication 89 (ICRP, 2002). To address this issue, the liver was reproduced directly 488 from the original CT image data which had been used for the construction of the P143 phantoms. 489 The liver was then adjusted to match the reference mass, isotropically enlarged to preserve the 490 original shape of the liver. During this reconstruction of the liver for the newborn phantoms, 491 the lower part of the ribs had to be moved outwards slightly (i.e. in the lateral direction); the 492 resulting rib cage was found to be within the range of typical shapes (Devlieger et al., 1991).

493 (30) In the present work, the organ models were mostly visualised, handled and refined 494 with the *RapidformTM* software (INUS Technology INC., Korea), with two exceptions: the 495 conversion of NURBS surfaces to PM surfaces and the generation of the blood and colon



496 passages and the eyes, which were accomplished with the *Rhinoceros 5.0* software (Robert497 McNeel, USA).

498 **3.2. Skeletal system**

(31) The majority of the bones of the paediatric MRCPs (i.e. upper humeri, lower humeri,
ulnae, radii, clavicles, cranium, upper femora, lower femora, tibiae, fibulae, patellae, mandible,
pelvis, ribs, scapulae and sternum) were produced directly from the UF/NCI phantom series
(Lee et al., 2010) using the same procedure as for the simple organs described in Section 3.1.
Some bones which were not properly represented in the UF/NCI phantoms were modified or
remodelled by using other existing high-quality models and analysing scientific literature and
measured data (Choi et al., 2021).

506 (32) The spine models (cervical, thoracic and lumbar regions) of the 1-year-old and older 507 MRCPs were replaced with high-quality PM models produced from serially sectioned 508 photographic images of adult male and female cadavers (Park et al., 2005) after several 509 adjustments. These adult models are considered to be applicable to children and adolescents, 510 except for the newborn, since ossification of the individual vertebrae of the spine is complete 511 within about five months after birth (Taylor, 1975) and only the anterior-posterior curvature of 512 the spine changes with growth. First, the adult models were scaled down in all directions, 513 matching the spine height of the P143 phantoms. The individual vertebrae were then translated 514 and rotated, matching the original spine topology (i.e. position and curvature) of the P143 515 phantoms. Finally, the individual vertebrae were scaled isotropically to match the reference 516 mass of Publication 89 (ICRP, 2002). Likewise, the hand and foot bones of the 1-year-old and 517 older MRCPs were replaced with high-quality PM models based on micro-CT images of adult 518 male and female cadavers (http://dk.kisti.re.kr/) in a similar way as for the spine. Note that the 519 models were available for both male and female and thus were used separately.

520 (33) The crania of the newborn and 1-year-old MRCPs were modified according to data 521 on fontanelle sizes and suture widths determined from the scientific literature. The anterior 522 fontanelle sizes of the newborn and 1 year were taken from the data provided by Noorizadeh 523 et al. (2015) and Duc and Largo (1986), respectively. The posterior fontanelle size of the 524 newborn was obtained from the data of Faix (1982). Note that the posterior fontanelle is closed 525 2-3 months after birth (Usman et al., 2011), which was thus defined only in the newborn 526 MRCPs. The suture widths were determined by scaling the newborn and 1-year-old values in 527 proportion to the head circumferences (Li et al., 2015). The crania of the newborn and 1-year-528 old MRCPs were matched to the target values within 5% difference.

(34) Some minor improvements were also made to several bones. The sacra were modified
to take account of anatomical changes in the sacral crest and foramina with growth (Kim et al.,
2014). The sterna of the 1-, 5- and 10-year-old MRCPs were extended in the vertical direction
to conform to the locations of the ribs. The mandibles of the 1- and 10-year-old MRCPs were
slightly adjusted for normal occlusion of the teeth.

(35) The bones of the paediatric MRCPs were finally divided into cortical bone, spongiosaand medullary cavity, in a similar way as for the P143 phantoms.

536 (36) The costal cartilage, intervertebral disks and pre-osseous cartilage were directly 537 produced from the UF/NCI phantoms. The intervertebral disks of the 1-, 5-, 10- and 15-year-538 old phantoms were adjusted to their positions in the new spine models produced from the high-539 quality PM models (Park et al., 2005). For the newborn and 1-year-old MRCPs, the fontanelle 540 cartilage was adjusted to the modified cranium. The other cartilages, which were not explicitly



- 541 modelled in the paediatric MRCPs, were included in the residual soft tissue (RST) which will
- 542 be discussed in Section 4.3.

543 (37) Fig. 3.2 shows the skeletal system of the newborn and 10-year-old male MRCPs, 544 including the cortical bone, spongiosa, medullary cavity and explicitly defined cartilage.



545

546

547 Fig. 3.2. Skeletal system of newborn male (upper) and 10-year-old male (lower) MRCPs: 548 cortical bone (white), spongiosa (red), medullary cavity (black), costal cartilage and 549 intervertebral disks (yellow) and pre-osseous cartilage (blue).

550 **3.3. Colon**

551 (38) In the P143 phantoms (ICRP, 2020a), the wall of the colon has the reference mass and 552 length given in *Publication 89* (ICRP, 2002). However, either the mass or the density of the 553 colon contents was significantly different from the reference values, due to the limitation of 554 the modelling approach using a simple cylinder (Lee et al., 2010). In addition, the middle part 555 of the transverse colon showed significant curvature.



556 (39) For the paediatric MRCPs, therefore, the colon was remodelled (Choi et al., 2022a). 557 First, the colon was modelled as a connection of three truncated curved cones, representing the 558 right, left and rectosigmoid colons, for the wall and the contents, respectively, as shown in 559 Table 3.1. The top and bottom radii of each truncated cone were determined by a numerical 560 approach, involving iteration of calculations, to connect the three truncated cones most 561 smoothly while matching all the reference values (i.e. mass, length and density of the right, left 562 and rectosigmoid colon, for both the wall and the contents). The details of the numerical 563 approach can be found in Choi et al. (2022a). The colon model was then subdivided into six regions based on the length data given in *Publication* 89 (ICRP, 2002): the right colon into the 564 565 ascending and the transverse right colon; the left colon into the transverse left and the descending colon; and the rectosigmoid colon into the sigmoid colon and the rectum. Finally, 566 the colon was produced in the NURBS format and then converted to the PM format for 567 568 incorporation into the paediatric MRCPs, while addressing the issue of the transverse colon curvature. 569

570 (40) Fig. 3.3 shows the developed colon of the 10-year-old male MRCP, together with the 571 P143 phantom.

Table 3.1. Schematic and dimensions of the colon models for the paediatric ages (Choi et al.,2022a).



Dhantoma				Rad	ius (cm)				Length (cm)				
Phantoms	a_{wall}	b_{wall}	Cwall	d_{wall}	<i>a</i> content	$b_{content}$	Ccontent	$d_{content}$	l_{ab}	l_{bc}	l_{cd}		
Newborn male/female	1.011	0.681	0.587	0.554	0.938	0.495	0.468	0.526	14	16	15		
1-year male/female	1.214	0.861	0.734	0.630	1.069	0.562	0.522	0.562	18	21	21		
5-year male/female	1.368	1.074	0.953	0.617	1.054	0.560	0.530	0.560	23	26	26		
10-year male/female	1.555	1.231	1.145	0.678	1.128	0.604	0.578	0.604	28	31	31		
15-year male	1.901	1.499	1.298	0.866	1.430	0.760	0.696	0.760	30	35	35		
15-year female	1.856	1.452	1.249	0.861	1.430	0.760	0.696	0.760	30	35	35		





576 Fig. 3.3. Colon of the P143 phantom (left) and the paediatric MRCP (right) for the 10-year-old 577 male with adjacent organs.

578 **3.4. Thyroid**

575

579 (41) The thyroids of the P143 phantoms show some anatomical abnormalities (e.g. the 580 thickness of the thyroid isthmus for all phantoms and the position of the thyroid for the newborn 581 and 1-year-old phantoms).

582 (42) For the paediatric MRCPs, the thyroid was therefore modified to have typical shape 583 and position (Yeom et al., 2022). First, the isthmus thickness, width and height were 584 determined from the scientific literature. The isthmus thickness at each age was taken from the data provided by Sea et al. (2019). The isthmus width and height of the newborn were obtained 585 from the data of Ozguner et al. (2014) and those of the 1, 5, 10 and 15 years, due to the absence 586 of data, were derived by linear interpolation between the newborn (Ozguner et al., 2014) and 587 588 adult data (Tong and Rubenfeld, 1972; Harjeet et al., 2004; Joshi et al., 2010; Ozgur et al., 589 2011; Won et al., 2013). The thyroid shape hardly changes after reaching adulthood (Harjeet et al., 2004; Sultana et al., 2011; Won et al., 2013) and, therefore, the adult age was set as 18 590 591 years for the interpolation. The thyroid isthmus of the paediatric MRCPs was matched to the 592 target values within 5% difference. Then, the thyroid was placed in the typical position (i.e. in front of the second and third tracheal cartilage) (Ellis, 2007; Naqshi et al., 2016), matching the 593 depth beneath the skin surface to the target values derived from the equations given in 594 595 Likhtarev et al. (1995), again within 5% difference.

596 (43) Fig. 3.4 shows the thyroid of the 1-year-old male MRCP, along with the P143 phantom.



598 Fig. 3.4. Thyroid of the P143 phantom (upper) and the paediatric MRCP (lower), shown for 599 the 1-year-old male.

600 **3.5. Lymphatic nodes**

601 (44) Due to the complexity of their distribution, the lymphatic nodes had to be generated 602 using a modelling approach. The lymphatic nodes of the paediatric MRCPs were generated by 603 employing the same method used for the adult MRCPs (ICRP, 2020c), but using the paediatric 604 lymphatic node data given in Table 3.2, which were derived from data from *Publications 23* 605 and 89 (ICRP, 1975, 2002) and were also employed for the SAF calculations in *Publication* 606 *IXX* (ICRP, 2022).

607 (45) Fig. 3.5 shows the lymphatic nodes of the 15-year-old male MRCP, together with the 608 corresponding P143 phantom.

609	Table 3.2. Lymphatic node numbers and masses for the paediatric ages derived from the data
610	of Publications 23 and 89 (ICRP, 1975, 2002).

Lymphotic	Derived			Mas	ss (g)		
node site	nodal	Newborn	1-year	5-year	10-year	15-year	15-year
node site	numbers	male/female	male/female	male/female	male/female	male	female
Extrathoracic	55	1.251	2.192	4.356	7.224	12.807	11.589
Cervical	19	0.432	0.757	1.505	2.495	4.424	4.003
Thoracic	55	0.523	0.916	1.822	3.021	5.356	4.846
Breast (left and right)	38	0.865	1.514	3.010	4.991	8.849	8.007
(left and right) (left and right)	350	1.251	2.192	4.356	7.224	12.807	11.589
Axillary (left and right)	23	0.865	1.514	3.010	4.991	8.849	8.007
Cubital (left and right)	38	7.963	13.947	27.721	45.969	81.502	73.746
Inguinal (left and right)	38	0.865	1.514	3.010	4.991	8.849	8.007
Popliteal (left and right)	38	0.865	1.514	3.010	4.991	8.849	8.007





611

Fig. 3.5. Lymphatic nodes of the P143 phantom (left) and the paediatric MRCP (right) for the15-year-old male.

614 **3.6. Extrathoracic region**

615 (46) The extrathoracic (ET) region consisting of the anterior nose (ET₁) and the posterior 616 nasal passages, pharynx and larynx (ET₂) is not properly represented in the P143 phantoms 617 (ICRP, 2020a), mainly because its intricate and narrow conduit geometry was not clearly 618 distinguishable in the original CT image data. In addition, the larynx was not included in the 619 ET2 region but tagged as cartilage during the modification of the UF/NCI phantoms to the 620 P143 phantoms.

621 (47) For the paediatric MRCPs, the ET region was, therefore, remodelled (Choi et al., 622 2022b). First, the anterior nose and the posterior nasal passage were manually modified, 623 referring to Kozak et al. (2014). Then, the remaining parts (i.e. pharynx and larynx) were replaced with new models which were produced by scaling down those of the adult MRCPs 624 (ICRP, 2020c), taking account of differences in the trachea mass between the adults and 625 626 children (ICRP, 1994a). Note that the adult models were available for both male and female and thus were used separately. The details of the scaling process can be found in Choi et al. 627 (2022b). The modified regions (i.e. anterior nose and posterior nasal passage) and replaced 628 629 regions (pharynx and larynx) were then connected, and were finally divided into the ET wall 630 and inner air, matching the volume ratio of the adult models due to the absence of reference values for children and adolescents in Publication 89 (2002). 631



(48) Fig. 3.6 shows the ET region of the paediatric MRCP for 5-year-old male, along withthat of the P143 phantom.



634

Fig. 3.6. Extrathoracic region (ET1 and ET2) of the P143 phantom (left) and the paediatricMRCP (right) for the 5-year-old male.

637 **3.7. Eyes**

(49) Due to their finite voxel resolutions (i.e. hundreds of micrometres to several
millimetres), the detailed structures of the eyes could not be fully modelled in the P143
phantoms (ICRP, 2020a).

(50) For the adult MRCPs (ICRP, 2020c), this issue was addressed by incorporating the
detailed eye model of Behrens et al. (2009), which was adopted in *Publication 116* (ICRP,
2010) for the calculation of the reference lens dose coefficients for adults. This eye model,
however, is not appropriate for the lens dose assessment of children and adolescents,
considering that the ocular dimensions of paediatric eyes are significantly different from scaled
versions of adult eyes (Ronneburger et al., 2006; Augusteyn, 2010).

(51) Therefore, a set of detailed eye models for children and adolescents at five different 647 ages (i.e. newborn, 1 year, 5 years, 10 years and 15 years) were developed for the paediatric 648 649 MRCPs following the approach used for the development of the Behrens' eye model, based on nine ocular parameters of the eve: anterior chamber depth along the optical axis (ACD), lens 650 thickness along the optical axis (LT), radius of curvature of the anterior surface of the lens 651 652 (RAL), radius of curvature of the posterior surface of the lens (RPL), radius of curvature of the anterior surface of the cornea (RAC), corneal thickness along the optical axis (CT), corneal 653 diameter (CD), equatorial diameter of the lens (ED) and radius of curvature of the anterior 654 surface of the sclera (RAS) (Han et al., 2021). 655

(52) The nine ocular parameters for children and adolescents were first determined by analysing the scientific literature and measured data, as shown in Table 3.3. Among these parameters, the ACD and LT are the most important parameters that mainly influence lens doses from external exposures. The ACD and LT of 5 years and younger were taken from the data provided by Larsen (1971a,b). The ACD and LT of 10 years and 15 years were determined



by using the regression equations provided by Zadnik et al. (2004). Note that the regression equations were derived from the data measured with children aged 6-14 years and, therefore, the ACD and LT of 14 years were taken as the values of 15 years. The remaining parameters were determined in a similar way to that applied to the ACD and LT or through other procedures as discussed by Han et al. (2021).

(53) According to the nine ocular parameters, the eye models were produced in the NURBS
format and then converted to the PM format. The eye models in the PM format were finally
refined and installed in the paediatric MRCPs, matching the centroid positions of the eyes of
the P143 phantoms, as shown in Fig. 3.7.

Table 3.3. Schematic and nine ocular parameters (unit: mm) of the eye models for the paediatric ages (Han et al., 2021).



672

ACD LT PAL	1.83 3.96 6.33	2.75 3.66	2.90	3.16	2 21	I_{amagn} (1071 a b)
LT	3.96 6.33	3.66	2 61		5.21	Larsen (19/1a,b)
DAI	633		3.01	3.41	3.44	Zadnik et al. (2004)
KAL	0.55	9.23	10.51	11.45	11.72	Mutti et al. (1998)
RPL	4.48	5.27	6.05	6.24	6.55	Frane et al. (2000)
						Frane et al. (2000)
RAC	7.11	7.82	7.72	7.72	7.72	Ehlers et al. (1976)
						Friedman et al. (1996)
CT	0.55	0.55	0.56	0.57	0.57	PEDIG (2011)
CD	0.66	11 15	11.90	11.90	11.90	Müller and Doughty (2002)
CD	9.00	11.15	11.80	11.80	11.80	Charles and Brown (1975)
						Atchison et al. (2008)
						Dilmen (2002)
ED	5.05	7.40	× 20	9 27	9 12	Goldstein et al. (1998)
ED	5.95	7.40	8.20	0.57	0.45	Ishii et al. (2013)
						Paquette (2009)
						Sukonpan and Phupong (2009)
RAS	9.10	9.45	10.96	11.30	11.63	Reference eye mass [†]

[†]RAS was determined to match the blood-inclusive reference mass of the eyes derived from *Publication 89* (ICRP, 2002) and Wayson et al. (2018).





Fig. 3.7. Detailed eye models inserted in the paediatric MRCPs for all ages.

677 **3.8. Teeth**

675

(54) In the P143 phantoms, the teeth are defined as a single homogeneous region with a
simplified geometry (i.e. ellipsoid). A more realistic representation was considered important
for applications including retrospective dosimetry based on electron paramagnetic resonance
(EPR).

682 (55) Detailed tooth models including the inner tooth tissues (i.e. enamel, dentin, pulp and 683 cementum) were developed for each paediatric age and sex (Shin et al., 2021). The target 684 masses of the tooth tissues for each age and sex were determined by analysing the scientific literature. First, the entire teeth mass was determined by adopting the reference values given in 685 686 Publication 89 (ICRP, 2002). The individual tooth masses were then determined using the tooth 687 mass fractions to the entire teeth derived from the data of Ogorelec et al. (1997). Finally, the masses of the enamel, dentin (including cementum) and pulp for each tooth were determined 688 689 based on the data of Publication 23 (ICRP, 1975) and Bayle et al. (2009) for the permanent 690 teeth and the deciduous teeth, respectively.

691 (56) The detailed tooth models were then developed by employing existing high-quality 692 PM tooth models as preliminary models. The preliminary models for the permanent teeth were constructed from the micro-CT images of adult male and female (http://dk.kisti.re.kr) and that 693 694 for the deciduous teeth was constructed by 3D scanning a mould of the teeth crowns of a child 695 and modelling the teeth roots based on image references (https://www.turbosquid.com/3dmodels/primary-teeth-dentition-max/953912). The permanent tooth models, but not the 696 697 deciduous tooth model, are available for both male and female and thus were used separately. 698 First, each tooth of the preliminary models was scaled to match the target tooth mass. In the 699 scaled tooth model, the inner tooth tissues were modelled referring to anatomical structures 700 represented by Schwartz (1995), matching the target tooth-tissue masses. The cementum was



- separated from the dentin according to the age-dependent cementum thickness (Zander et al.,
- 1958). In total, 332 detailed tooth models (i.e. newborn: 20, 1 year: 28, 5 years: 48, 10 years:
- 703 38 and 15 years: 32 for each sex) were produced individually, which were finally inserted in
- the paediatric MRCPs.
- 705 (57) Fig. 3.8 shows, as an example, the detailed tooth models of the 15-year-old male
- 706 MRCP, including the internal structures.



707

Fig. 3.8. Detailed tooth models of the 15-year-old male MRCP.

709 **3.9. Blood in large vessels**

(58) In the P143 phantoms, only a small portion of the blood in the large blood vessels was modelled because of the finite voxel resolutions of the original CT image data (Wayson, 2012; ICRP, 2020a). Consequently, the masses of the blood explicitly defined in the phantoms are significantly smaller than their reference values. Note that these values are not given in *Publication 89* (ICRP, 2002) but can be estimated based on the reference regional volume fractions derived by Wayson et al. (2018) and adopted in the calculation of the paediatric SAFs in *Publication 1XX* (ICRP, 2022).

(59) For the paediatric MRCPs, therefore, the blood in the large vessels was remodelled.
First, the flow lines of the blood in the large vessels were manually generated, referring to the
high-quality 3D blood models provided by BioDigital Human (http://www.biodigital.com).
Next, the blood models were constructed in the NURBS format along the flow lines and then
were converted to the PM format. Finally, the PM models were adjusted to match the reference
masses.

(60) Fig. 3.9 shows the blood model for the 5-year-old male MRCP, together with the blood
 model of the corresponding P143 phantom. Note that the intra-organ vasculature was not
 modelled in the MRCPs and the blood in the intra-organ vasculature was assumed to be
 homogeneously distributed with the organ parenchyma.





727

Fig. 3.9. Blood in large vessels of the P143 phantom (left) and the paediatric MRCP (right) for

the 5-year-old male. In the MRCP, the blood in the large arteries (red) and the large veins (blue)

730 was modelled separately.

731 **3.10.Muscle**

(61) The muscle of the P143 phantoms (ICRP, 2020a) was developed by using a voxel
growing algorithm (Stepusin, 2016), by which the complex and heterogeneous anatomical
structures of the various muscles of the body could not be modelled delicately.

735 (62) In the present work, the muscle was modelled using the construction procedure 736 described by Choi et al. (2019). First, the exterior surface of the muscle was produced by replicating and reducing the skin model, and the interior surface of the muscle was generated 737 738 by producing a surface which covers all of the internal organs except for the blood in the large 739 vessels and the lymphatic nodes. Then, a preliminary muscle model was produced by merging 740 the exterior and interior surfaces of the muscle and then subtracting the blood in the large 741 vessels and the lymphatic nodes. Finally, the preliminary muscle model was adjusted to provide a more anatomically realistic representation, referring to the anatomy text of Drake et al. 742 743 (2004).

(63) Fig. 3.10 shows the muscle model for the 1-year-old male phantom, along with themodel of the corresponding P143 phantom.





Fig. 3.10. Muscle of the P143 phantom (left) and the paediatric MRCP (right) for 1-year-oldmale.

749 **3.11. Exterior body contour**

(64) The exterior body contours of the P143 phantoms (ICRP, 2020a) were produced for the head, torso and limbs separately, matching eight reference anthropometric dimensions (i.e. standing and sitting height; arm length; biacromial breadth; and head, neck, waist and buttock circumference), but the individual body parts (i.e. head, torso and limbs) were not realistically connected, especially at the hip and the shoulder joints.

(65) For the paediatric MRCPs, therefore, the connected regions were deformed to obtain
a more realistic shape. To maintain the total volume of the exterior body contour, the remaining
regions were slightly adjusted while matching the reference anthropometric dimensions to
within 5% of deviation (see Table 3.4).

(66) Fig. 3.11 shows the exterior body contour of the 5-year-old male MRCP, together withthat of the corresponding P143 phantom.

761	Table 3.4.	Anthropometric	dimensions	(unit:	cm)	of the	paediatric	MRCPs,	along	with
762	reference v	alues given in the	P143 phante	om (ICI	RP, 20	020a).				

		<u> </u>				· · · ·	,								
		St	anding heig	ght	5	Sitting heigl	ht		Arm length	ı	Bia	cromial bre	adth		
Phant	toms	Ref.	MRCP	Diff. (%)	Ref.	MRCP	Diff. (%)	Ref.	MRCP	Diff. (%)	Ref.	Ref. MRCP			
Manulation	Male	51.0	-	_	34.0	33.0	-2.9								
Newdorn	Female	51.0	-	-	34.0	33.0	-2.9								
1 vear	Male	76.0	76.0	0.0	48.8	47.3	-3.1	32.6	32.0	-1.8					
i year	Female	76.0	76.0	0.0	48.8	47.3	-3.1	32.6	32.0	-1.8					
5	Male	109.0	109.0	0.0	60.4	61.0	1.0	47.1	47.0	-0.2	25.0	25.3	1.1		
5 years	Female	109.0	109.0	0.0	60.4	61.0	1.0	47.1	47.0	-0.2	25.0	25.4	1.4		
10 voor	Male	138.0	138.0	0.0	73.4	75.2	2.5	61.0	61.1	0.2	31.2	30.3	-2.8		
10 years	Female	138.0	138.0	0.0	73.4	75.2	2.5	61.0	61.1	0.2	31.2	30.1	-3.6		
15 years	Male	167.0	167.0	0.0	88.8	86.5	-2.6	75.0	75.1	0.1	38.8	40.3	4.0		



	Female	161.0	161.0	0.0	85.5	83.0	-2.9	70.7	71.8	1.6	36.3	35.3	-2.9		
		Hea	d circumfer	rence	Necl	k circumfer	ence	Wais	st circumfe	rence	Butto	Buttock circumference			
Phant	oms	Ref.	MRCP	Diff. (%)	Ref.	MRCP	Diff. (%)	Ref.	MRCP	Diff. (%)	Ref.	MRCP	Diff. (%)		
Naruham	Male	33.1	34.5	4.3											
INEWDOIN	Female	33.1	34.5	4.3											
Newborn Fe 1 year 5 years Fe	Male	47.3	47.2	1.1											
	Female	47.3	47.2	1.1											
5	Male	51.1	52.4	2.6	24.9	25.8	3.7	55.0	53.8	-2.2	57.9	57.0	-1.6		
5 years	Female	51.1	52.4	2.6	24.9	25.8	3.8	55.0	54.3	-1.3	57.9	57.4	-0.9		
10	Male	52.8	53.4	1.1	27.9	28.4	1.6	66.7	65.7	-1.5	75.2	72.6	-3.4		
10 years	Female	52.8	53.4	1.1	27.9	28.6	2.4	66.7	65.7	-1.5	75.2	72.3	-3.8		
15	Male	55.4	54.0	-2.5	32.8	33.8	3.1	80.1	79.0	-1.3	92.5	88.9	-3.9		
15 years	Female	54.3	53.5	-1.5	30.8	32.0	3.8	78.8	76.6	-2.8	93.4	89.8	-3.8		



Fig. 3.11. Exterior body contour of the P143 phantom (left) and the paediatric MRCP (right) for 5-year-old male.



767

4. INCLUSION OF BLOOD IN ORGANS AND TISSUES

768 (67) The organs of the P143 phantoms (ICRP, 2020a) are based on the reference values for 769 organ parenchyma (i.e. excluding the intra-organ blood content), given in Table 2.8 of 770 Publication 89 (ICRP, 2002). In a living person, however, a considerable amount of blood is 771 situated in the small vessels and capillaries in the organs. The most realistic phantom design 772 would represent the organ parenchyma and intra-organ vasculature separately, but this is 773 technically challenging due to the complexity and wide distribution of the vasculature. 774 Consideration of the blood content is nevertheless necessary in phantom construction, especially for the purpose of internal dosimetry when the blood is considered as a source region 775 776 (ICRP, 2016, 2022; Wayson et al., 2018). In addition, the increase in the organ masses due to 777 the inclusion of the blood content can affect the SAF calculations, especially for the self-778 irradiation resulting from weakly penetrating radiations (ICRP, 2016, 2022).

(68) For the paediatric MRCPs as for the adult MRCPs, therefore, the organ masses,
densities and elemental compositions were recalculated to include intra-organ blood content.
The organs of the MRCPs were then adjusted to the new blood-inclusive reference organ
masses.

783 (69) The reference organ parenchymal masses in Table 2.8 of *Publication* 89 (ICRP, 2002) 784 were used to calculate the blood-inclusive reference organ masses, with two exceptions. The 785 breast parenchymal masses for the ages of 10 years and younger, which are not given in the 786 table, were derived using a similar method to that used for the P143 phantoms; that is, the breast 787 parenchymal masses were calculated by adopting the glandular tissue masses of the stylised phantoms (Cristy and Eckerman, 1987) and considering the glandular tissue fraction in 788 789 Publication 89. The active marrow parenchymal masses were adopted, with slight adjustment, 790 from the P143 phantoms which differ from the reference values in *Publication* 89.

4.1. Calculation of mass, density and elemental composition of organs and tissues inclusive of blood content

(70) The blood-content masses were calculated for the organs listed in Table 2.8 of *Publication 89* (ICRP, 2002) based on the age-dependent regional blood volume fractions
derived by Wayson et al. (2018), which are replicated in Table 4.1.

796 (71) For the organs for which the regional blood volume fraction is explicitly given in the 797 table [i.e. fat, brain, stomach/oesophagus, small intestine, colon, right heart, left heart, coronary 798 tissues, kidneys, liver, pulmonary, bronchial tissue, skeletal muscle, pancreas, active marrow, 799 trabecular bone, cortical bone, other skeletal tissues, skin, spleen, thyroid, lymph nodes, gonads 800 (testes or ovaries), adrenal glands and urinary bladder], the blood-content masses were simply 801 calculated as the product of their regional blood volume fractions and the total blood mass. 802 Among them, for the organs for which the regional blood fractions are grouped into a single 803 value in Table 4.1 (i.e. stomach/oesophagus and other skeletal tissues), the blood masses were 804 assigned in proportion to their masses. Likewise, for the organs for which regional blood 805 fraction is not explicitly given in the table, but listed in Table 2.8 of Publication 89 (ICRP, 806 2002) (i.e. tongue, salivary glands, gall bladder wall, breasts, eyes, pituitary gland, larynx, 807 trachea, thymus, tonsils, ureters, urethra, epididymis, prostate, fallopian tubes, uterus and 808 remaining tissues), which are represented as 'all other tissues' in Table 4.1, the blood masses 809 were assigned in proportion to their masses. Note that for this calculation, the mass of the 810 remaining tissues was reduced by the mass of the lymphatic nodes, as the regional blood 811 fraction of the lymphatic nodes is given separately, as shown in Table 4.1.



812 (72) The calculated values of blood content are listed in Table 4.2, together with the 813 reference masses of organ parenchyma. Note that all the organs of 'all other tissues' have 814 slightly different blood-content masses in males and females, even for 10 years and younger, 815 due to the different organ masses of the sex-specific organs and thus different mass proportions.

		Ble	bod content (% 1	total blood volum	e)	
Organ	Newborn male/female	1-year male/female	5-year male/female	10-year male/female	15-year male	15-year female
Fat	2.212	4.958	4.061	4.159	3.602	6.608
Brain	5.413	5.276	4.311	2.670	1.568	1.370
Stomach/oesophagus	0.767	0.745	0.935	0.987	0.932	0.866
Small intestine	2.837	2.809	3.805	3.933	3.591	3.327
Colon	1.596	1.641	2.062	2.217	2.107	1.852
Right heart	4.500	4.500	4.500	4.500	4.500	4.500
Left heart	4.500	4.500	4.500	4.500	4.500	4.500
Coronary tissues	1.088	0.951	0.846	0.857	0.831	0.897
Kidneys	0.704	1.759	2.159	2.171	1.905	1.763
Liver	12.922	11.359	10.268	9.188	8.530	9.379
Lungs						
Pulmonary	10.500	10.500	10.500	10.500	10.500	10.500
Bronchial tissue	2.000	2.000	2.000	2.000	2.000	2.000
Skeletal muscle	6.667	5.535	8.538	10.306	13.684	10.303
Pancreas	0.430	0.502	0.460	0.484	0.557	0.505
Skeletal tissues						
Active marrow	5.190	4.969	4.918	4.916	4.841	4.983
Trabecular bone	3.639	4.388	4.376	4.397	4.051	4.352
Cortical bone	1.294	1.584	1.607	1.612	1.387	1.490
Other skeletal tissues	0.659	0.660	0.672	0.797	0.856	0.858
Skin	3.067	2.066	1.761	1.557	2.147	2.240
Spleen	1.505	1.576	1.422	1.398	1.433	1.414
Thyroid	0.066	0.032	0.031	0.045	0.043	0.043
Lymphatic nodes	0.163	0.165	0.164	0.168	0.181	0.177
Gonads	0.012	0.009	0.008	0.007	0.022	0.011
Adrenals	0.415	0.097	0.063	0.054	0.051	0.042
Urinary bladder	0.028	0.022	0.020	0.019	0.019	0.018
All other tissues	3.826	3.397	2.013	2.558	2.162	2.002
Aorta and large arteries	6.000	6.000	6.000	6.000	6.000	6.000
Large veins	18.000	18.000	18.000	18.000	18.000	18.000

816 Table 4.1. Regional blood volume fractions for children and adolescents (Wayson et al., 2018).



Table 4.2. Reference masses of organ parenchyma and their respective blood content for children and adolescents.

	Newbor	n male	Newborn	n female	1-yea	r male	1-year	female	5-yea	r male	5-year	female	10-yea	ir male	10-year	female	15-yea	ir male	15-yea	r female
Organs	Organ/ tissue only (g)	Blood content (g)	Organ/ tissue only (g)	Blood content (g)	Organ/ tissue only (g)	Blood content (g)	Organ/ tissue only (g)	Blood content (g)	Organ/ tissue only (g)	Blood content (g)	Organ/ tissue only (g)	Blood content (g)	Organ/ tissue only (g)	Blood content (g)						
Adipose tissue	890.000	6.414	890.000	6.414	3600.000	26.277	3600.000	26.277	5000.000	60.913	5000.000	60.913	7500.000	103.969	7500.000	103.969	9500.000	172.915	16000.000	231.288
Adrenals	6.000	1.203	6.000	1.203	4.000	0.512	4.000	0.512	5.000	0.948	5.000	0.948	7.000	1.360	7.000	1.360	10.000	2.430	9.000	1.469
Tongue	3.500	0.298	3.500	0.297	10.000	0.414	10.000	0.413	19.000	0.762	19.000	0.650	32.000	1.448	32.000	1.285	56.000	3.154	53.000	1.901
Salivary glands	6.000	0.512	6.000	0.509	24.000	0.993	24.000	0.992	34.000	1.363	34.000	1.163	44.000	1.991	44.000	1.767	68.000	3.830	65.000	2.331
Oesophagus, Wall	2.000	0.494	2.000	0.494	5.000	0.789	5.000	0.789	10.000	2.338	10.000	2.338	18.000	4.311	18.000	4.311	30.000	8.951	30.000	6.061
Oesophagus, Contents	2.022		2.022		3.786		3.786		7.135		7.135		11.908		11.908		21.842		21.033	
Stomach, Wall	7.000	1.730	7.000	1.730	20.000	3.157	20.000	3.157	50.000	11.691	50.000	11.691	85.000	20.356	85.000	20.356	120.000	35.805	120.000	24.242
Stomach, Contents	40.000		40.000		67.000		67.000		83.000		83.000		117.000		117.000		200.000		200.000	
Small intestine, Wall	30.000	8.226	30.000	8.226	85.000	14.889	85.000	14.889	220.000	57.081	220.000	57.081	370.000	98.325	370.000	98.325	520.000	172.343	520.000	116.429
Small intestine, Contents	56.000		56.000		93.000		93.000		117.000		117.000		163.000		163.000		280.000		280.000	
Right colon, Wall	7.000	1.906	7.000	1.906	20.000	3.479	20.000	3.479	49.000	12.627	49.000	12.627	85.000	22.435	85.000	22.435	122.000	41.125	122.000	26.358
Right colon, Contents	24.000		24.000		40.000		40.000		50.000		50.000		70.000		70.000		120.000		120.000	
Left colon, Wall	7.000	1.906	7.000	1.906	20.000	3.479	20.000	3.479	49.000	12.627	49.000	12.627	85.000	22.435	85.000	22.435	122.000	41.125	122.000	26.358
Left colon, Contents	12.000		12.000		20.000		20.000		25.000		25.000		35.000		35.000		60.000		60.000	
Rectosigmoid, Wall	3.000	0.817	3.000	0.817	10.000	1.740	10.000	1.740	22.000	5.669	22.000	5.669	40.000	10.557	40.000	10.557	56.000	18.877	56.000	12.099
Rectosigmoid, Contents	12.000		12.000		20.000		20.000		25.000		25.000		35.000		35.000		60.000		60.000	
Liver	130.000	37.475	130.000	37.475	330.000	60.205	330.000	60.205	570.000	154.019	570.000	154.019	830.000	229.688	830.000	229.688	1300.000	409.440	1300.000	328.278
Gallbladder, Wall	0.500	0.043	0.500	0.042	1.400	0.058	1.400	0.058	2.600	0.104	2.600	0.089	4.400	0.199	4.400	0.177	7.700	0.434	7.300	0.262
Gallbladder, Contents	2.800		2.800		8.000		8.000		15.000		15.000		26.000		26.000		45.000		42.000	
Pancreas	6.000	1.248	6.000	1.248	20.000	2.659	20.000	2.659	35.000	6.892	35.000	6.892	60.000	12.100	60.000	12.100	110.000	26.726	100.000	17.677
Brain	380.000	15.698	380.000	15.698	950.000	27.965	950.000	27.965	1310.000	64.657	1180.000	64.657	1400.000	66.751	1220.000	66.751	1420.000	75.284	1300.000	47.939
Breasts	0.268	0.023	0.268	0.023	1.830	0.076	1.830	0.076	3.775	0.151	3.775	0.129	6.500	0.294	6.500	0.261	15.000	0.845	250.000	8.965
Blood in heart chambers	26.000	26.000	26.000	26.000	48.000	48.000	48.000	48.000	135.000	135.000	135.000	135.000	230.000	230.000	230.000	230.000	430.000	430.000	320.000	320.000
Heart – tissue only	20.000	3.157	20.000	3.157	50.000	5.043	50.000	5.043	85.000	12.696	85.000	12.696	140.000	21.416	140.000	21.416	230.000	39.892	220.000	31.410
Blood	290.000		290.000		530.000		530.000		1500.000		1500.000		2500.000		2500.000		4800.000		3500.000	
Eyes	6.000	0.511	6.000	0.511	7.000	0.289	7.000	0.289	11.000	0.409	11.000	0.409	12.000	0.512	12.000	0.512	13.000	0.599	13.000	0.599
Skin	175.000	8.895	175.000	8.895	350.000	10.952	350.000	10.952	570.000	26.415	570.000	26.415	820.000	38.916	820.000	38.916	2000.000	103.076	1700.000	78.392
Muscle, skeletal	800.000	19.334	800.000	19.334	1900.000	29.338	1900.000	29.338	5600.000	128.075	5600.000	128.075	11000.000	257.653	11000.000	257.653	24000.000	656.842	17000.000	360.601
Pituitary gland	0.100	0.009	0.100	0.008	0.150	0.006	0.150	0.006	0.250	0.010	0.250	0.009	0.350	0.016	0.350	0.014	0.500	0.028	0.500	0.018
Larynx	1.300	0.111	1.300	0.110	4.000	0.166	4.000	0.165	7.000	0.281	7.000	0.239	12.000	0.543	12.000	0.482	22.000	1.239	15.000	0.538
Trachea	0.500	0.043	0.500	0.042	1.500	0.062	1.500	0.062	2.500	0.100	2.500	0.085	4.500	0.204	4.500	0.181	7.500	0.422	6.000	0.215

Blood in lung	30.000	30.000	30.000	30.000	70.000	70.000	70.000	70.000	175.000	175.000	175.000	175.000	290.000	290.000	290.000	290.000	570.000	570.000	460.000	460.000
Lung – tissue only	30.000		30.000		80.000		80.000		125.000		125.000		210.000		210.000		330.000		290.000	
Bone, cortical	69.581	3.753	69.581	3.753	268.189	8.398	268.189	8.398	717.993	24.106	717.993	24.106	1669.036	40.307	1669.036	40.307	3180.576	66.574	2915.480	52.151
Bone, trabecular	100.419	10.552	100.419	10.552	321.811	23.255	321.811	23.255	542.007	65.636	542.007	65.636	630.964	109.927	630.964	109.927	869.424	194.467	784.520	152.336
Marrow, active	50.000	15.051	50.000	15.051	155.548	26.336	155.548	26.336	374.931	73.772	374.931	73.772	754.144	122.896	754.144	122.896	1053.496	232.349	1049.098	174.408
Marrow, inactive		0.000		0.000	14.452	0.119	14.452	0.119	125.069	1.586	125.069	1.586	505.856	6.974	505.856	6.974	1506.504	21.749	1330.902	16.432
Cartilage	130.000	1.648	130.000	1.648	360.000	2.965	360.000	2.965	600.000	7.610	600.000	7.610	820.000	11.304	820.000	11.304	1140.000	16.458	920.000	11.359
Teeth	0.700	0.009	0.700	0.009	5.000	0.041	5.000	0.041	15.000	0.190	15.000	0.190	30.000	0.414	30.000	0.414	45.000	0.650	35.000	0.432
Miscellaneous	20.000	0.254	20.000	0.254	45.000	0.371	45.000	0.371	55.000	0.698	55.000	0.698	90.000	1.241	90.000	1.241	155.000	2.238	145.000	1.790
Spleen	9.500	4.365	9.500	4.365	29.000	8.352	29.000	8.352	50.000	21.329	50.000	21.329	80.000	34.951	80.000	34.951	130.000	68.786	130.000	49.494
Thymus	13.000	1.108	13.000	1.104	30.000	1.242	30.000	1.240	30.000	1.202	30.000	1.026	40.000	1.810	35.000	1.406	35.000	1.972	30.000	1.076
Thyroid	1.300	0.190	1.300	0.190	1.800	0.168	1.800	0.168	3.400	0.471	3.400	0.471	7.900	1.120	7.900	1.120	12.000	2.041	12.000	1.497
Tonsils (2 palatine)	0.100	0.009	0.100	0.008	0.500	0.021	0.500	0.021	2.000	0.080	2.000	0.068	3.000	0.136	3.000	0.121	3.000	0.169	3.000	0.108
Kidneys (2)	25.000	2.042	25.000	2.042	70.000	9.323	70.000	9.323	110.000	32.390	110.000	32.390	180.000	54.284	180.000	54.284	250.000	91.438	240.000	61.707
Ureters (2)	0.770	0.066	0.770	0.065	2.200	0.091	2.200	0.091	4.200	0.168	4.200	0.144	7.000	0.317	7.000	0.281	12.000	0.676	12.000	0.430
Urinary bladder, Wall	4.000	0.080	4.000	0.080	9.000	0.115	9.000	0.115	16.000	0.304	16.000	0.304	25.000	0.487	25.000	0.487	40.000	0.907	35.000	0.619
Urinary bladder, Contents	12.400		12.400		32.900		32.900		64.700		64.700		103.000		103.000		160.000		140.000	
Urethra	0.480	0.041	0.140	0.012	1.400	0.058	0.420	0.017	2.600	0.104	0.780	0.027	4.400	0.199	1.300	0.052	7.700	0.434	2.300	0.082
Testes (2)	0.850	0.036			1.500	0.046			1.700	0.115			2.000	0.179			16.000	1.037		
Epididymes (2)	0.250	0.021			0.350	0.014			0.450	0.018			0.600	0.027			1.600	0.090		
Prostate	0.800	0.068			1.000	0.041			1.200	0.048			1.600	0.072			4.300	0.242		
Ovaries (2)			0.300	0.036			0.800	0.046			2.000	0.115			3.500	0.179			6.000	0.386
Fallopian tubes (2)			0.250	0.021			0.250	0.010			0.350	0.012			0.500	0.020			1.100	0.039
Uterus			4.000	0.340			1.500	0.062			3.000	0.103			4.000	0.161			30.000	1.076
Lymphatic node	14.300	0.471	14.300	0.471	25.000	0.873	25.000	0.873	48.800	2.453	48.800	2.453	80.900	4.202	80.900	4.202	142.700	8.693	130.800	6.212
Blood, arteries		17.400		17.400		31.800		31.800		90.000		90.000		150.000		150.000		288.000		210.000
Blood, veins		52.200		52.200		95.400		95.400		270.000		270.000		450.000		450.000		864.000		630.000
Remaining tissues	96.560	14.584	94.250	14.351	349.684	10.424	350.964	10.453	632.690	37.892	762.510	38.542	1240.942	73.675	1425.242	74.722	1589.158	121.649	1465.967	24.937
Total body (kg)	3.5	0.29	3.5	0.29	10	0.53	10	0.53	19	1.5	19	1.5	32	2.5	32	2.5	56	4.8	53	3.5



(73) Subsequently, the densities and elemental compositions of the organs inclusive of
blood content were calculated using data given in the scientific literature (White et al., 1987;
ICRU, 1992; ICRP, 2002), assuming that the blood content is uniformly distributed within the
organs. The density and hydrogen mass percentage of the blood-inclusive brain, for example,
were calculated by using the following equations:

825
$$\rho_{brain}^{with-blood} = \frac{m_{brain}^{lCRP89} + m_{blood-in-brain}}{\frac{m_{brain}^{lCRP89}}{\rho_{brain}^{lCRV46}} + \frac{m_{blood-in-brain}}{\rho_{blood}^{lCRU46}}}$$
(1)

826
$$(\%H)_{brain}^{with-blood} = \frac{(\%H)_{brain}^{ICRU46} m_{brain}^{ICRP89} + (\%H)_{blood}^{ICRU46} m_{blood-in-brain}}{m_{brain}^{ICRP89} + m_{blood-in-brain}}$$
(2)

where $\rho_{brain}^{with-blood}$ is the density of the blood-inclusive brain, ρ_{brain}^{ICRU46} is the density of the brain parenchyma as given in ICRU *Report 46* (ICRU, 1992), ρ_{blood}^{ICRU46} is the density of the blood as given in ICRU *Report 46* (ICRU, 1992), m_{brain}^{ICRP89} is the mass of the brain parenchyma as given 827 828 829 830 in Publication 89 (ICRP, 2002), $m_{blood-in-brain}$ is the calculated mass of the blood in the brain, $(\%H)_{brain}^{with-blood}$ is the hydrogen mass percentage in the blood-inclusive brain, 831 $(\%H)_{brain}^{ICRU46}$ is the hydrogen mass percentage in the brain parenchyma as given in ICRU Report 832 46 (ICRU, 1992) and $(\%H)_{blood}^{ICRU46}$ is the hydrogen mass percentage in the blood. The mass 833 percentages of all other elements in the blood-inclusive tissues have been assessed accordingly. 834 835 The calculated densities and elemental compositions are given in Tables B.1–B.10.

836 4.2. Phantom adjustment for blood inclusion

(74) The volumes of the organs, produced in the PM format, were subsequently adjusted to match the blood-inclusive reference masses based on the blood-inclusive density, following the same procedure applied to the adult MRCPs (ICRP, 2020c). First, the PM models were isotropically increased, preserving the original shape and centroid of the organs. After enlargement, resulting overlaps between some of the neighbouring organs were eliminated by preferentially modifying the larger organs, rather than the smaller ones, to minimise the geometric distortion of the organs.

844 (75) To evaluate the change of topology in the organs due to the inclusion of the blood
845 content, the geometric similarity was again investigated by calculating the DI and CD values
846 for the organs, as discussed in Section 6.2.

847 **4.3. Definition of residual soft tissue (RST)**

848 (76) In the paediatric MRCPs, several organs listed in Table 4.2 (i.e. adipose tissue, urethra, 849 epididymis, fallopian tubes and some parts of cartilage) are not explicitly defined, while several 850 organs implicitly included in 'remaining tissues and regions' [i.e. main bronchi (= generation 851 1), spinal cord, urine, oesophagus contents, ET region and inner air] are defined in the 852 phantoms. Consequently, the total body masses of the phantoms are smaller than the reference 853 masses. For this reason, as done for other ICRP reference phantoms (ICRP, 2009, 2020a,c), the 854 total body masses of the paediatric MRCPs were matched to the reference masses by defining 855 an additional compensating tissue, called 'residual soft tissue (RST)'. The RST is a 856 homogeneous mixture of all the organs not explicitly defined in the phantoms, a commonly



- used approach in the field of phantom development to match the target body mass (ICRP, 2009, 2020c; Lee et al., 2010; Kim et al., 2011; Yeom et al., 2013).



5. INCLUSION OF THIN TARGET AND SOURCE REGIONS

861 **5.1. Skin**

862 (77) In the skin, the basal cells of the epidermis and hair follicles are considered as the relevant target cells at radiogenic risk for stochastic effects. The target cells for adults are 863 assumed to be at a depth of 50 to 100 µm below the skin surface (ICRP, 1977, 2010, 2015) and, 864 865 in the present work, the same depth was assumed for adolescents. The skin target region for 10 years and younger was assumed to be slightly wider (i.e. 40–100 µm below the skin surface) 866 considering that the epidermis thickness is thinner but the hair follicles are more densely 867 868 distributed over the skin at younger ages. Note that a substantial proportion of the stem cells that are the assumed targets are not in the inter-follicular basal layer between hair follicles but 869 870 in the hair follicles themselves that penetrate through the dermis (ICRP, 1991a, 2012). In the 871 paediatric MRCPs, therefore, the target layer was defined at a depth of 40–100 µm for 10 years 872 and younger and 50–100 μ m for 15 years.

873 (78) Fig. 5.1 shows the skin of the 1-year-old female and 15-year-old male phantoms,
874 including the target layer.



875



877 5.2. Alimentary tract

878 (79) The target and source regions were defined for the alimentary tract organs (i.e. oral 879 cavity, oesophagus, stomach, small intestine and colon) of the paediatric MRCPs (Choi et al., 880 2022a), following the morphometric data given in *Publication 100* (ICRP, 2006), which are 881 summarised in Table 5.1. Except for the oral cavity, the target and source regions of all the 882 alimentary tract organs were simply defined according to their depth and thickness. Note that 883 in *Publication 100*, the depth and thickness of all the target and source regions for adults, with



884 one exception, are assumed to be applicable to children and adolescents; the exception is the 885 source region in the villi of the small intestine for 5 years and younger, the thickness of which 886 is considered to be 100 μ m thinner than that for adults (= 500 μ m). This thickness variation of 887 the villus layer with age was reflected in the paediatric MRCPs.

Table 5.1. Information on source (upper) and target (lower) regions of alimentary tract organs
from the data of *Publication 100* (ICRP, 2006).

Alimentary tract organ	Source region	Source location [¶]						
	Food (or liquid)	5 mm (on top of the tongue,						
Oral cavity -	Food (of liquid)	outward)						
Of all Cavity	Patantion on teath	$10 \ \mu m$ (on inner and outer surfaces						
	Retention on teem	of the teeth, outward)						
Oecophague -	Contents (fast)	*						
Oesophagus	Luminal surface (slow)	**						
Stomach -	Mucosa	0–300 µm (outward)						
Stomach	Contents	*						
_	Villi	$0-400^{\dagger}/500^{\dagger\dagger} \mu m$ (inward)						
Small intestine	Mucosa	0–200 µm (outward)						
	Contents	*						
Pight colon -	Mucosa	0–300 µm (outward)						
	Contents	*						
Laft colon –	Mucosa	0–300 µm (outward)						
	Contents	*						
Pactosigmoid -	Mucosa	0–300 µm (outward)						
Rectosignioid	Contents	*						
Alimentary tract organ	Target region	Target location [¶]						
	P oof of mouth	190–200 μ m (from the top surface of						
_	Kool of mouth	the food, outward)						
Oral cavity	Tongue	190–200 μ m (from the surface of the						
	Toligue	tongue, inward)						
	Lins and cheek	190–200 μ m (from the outer surface						
	Lips and check	of retention on teeth, outward)						
Oesophagus	Basal cells	190–200 µm (outward)						
Stomach	Stem cells	60–100 μm (outward)						
Small intestine	Stem cells	130–150 µm (outward)						
Right colon	Stem cells	280–300 µm (outward)						
Left colon	Stem cells	280–300 µm (outward)						
Rectosigmoid	Stem cells	280–300 μm (outward)						

890 [¶]Default depth is from the luminal surface.

891 * Volume of the contents is the source region.

892 ** Surface of the contents is the source region.

^{*}Depth of the small intestine villi for newborn, 1 year and 5 years.

894 ^{††} Depth of the small intestine villi for 10 years and 15 years.

895 (80) For the oral cavity, two source regions were defined in the paediatric MRCPs: food 896 (or liquid) on the top of the tongue and radionuclides retained on the surface of the teeth. The 897 food volume has been estimated only for the adults (= 20 cm^3) (ICRP, 2006); for the paediatric 898 MRCPs, therefore, the food volume was estimated by scaling in proportion to the area of the


tongue, assuming that the thickness of the food region (= 5 mm) is identical for all ages. The food region was then modelled in the paediatric MRCPs using the same modelling approach used for the adult MRCPs (ICRP, 2020c). The source region for radionuclides retained on teeth was defined by adding a 10- μ m-thick layer on the exposed surfaces of the teeth. The target region in the oral cavity was defined in three parts (i.e. roof of mouth, tongue and lips, and cheek) by defining a 10- μ m-thick layer at a depth of 190 μ m from the source regions.

905 (81) Fig. 5.2 shows, as examples, the target and source regions defined in the oral cavity 906 and small intestine of the 15-year-old male phantom.



907

Fig. 5.2. Target and source regions of the oral cavity and small intestine in the 15-year-old maleMRCP.

910 5.3. Respiratory tract

911 (82) For the paediatric MRCPs as for the adult MRCPs, the target and source regions were
912 defined in the respiratory tract tissues (Choi et al., 2022b), following the morphometric data of
913 *Publication 66* (ICRP, 1994a), which are summarised in Table 5.2. The respiratory tract tissues
914 comprise ET region (i.e. ET1 and ET2), trachea, bronchi (BB), bronchioles (bb) and alveolar915 interstitium (AI). In the present work, the AI was not explicitly defined in the phantoms but
916 was assumed to be homogeneously distributed in the lungs.

Table 5.2. Information on source (upper) and target (lower) regions of respiratory tract organs
from the data of *Publication 66* (ICRP, 1994a).

Source region	Source location [¶]
Surface	$0-8 \ \mu m$ (outward)
Surface	0–15 µm (inward)
Bound	$0-55 \ \mu m$ (outward)
Sequestered	55–65 μm (outward)
Fast mucus	6–11 µm (inward)
	Source region Surface Surface Bound Sequestered Fast mucus



	Slow mucus	0–6 μm (inward)					
	Bound	0–60 μm (outward)					
	Sequestered	60–70 µm (outward)					
	AI	*					
	Fast mucus	4–6 μm (inward)					
_	Slow mucus	0–4 μm (inward)					
bb	Bound	0–20 µm (outward)					
	Sequestered	20–25 µm (outward)					
	AI	*					
Respiratory tract organ	Target region	Target location [¶]					
ET_1	Basal cells	40–50 µm (outward)					
ET_2	Basal cells	40–50 µm (outward)					
BB	Basal cells	35–50 µm (outward)					
DD	Secretory cells	10–40 µm (outward)					
bb	Secretory cells	$4-12 \ \mu m \ (outward)$					

919 [¶]Default depth is from the airway surface.

920 * AI as a source region is determined by radiation types and energies.

921 (83) For the ET_1 , ET_2 , trachea and main BB (i.e. generation 1) regions, the target and source regions were simply defined according to their depth and thickness. This approach, however, 922 923 could not be used for the other generations of the BB (i.e. generations 2-8) and all the 924 subsequent generations of the bb (i.e. generations 9–15), which are not represented in the P143 925 phantoms (ICRP, 2020a). These airways were modelled in constructive solid geometry (CSG) 926 format based on airway dimensions (i.e. lengths and diameters) derived using the scaling 927 method of Publication 66, using the computer program applied for the adult MRCPs (Kim et 928 al., 2017). The total lengths of the airway branches for each generation were matched to their 929 reference values within 10% difference. Note that as an exception, the newborn airway 930 dimensions were derived by scaling the adult male values in proportion to the cube root of lung 931 volume; this is because the scaling method of Publication 66, for which limited data on 932 newborn subjects were used, proved insufficient for the newborn.

933 (84) The airways generated in the CSG format could have been converted to PM format 934 for easy incorporation into the paediatric MRCPs, but the resulting airways would require a 935 very large number of facets and a large computer memory allocation (i.e. >50 GB) (Kim et al., 936 2017). In the present work, therefore, the airways in the CSG format were not converted to the 937 PM format, but directly incorporated into the paediatric MRCPs using the overlying approach used for the adult MRCPs (Kim et al., 2017; ICRP, 2020c). Note that the overlying approach 938 939 makes it possible to perform dose calculation for the airways with a minimal addition of 940 memory usage and computation time.

941 (85) Fig. 5.3 shows the target and source regions of the ET_2 of the 5-year-old female 942 phantom and the airway model produced in the lungs of the 5-year-old male phantom with the target and source regions of the bb. 943



944

945

Fig. 5.3. Target and source regions of the ET_2 region in the 5-year-old female MRCP (upper) and lung airway of the 5-year-old male MRCP including the target and source regions (lower).

948 **5.4. Urinary bladder**

949 (86) The basal cells in the epithelium of the urinary bladder are considered to be the 950 relevant target cells for carcinogenesis (Colin et al., 2009). Eckerman and Veinot (2018) 951 derived the depth and thickness of the target layer of the urinary bladder for adults, which were 952 used to define the target layer of the urinary bladder in the adult MRCPs (ICRP, 2020c). In 953 their subsequent study, the values for children and adolescents were also derived, as shown in 954 Table 5.3. In the paediatric MRCPs, these values were adopted to define the target layer of the 955 urinary bladder.

956 (87) Fig. 5.4 shows the urinary bladder of the 10-year-old male phantom including the 957 source and target regions.

958	Table 5.3. De	pth and thickness	of target lay	ver of urinary	bladder for d	children and adolescents.
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Age	Sex	Depth (µm)	Thickness (µm)
Newborn	Male Female	54	178
1 year	Male Female	71	167
5 years	Male Female	86	107





960 961 Fig. 5.4. Source and target regions of the urinary bladder in the 10-year-old male MRCP.



962 6. DESCRIPTION OF THE PAEDIATRIC MESH-TYPE REFERENCE 963 COMPUTATIONAL PHANTOMS

964 6.1. General phantom characteristics

965 (88) Fig. 6.1 shows the paediatric MRCPs and Table 6.1 gives the standing height and total
966 body mass of these phantoms, which are consistent with the reference values in *Publication 89*967 (ICRP, 2002).

968 (89) The paediatric MRCPs include all the radiosensitive organs required for dose 969 assessment from ionising radiation exposures for radiological protection purpose (ICRP, 2007). 970 These phantoms also include the micrometre-scale target and source regions in the respiratory 971 and alimentary tracts, skin, eye lens and urinary bladder, assimilating the supplementary organ-972 specific stylised models. The new phantoms at 10 years and younger, unlike the P143 phantoms, 973 have different masses and/or shapes for several organs, besides the sex-specific organs, due to 974 the adoption of individual sex-specific organ masses (i.e. brain for 5 and 10 years and thymus 975 for 10 years) and high-quality organ models (i.e. spine, hand/foot bones, ET region and teeth). 976 Note that the complex microstructures of skeletal target tissues [i.e. red bone marrow (RBM) 977 and endosteum] in trabecular spongiosa and medullary cavity are not explicitly modelled; thus, 978 skeletal dosimetry should be performed by employing the approximation techniques, i.e. 979 simplified approach and fluence-to-dose response functions, which are described in Section 3.4 980 and Annex D of Publication 116 (ICRP, 2010), respectively.



982 Fig. 6.1. Paediatric male (M) and female (F) MRCPs.

983	Table 6.1. Standing	height and	total body m	nass of the p	paediatric MRCPs.
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		<u> </u>					
A co	Standing h	neight (cm)	Total body mass (kg)				
Age	Male	Female	Male	Female			
Newborn	_	_	3.50	3.50			
1 year	76.0	76.0	10.0	10.0			
5 years	109.0	109.0	19.0	19.0			



10 years	138.0	138.0	32.0	32.0
15 years	167.0	161.0	56.0	53.0

984 (90) The final geometric format of the paediatric MRCPs, as for the adult MRCPs of 985 Publication 145 (ICRP, 2020c), is the TM format. Table 6.2 lists the number and average 986 volume of tetrahedra composing the phantoms and the sizes of the phantom files. Note that at 987 the final stage of phantom construction, the phantoms produced in the PM format were 988 converted into the TM format through a 'tetrahedralisation' process; that is, the phantoms were filled with millions of tetrahedra, while maintaining the original organ shapes of the PM-format 989 990 phantoms. For this, a computer program dedicated to phantom tetrahedralisation was used (Han 991 et al., 2020), which is based on the TetGen code (Si, 2015).

992 (91) The TM-format phantoms, when compared with the PM-format phantoms, show 993 much faster computation speed in Monte Carlo dose calculations (i.e. by a factor of tens to 994 hundreds for photons, electrons, neutrons and protons in the energy range of 10 keV–10 GeV) 995 (Yeom et al., 2014). In addition, the TM-format phantoms show better compatibility with 996 Monte Carlo codes; the TM-format phantoms can be used in major Monte Carlo codes such as 997 Geant4, PHITS and MCNP6 without any user-plugin tools, while the PM-format phantoms can 998 be used only in Geant4 (Han et al., 2018). The present publication also provides the PM-format 999 phantoms with detailed information to support users who are interested in modifying the 1000 phantoms, for example, to produce phantoms with different body sizes and/or postures for 1001 individualised dosimetry.

Phant	toms	Number of tetrahedra	Average volume of tetrahedra (mm ³)	File size (ASCII) (MB)
Nawhorn	Male	7,556,192	0.45	423
Newborn	Female	7,650,313	0.44	407
1	Male	6,715,716	1.47	373
i yeai	Female	6,943,945	1.42	387
5 voors	Male	8,178,096	2.27	462
Jyears	Female	8,440,293	2.19	478
10 voore	Male	6,925,977	4.48	385
10 years	Female	7,103,129	4.37	396
15 years	Male	7,366,440	7.43	412
15 years	Female	7,519,627	6.96	422

1002 Table 6.2. Numerical information on paediatric MRCPs.

1003 (92) The masses of the organs of the paediatric MRCPs are in accordance with the 1004 reference values inclusive of blood content (see Table 4.2) within 0.1% deviation. Tables A.1-1005 A.2 list the organ IDs, medium and mass for each organ of the paediatric MRCPs. Tables B.1– 1006 B.10 list the elemental composition and density for each organ. Table C.1 lists the anatomical 1007 source regions, their acronyms and corresponding ID numbers. Table D.1 lists the anatomical 1008 target regions, their acronyms and corresponding organ ID numbers.

1009 (93) For dose calculations for the organs in which micron-scale target regions are explicitly defined (e.g. alimentary and respiratory tract organs), due to their small target volumes, longer 1010 1011 computation times are generally required to achieve an acceptable statistical precision when 1012 compared to calculations for other organs. To save computation time, entire regions instead of 1013 the thin target regions can be used in dose calculations for cases where the entire regions of the 1014 organs provide dose values similar to those calculated using the target regions (Yeom et al., 1015 2019b, 2020; ICRP, 2020c). For example, for external exposures to penetrating radiations (e.g. 1016 photons and neutrons), where low dose gradients are generally observed in the organs, the 1017 absorbed doses to the thin target regions tend to be close to those to the entire regions, and thus



1018 the entire regions can be used instead of the thin target regions; exceptions are the skin and lens 1019 of the eye, for which the thin target regions should be considered, because charged-particle equilibrium (CPE) is not always established in these superficial tissues. For external exposures 1020 1021 to weakly penetrating radiations (e.g. alpha particles and protons), the radiosensitive regions 1022 should be used for dose calculation because significant spatial dose gradients could be observed, 1023 depending on the particle energies and organ topologies. The dose discrepancies between the 1024 thin target regions and the entire regions for external exposures are discussed by Yeom et al. 1025 (2019b, 2020). For internal exposures to penetrating radiations, dose calculations for entire regions can replace those for thin target regions to estimate cross-fire irradiation doses (e.g. 1026 1027 lungs \leftarrow liver).

1028 (94) However, in cases where subregions of the same organs are considered as source 1029 regions (e.g. source region: BB bound region; target region: BB secretory region), the thin 1030 target regions should be used in dose calculation, again due to the lack of CPE. For internal 1031 exposures to weakly penetrating radiations which could establish steep dose gradients in the 1032 organs, it is recommended to calculate doses using the thin target regions.

1033 (95) The paediatric MRCPs overcome the limitations of the P143 phantoms resulting from 1034 the inherent nature of voxel geometry and finite voxel resolutions. Fig. 6.2 shows, as an 1035 example, the 15-year-old female MRCP, along with the 15-year-old female P143 phantom, 1036 viewed in superior-inferior direction. It can be seen that the organs of the P143 voxel phantom 1037 are represented with stair-stepped surfaces, whereas those of the mesh phantom are represented with smooth surfaces. Moreover, in the voxel phantom, several radiosensitive organs (e.g. 1038 1039 breasts and muscle) are not fully covered by skin voxels and are, thus, directly exposed to the air. This limitation is addressed in the mesh phantoms, preventing significant overestimations 1040 1041 in dose calculations for these organs for external exposures to weakly penetrating radiations. 1042 Similarly, in the voxel phantoms, the spongiosa is not fully covered by the cortical bone, which 1043 is also addressed in the mesh phantoms (see Fig. 6.3).



1044

Fig. 6.2. P143 phantom (left) and paediatric MRCP (right) for 15-year-old female viewed in
superior-inferior direction: spongiosa (red), muscle (brown) and breasts (yellow) in P143
phantom.





Fig. 6.3. Skeletal system of P143 phantom (left) and paediatric MRCP (right) for 15-year-old
 female viewed in superior-inferior direction: spongiosa (red) and cortical bone (white).

1051 6.2. Geometric comparison with the P143 phantoms

1048

(96) In order to investigate the geometric similarity between the paediatric MRCPs
developed in the present work and the P143 phantoms (ICRP, 2020a), the DI and CD of the
organs were calculated as shown in Table 6.3.

1055 (97) The DI and CD values are mostly higher than 0.7 and lower than 10 mm, respectively, 1056 with some exceptions. For the spine models, except for the newborn, relatively large 1057 dissimilarity is found, which is due mainly to the fact that the spine models of the paediatric 1058 MRCPs, except for the newborn, were not directly converted from the P143 phantoms, but constructed based on the PM models of Park et al. (2005). For the colon models, the relatively 1059 1060 large dissimilarity is attributed to the fact that the colon models were reproduced with different 1061 colon shapes. Large dissimilarity is also found for the organs which were modelled in the 1062 present work (i.e. thyroid and ET region models). The large dissimilarity observed for the ureters is mainly due to the shape of the organ; the ureters are very thin and a slight shift in the 1063 1064 location results in a very small DI value. Large dissimilarity is also found for some small organs due to the shift of their positions caused by the changes in the adjacent large organs. For 1065 example, the low DI values for the spleen of the newborn phantoms and the uterus of the 1-1066 year-old female phantom can be attributed to their shifting due to the change of the colon 1067 models. The other large dissimilarities in specific phantoms generally reflect the procedures 1068 1069 used in the phantom construction process.

1070 (98) The organ depth distributions (ODDs) and the chord length distributions (CLDs) of 1071 the paediatric MRCPs were compared with those of the P143 phantoms, as shown in Annexes 1072 E and F. The ODD represents the distance from the body surface to the organ and the CLD 1073 represents the distance from the source organ to the target organ, which mainly influence the 1074 doses from external and internal exposures, respectively. Although the organs of the paediatric 1075 MRCPs were adjusted for blood inclusion, the comparison results show that the ODDs and 1076 CLDs of the paediatric MRCPs are generally in good agreement with those of the P143 1077 phantoms for most of the organs.



1078 (99) The results of the geometric similarity investigation show that, in overall, the 1079 paediatric MRCPs preserve the shape and location of the organs in the P143 phantoms, and 1080 thus they are expected to provide similar dose values for penetrating radiations in both external 1081 and internal exposures. For weakly penetrating radiations, however, they will provide 1082 significantly different dose values, more accurate and reliable, especially for the organs with 1083 large dissimilarities (e.g. colon and thyroid).



Table 6.3. Dice index (DI) and centroid distance (CD) comparing the paediatric MRCPs and the P143 phantoms (ICRP, 2020a).

_	Newborn male Newborn female 1-year male 1-year fema		female	5-year male		5-year female		10-year male		10-year female		e 15-year male		15-year female						
Organs	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)	DI	CD (cm)
Humeri	0.92	0.02	0.92	0.02	0.95	0.01	0.94	0.08	0.93	0.17	0.93	0.18	0.95	0.18	0.95	0.19	0.91	0.48	0.88	0.29
Ulnae and radii	0.89	0.05	0.89	0.06	0.93	0.05	0.93	0.06	0.91	0.18	0.91	0.18	0.94	0.12	0.94	0.12	0.91	0.26	0.90	0.20
Wrists and hand bones	0.88	0.02	0.88	0.02	0.58	0.30	0.59	0.22	0.66	0.44	0.66	0.44	0.67	0.08	0.67	0.08	0.69	0.64	0.74	0.27
Clavicles	0.87	0.01	0.87	0.01	0.87	0.03	0.87	0.03	0.85	0.07	0.85	0.07	0.81	0.06	0.81	0.06	0.70	0.28	0.83	0.23
Cranium	0.44	0.26	0.44	0.27	0.75	0.14	0.75	0.14	0.78	0.63	0.88	0.40	0.74	0.20	0.78	0.13	0.84	0.33	0.84	0.24
Femora	0.92	0.01	0.92	0.01	0.95	0.02	0.95	0.02	0.93	0.10	0.93	0.10	0.93	0.12	0.93	0.12	0.92	0.38	0.90	0.17
Tibiae, fibulae and patellae	0.91	0.04	0.91	0.03	0.95	0.01	0.95	0.01	0.93	0.12	0.93	0.12	0.95	0.10	0.95	0.10	0.92	0.40	0.91	0.07
Ankles and foot bones	0.89	0.08	0.88	0.08	0.70	0.19	0.70	0.51	0.50	0.63	0.58	0.55	0.53	0.96	0.54	0.96	0.58	1.25	0.72	1.15
Mandible	0.67	0.02	0.67	0.03	0.69	0.32	0.69	0.31	0.72	0.55	0.72	0.50	0.50	0.66	0.49	0.70	0.75	0.16	0.73	0.35
Pelvis	0.91	0.02	0.91	0.02	0.94	0.01	0.94	0.01	0.92	0.07	0.92	0.07	0.91	0.08	0.90	0.08	0.83	0.26	0.86	0.17
Ribs	0.14	0.20	0.14	0.20	0.87	0.07	0.87	0.08	0.85	0.04	0.85	0.04	0.78	0.05	0.77	0.05	0.66	0.25	0.74	0.39
Scapulae	0.66	0.17	0.66	0.17	0.93	0.03	0.93	0.03	0.90	0.14	0.90	0.14	0.89	0.14	0.89	0.14	0.73	0.64	0.81	0.19
Cervical spine	0.87	0.05	0.87	0.05	0.35	0.35	0.40	0.21	0.54	0.13	0.59	0.14	0.59	0.20	0.56	0.20	0.61	0.37	0.64	0.48
Thoracic spine	0.87	0.07	0.87	0.07	0.48	0.65	0.47	0.53	0.64	0.73	0.65	0.73	0.70	0.54	0.70	0.54	0.53	0.40	0.56	0.69
Lumbar spine	0.90	0.02	0.90	0.02	0.55	0.18	0.55	0.09	0.66	0.27	0.66	0.27	0.74	0.27	0.74	0.27	0.76	0.15	0.72	0.50
Sacrum	0.83	0.08	0.83	0.08	0.43	0.49	0.42	0.49	0.87	0.15	0.87	0.15	0.70	0.52	0.70	0.52	0.85	0.25	0.78	0.44
Sternum	0.33	0.26	0.33	0.26	0.50	0.82	0.50	0.82	0.68	1.17	0.68	1.17	0.76	1.08	0.76	1.08	0.86	0.44	0.85	0.13
Teeth									0.28	0.40	0.28	0.44	0.35	0.36	0.35	0.36	0.39	0.35	0.44	0.34
Tongue	0.33	1.32	0.33	1.23	0.46	1.39	0.43	1.49	0.57	1.26	0.54	1.33	0.71	0.96	0.72	0.87	0.84	0.40	0.77	0.76
Oesophagus	0.60	0.11	0.60	0.12	0.66	0.13	0.67	0.15	0.68	0.18	0.63	0.52	0.67	0.12	0.66	0.18	0.64	0.93	0.67	0.48
Stomach	0.80	0.26	0.80	0.26	0.95	0.13	0.95	0.13	0.96	0.01	0.96	0.01	0.95	0.04	0.95	0.04	0.96	0.09	0.95	0.17
Small intestine	0.76	0.19	0.75	0.19	0.79	0.12	0.79	0.12	0.73	0.50	0.73	0.49	0.92	0.27	0.92	0.26	0.86	0.25	0.88	0.11
Colon	0.54	1.11	0.54	1.11	0.42	1.12	0.41	1.12	0.48	1.43	0.49	1.43	0.43	1.61	0.43	1.61	0.58	0.79	0.51	2.10
Salivary glands	0.93	0.02	0.93	0.02	0.77	0.21	0.77	0.22	0.94	0.03	0.94	0.03	0.69	0.43	0.82	0.23	0.86	0.19	0.89	0.09
Tonsils	0.88	0.01	0.88	0.01	0.92	0.01	0.91	0.01	0.92	0.02	0.71	0.20	0.92	0.01	0.65	0.20	0.39	0.51	0.89	0.04
Liver	0.73	0.64	0.73	0.64	0.91	0.18	0.91	0.19	0.88	0.18	0.88	0.18	0.88	0.26	0.88	0.26	0.86	0.55	0.88	0.17
Gall bladder	0.97	0.00	0.97	0.00	0.94	0.08	0.94	0.08	0.95	0.04	0.94	0.05	0.95	0.02	0.95	0.03	0.95	0.03	0.95	0.01
Pancreas	0.66	0.60	0.66	0.60	0.92	0.04	0.92	0.04	0.89	0.08	0.89	0.08	0.91	0.04	0.91	0.04	0.85	0.26	0.87	0.09
Heart	0.69	0.24	0.69	0.23	0.97	0.01	0.97	0.01	0.96	0.05	0.96	0.05	0.96	0.05	0.96	0.05	0.94	0.17	0.96	0.08
Kidneys	0.97	0.01	0.97	0.01	0.95	0.01	0.95	0.01	0.89	0.08	0.89	0.08	0.90	0.01	0.90	0.01	0.86	0.25	0.88	0.15
Ureters	0.59	0.07	0.42	0.34	0.16	0.24	0.16	0.24	0.51	0.03	0.50	0.06	0.47	0.12	0.45	0.34	0.52	0.50	0.56	0.09
Urinary bladder	0.92	0.02	0.90	0.05	0.64	0.11	0.62	0.27	0.95	0.14	0.96	0.03	0.97	0.01	0.98	0.01	0.97	0.04	0.96	0.05
Gonads	0.95	0.01	0.88	0.01	0.94	0.01	0.89	0.05	0.88	0.10	0.92	0.03	0.91	0.02	0.88	0.08	0.93	0.08	0.90	0.40
Prostate / uterus	0.94	0.02	0.93	0.02	0.52	0.41	0.00	1.02	0.82	0.15	0.85	0.10	0.92	0.02	0.92	0.01	0.90	0.03	0.84	0.13
Adrenals	0.91	0.01	0.90	0.01	0.88	0.06	0.88	0.06	0.81	0.07	0.81	0.07	0.81	0.09	0.81	0.09	0.77	0.36	0.86	0.09
Breasts	0.86	0.02	0.87	0.01	0.90	0.02	0.90	0.02	0.87	0.08	0.87	0.08	0.66	0.05	0.90	0.04	0.90	0.23	0.92	0.07
Brain	0.85	0.50	0.85	0.50	0.98	0.03	0.98	0.03	0.94	0.29	0.98	0.03	0.94	0.29	0.98	0.02	0.97	0.14	0.97	0.05
Pituitary glands	0.91	0.00	0.91	0.00	0.90	0.01	0.90	0.01	0.87	0.03	0.87	0.03	0.85	0.02	0.85	0.02	0.78	0.12	0.85	0.05
Spinal	0.82	0.27	0.82	0.28	0.42	0.95	0.42	0.37	0.65	1.97	0.64	2.45	0.87	0.65	0.87	0.68	0.43	0.55	0.48	0.72
Spleen	0.45	0.74	0.45	0.74	0.83	0.28	0.83	0.28	0.82	0.09	0.82	0.09	0.82	0.11	0.82	0.11	0.79	0.09	0.82	0.20
Thymus	0.95	0.02	0.95	0.02	0.65	0.15	0.65	0.15	0.89	0.17	0.89	0.17	0.91	0.07	0.92	0.09	0.90	0.20	0.91	0.17
Thyroid	0.39	0.58	0.39	0.58	0.02	1.44	0.02	1.44	0.23	0.95	0.20	0.96	0.32	1.11	0.32	1.12	0.38	0.98	0.18	1.30
ET	0.46	1.12	0.52	0.80	0.41	1.91	0.45	1.47	0.72	0.79	0.70	0.88	0.70	0.89	0.70	0.71	0.55	2.45	0.47	2.18
Trachea Lungs	0.93 0.81	0.03 0.10	0.89 0.81	0.08 0.10	0.93 0.94	0.09 0.17	0.93 0.94	0.09 0.17	0.84 0.90	0.10 0.17	0.84 0.90	0.10 0.17	0.90 0.96	0.10 0.12	0.90 0.96	0.10 0.12	0.92 0.93	0.09 0.37	0.91 0.92	0.08 0.14



1086 **6.3. Computational performance in Monte Carlo codes**

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(100) The TM geometry of the paediatric MRCPs can be directly implemented in generalpurpose Monte Carlo codes such as Geant4 (version 8.0 and later versions), PHITS (version
2.82 and later versions) and MCNP6 (version 1.0 and later versions) (ICRP, 2020c). The
features of these codes that enable implementation of the TM geometry have been significantly
improved in the last few years (Allison et al., 2016; Furuta et al., 2017; Martz et al., 2017). In
this section, as an example, the computational performance of the 5-year-old male MRCP and
P143 phantom (ICRP, 2020a) were compared in terms of run time and memory usage.

1095 (101) Computational performances were measured for Geant4 (version 10.06.p01), PHITS 1096 (version 3.10) and MCNP6 (version 2.0) on a single core of the Intel[®] Xeon[®] CPU E5-2698 v4 1097 (@ 2.20 GHz and 512 GB memory). Run time was measured for photons, electrons and 1098 neutrons in the left-lateral (LLAT) irradiation geometry by simulating 10^5 primary particles 1099 with energies of 10^{-2} – 10^4 MeV for photons and electrons and 10^{-9} – 10^4 MeV for neutrons. The 1100 run time results were obtained by averaging values from multiple measurements to achieve 1101 relative errors less than 5%.

1102 (102) For Geant4, the physics library of G4EmLivermorePhysics was used for the 1103 transportation of photons and electrons, and the physics models and cross-sections of 1104 *NeutronHPThermalScattering*, *NeutronHPElastic*, *ParticleHPInelastic*, *Neutron-HPCapture* 1105 and NeutronHPFission were used for the transportation of neutrons. A range cut-off of 1 µm 1106 was applied for the production of secondary particles. For PHITS, the EGS5 physics library 1107 was used for the transportation of photons and electrons and the JENDL-4.0 physics library 1108 and the event generator mode version 2 were used for the transportation of neutrons. For the 1109 MCNP6 code, the default physics libraries based on Lawrence Livermore National Laboratory 1110 evaluated data were used for the transportation of photons and electrons and the ENDF70 1111 physics library was used for the transportation of neutrons. For the energy cut-off values, 1112 considering the range cut-off value of 1 μ m used for Geant4 calculations, the equivalent energy 1113 cut-off values were applied in the PHITS and MCNP6 codes. Variance reduction techniques 1114 were not used.

1115 (103) Fig. 6.4 compares the run time measured for the 5-year-old male MRCP and P143 1116 phantom implemented in Geant4, PHITS and MCNP6. The results of Geant4 show that for 1117 photons, the run time of the MRCP is longer than that of the P143 phantom when the energy is 1118 lower than 1 MeV, by up to 7.0 times, and shorter when the energy is higher, by up to 4.3 times. 1119 For electrons, similar differences were found: the run time of the MRCP is longer when the 1120 energy is lower than 10 MeV, by up to 5.2 times, and shorter when the energy is higher, by up 1121 to 3.2 times. For neutrons, it can be seen that the run time of the MRCP phantom is similar in the energy range of 10^{-5} -1 MeV and longer than that of the P143 phantom in the other energy 1122 1123 ranges, by up to a factor of ~ 4 and ~ 2 at the lower and higher energies, respectively.

1124 (104) For PHITS, the run time of the MRCP is generally shorter than that of the P143 phantom for all three radiation types. Unlike Geant4, the run time of the MRCP is shorter at 1125 low energies; the maximum difference is ~4 times for both photons and electrons at 0.01 MeV 1126 and ~2 times for neutrons at 10^{-9} MeV. For photons and electrons with energies higher than 1 1127 MeV, on the other hand, the run time of the MRCP is similar to that of the P143 phantom. This 1128 1129 high computation speed of the MRCP at low energies is due to the fact that the computation 1130 speed of the TM geometry in PHITS is accelerated by using the octree decomposition technique 1131 (Furuta et al., 2017).



1132 (105) For MCNP6, the run time of the MRCP is significantly longer than that of the P143 1133 phantom for all three radiation types. The differences are 3–11 times except for high-energy (\geq 100 MeV) photons and electrons for which even larger differences (20-27) are found. Such 1134 1135 slow computation speeds for the MRCP are due mainly to the fact that MCNP6 uses features 1136 dedicated to unstructured mesh geometry; that is, MCNP6 is overly sophisticated for 1137 implementing simple TM geometry, although it can additionally implement pentahedral and 1138 hexahedral mesh geometry (Martz et al., 2017). Note that Geant4 and PHITS have features 1139 dedicated to TM geometry.

1140 (106) The run times of the MRCP were compared between Geant4, PHITS and MCNP6. 1141 Geant4 shows the shortest run time of the three codes for photons and electrons. For photons, 1142 PHITS and MCNP6 take 1.8–7.8 and 6.3–24.1 times longer than Geant4, respectively. For electrons, PHITS and MCNP6 take 1.4–7.0 and 6.3–26.0 times longer than Geant4. On the 1143 1144 other hand, for neutrons, except for the highest energy point, PHITS shows the shortest run 1145 time of the three codes; Geant4 and MCNP6 take 1.7–3.3 and 1.6–3.4 times longer run time 1146 than PHITS. At the highest energy point (i.e. 10^4 MeV), the run time of MCNP6 is shorter than 1147 that of Geant4 and PHITS by a factor of 3.0 and 2.4.

1148 (107) Table 6.4 compares the memory usage required for implementing the 5-year-old male 1149 MRCP and P143 phantom in Geant4, PHITS and MCNP6. It can be seen that PHITS requires 1150 relatively small memory for the implementation of the MRCP, which is because the memory space is dynamically allocated in PHITS (Han et al., 2018). In addition, while PHITS requires 1151 1152 smaller memory usage for the MRCP than for the P143 phantom, in the other codes, the 1153 memory usage for the MRCP is larger than that for the P143 phantom by a factor of 1154 approximately 12.1 for Geant4 and 2.4 for MCNP6. However, the memory usage for the MRCP 1155 for all three codes is much smaller than 16 GB, which is within the capacity of personal 1156 computers.

Table 6.4. Memory usage required to implement 5-year-old male MRCP and P143 phantom inGeant4, PHITS and MCNP6.

		Geant4	PHITS	MCNP6
	MRCP	8.5 GB	1.4 GB	4.5 GB
-	P143 phantom	0.7 GB	2.2 GB	1.9 GB





1161

Fig. 6.4. Run time measured for the 5-year-old male MRCP and P143 phantom, implemented in Geant4, PHITS and MCNP6, for transporting 105 source particles in the left-lateral (LLAT)

1164 irradiation geometry.



1166 1167

7. DOSIMETRIC IMPACT OF THE PAEDIATRIC MESH-TYPE REFERENCE COMPUTATIONAL PHANTOMS

(108) This chapter discusses the dosimetric impact of the paediatric mesh-type reference 1168 1169 computational phantoms (MRCPs) for external and internal exposure geometries, compared 1170 with the P143 phantoms (ICRP, 2020a) and the Publications 66 and 100 mathematical models for the respiratory and alimentary tracts (ICRP, 1994a, 2006) which have been used to estimate 1171 reference dose coefficients (DCs) under the current ICRP dosimetry system (ICRP, 2007). In 1172 1173 the present work, the Geant4 code (version 10.06.p02) (Allisons et al., 2016) was used for all 1174 the calculations, and the MCNP6 (version 2.0) (Martz et al., 2017) and PHITS (version 3.10) (Furuta et al., 2017) codes were used for some limited cases for spot checking purposes. 1175

1176 **7.1. External exposures**

1177 (109) Organ DCs were calculated for idealised external exposures, in terms of mean absorbed dose per fluence (pGy cm²), for six organs [i.e. RBM, colon, lungs, stomach, breasts 1178 and skin] and four radiation types (i.e. photons, neutrons, electrons and helium ions) and then 1179 1180 compared with values calculated using the P143 phantoms (see Annex H for calculation details). All the selected organs have the highest w_T (= 0.12) except skin; the skin, despite the 1181 small w_T (= 0.01), could significantly affect the effective dose calculation for external 1182 1183 exposures to weakly penetrating radiations of low energies (Yeom et al., 2016, 2017) and its 1184 DCs themselves are important in the current ICRP dosimetry system (ICRP, 2007).

1185 (110) The comparison of the values shows that for uncharged particles (i.e. photons and neutrons), the DCs calculated using the MRCPs tend to be close to the values obtained using 1186 the P143 phantoms and the differences are less than 10% for most cases. Exceptions are 1187 1188 observed for photons at low energies (<20 keV), for which relatively large differences are 1189 found. For the low-energy photons, the colon DCs tend to show the largest differences, which is as expected because the colon was significantly modified in the MRCPs. The RBM DCs of 1190 1191 the MRCPs tend to be smaller than those of the P143 phantoms, which is because in the 1192 MRCPs, in contrast to the P143 phantoms, the spongiosa region is fully covered by the cortical 1193 bone.

1194 (111) For charged particles (i.e. electrons and helium ions), the DCs calculated using the 1195 MRCPs are close to the values of the P143 phantoms for electrons ≥ 20 MeV (≥ 2 MeV for the 1196 skin) and helium ions ≥500 MeV/u (≥50 MeV/u for the skin). At lower energies, on the other 1197 hand, significant differences are observed for the breast, RBM and skin. The breast DCs of the 1198 10- and 15-year-old MRCPs, for example, are significantly smaller (i.e. up to four orders of 1199 magnitude) than those of the P143 phantoms, which is due to the fact that the breasts are fully 1200 covered by skin in the MRCPs but not in the P143 phantoms. The RBM DCs of the MRCPs 1201 tend to be significantly smaller, which is because, as mentioned earlier, the spongiosa region 1202 is fully covered by the cortical bone in the MRCPs. The skin DCs of the MRCPs and the P143 phantoms are significantly different (i.e. up to five orders of magnitude), which is due to the 1203 1204 consideration of the micron-scale radiosensitive skin target layer in the MRCPs which was not 1205 possible for the P143 phantoms due to the resolution of the voxel geometry.

(112) The effective DCs were also calculated using the MRCPs, in terms of effective dose
per fluence (pSv cm²), and then compared with the values obtained using the P143 phantoms.
For uncharged particles, the DCs calculated using the MRCPs are very close to those obtained
using the P143 phantoms and the differences are less than 5% for most cases. Only for photons
at low energies (<50 keV), relatively large differences are found, but these are still less than



1211 45%. For charged particles, the differences of DCs between the MRCPs and P143 phantoms 1212 are very small for electrons >10 MeV and helium ions >200 MeV/u (i.e. mostly less than 5%). 1213 At lower energies, however, large differences are observed (i.e. up to four orders of magnitude), 1214 which is due mainly to the differences in the skin DCs resulting from the consideration of the 1215 radiosensitive skin target layer in the MRCPs. Note that the skin dose, despite the small w_T (= 1216 0.01), dominates contributions to effective dose for low-energy charged particles which do not 1217 reach the internal organs.

1218 (113) The DCs for the entire lens were calculated for photons using the paediatric MRCPs 1219 and the calculated values were compared with those obtained using the P143 phantoms (see 1220 Annex H for calculation details). For the AP geometry in which the lens dose is of primary 1221 concern, significant differences are observed by up to 2.5 times, except for the newborn, due to the different depth of the lens between the MRCPs and P143 phantoms. In other irradiation 1222 1223 geometries, except at very low energies (<20 keV), the lens DCs calculated using the MRCPs are close to those obtained using the P143 phantoms (i.e. differences <20%). For electrons, 1224 1225 considering that the P143 phantoms will not be used for the calculation of lens DCs for 1226 electrons, the lens DCs of the paediatric MRCPs were compared with those calculated with the 1227 adult MRCPs, which shows that the differences are generally less than 15%. Exceptions are 1228 observed for PA geometry where the head size has a large influence; large differences by up to 1229 a factor of ~3. The DCs for the radiosensitive region of the lens were also calculated and 1230 compared with those of the entire lens (Han et al., 2021). The results show that for photons, the DCs of the radiosensitive region of the lens are very close to those of the entire lens (i.e. 1231 1232 differences <10%) for the larger part of the energy range considered (0.02–1.5 MeV). For the electrons at low energies (<2 MeV), however, the DCs of the radiosensitive region of the lens 1233 1234 are found significantly larger than those of the entire lens (e.g. by up to ~5 times at 0.8 MeV). 1235 This is in agreement with the findings of Publication 116 (ICRP, 2010) using the detailed eye 1236 model of Behrens et al. (2009).

1237 (114) In the paediatric MRCPs, the sub-regions of the teeth (i.e. enamel, cementum, dentin 1238 and pulp) were explicitly modelled, in particular to support electron paramagnetic resonance (EPR) retrospective dosimetry. Shin et al. (2021) calculated DCs for the enamel of the teeth, 1239 1240 in terms of dose per air kerma, for the AP and RLAT geometries using the MRCPs and then 1241 compared the calculated values with DCs for the entire teeth obtained using the P143 phantoms. 1242 The results of the study show that the differences in DCs are very large; that is, the differences 1243 are a few tens of times for most phantoms at 10 and 20 keV for the AP and RLAT geometry, respectively. In the same study, the calculated values were also compared with those calculated 1244 by Ulanovsky et al. (2005) who used a modified Golem phantom (Zankl and Wittmann, 2001) 1245 1246 which is the predecessor of the P110 adult male phantom and by Ulanovsky and Wieser (2007) 1247 who used a modified 5-year-old mathematical phantom, the results of which generally 1248 confirmed that the paediatric MRCPs produce reasonable values for the enamel DCs.

1249 **7.2. Internal exposures**

(115) Specific absorbed fractions (SAFs) were calculated for photons and electrons and then
compared with values calculated using the P143 phantoms as well as *Publication 1XX* values
(ICRP, 2022) which were calculated using the P143 phantoms and the MCNPX code (version
2.7) (Pelowitz, 2008) (see Annex I for calculation details). Note that the SAFs obtained from
the P143 phantom for self-irradiation were scaled to account for blood content, as were the *Publication 133* and *1XX* values (ICRP, 2016, 2022). The calculated SAFs cover four source



organs (i.e. liver, lungs, cortical bone and thyroid) and four target organs selected for eachsource organ considering contributions to effective dose.

(116) For most cases, the SAFs calculated using the P143 phantoms in the present work are 1258 1259 in good agreement with the P1XX values; the differences are mostly less than 10%, which 1260 mainly result from the differences in physics models or cross-section data between the Geant4 code used in the present work and the MCNPX code used in Publication 1XX. For photons and 1261 1262 electrons at low energies (<20 keV), however, very large differences are found, which is due mainly to the fact that the P1XX values at these low energies were calculated by a special data-1263 smoothing algorithm involving extrapolation (Schwarz et al., 2021), not by direct Monte Carlo 1264 simulations. Therefore, the following paragraphs mainly compare the SAFs calculated using 1265 1266 the same Monte Carlo code (i.e. Geant4 code) to solely focus on the dosimetric impact of the anatomical and geometrical improvements in the paediatric MRCPs compared to the P143 1267 1268 phantoms.

(117) The comparison of the values for photons shows that for the liver, lungs and cortical
bone as source organ, the SAFs of the MRCPs and P143 phantoms are marginally different,
except at energies <50 keV for which the SAFs of the MRCPs tend to have higher values than
those of the P143 phantoms. This tendency is mainly attributable to the closer distance between
the source and target organs enlarged by the inclusion of blood content in the MRCPs.

1274 (118) The opposite tendency is also observed. For example, the (RBM \leftarrow liver) SAFs of the 1275 MRCPs are generally smaller than those of the P143 phantoms at the lowest energy considered (i.e. 10 keV), which is due to the fact that the spongiosa of the MRCPs, unlike that of the P143 1276 1277 phantoms, is fully covered by the cortical bone which effectively shields low-energy photons. For another example, the (muscle \leftarrow cortical bone) SAFs of the MRCPs are much smaller than 1278 1279 those of the P143 phantoms for all cases. This is explained because in the MRCPs, the muscle 1280 was modelled to have a realistic shape while in the P143 phantoms, the muscle was produced from the surface of the bones by a simple voxel growing algorithm (Stepusin, 2016); 1281 1282 consequently, the muscle of the P143 phantoms is closer to the bones, resulting in larger SAFs.

1283 (119) Photon SAFs obtained using the MRCPs and P143 phantoms show relatively large 1284 differences when the thyroid is the source organ, which is because in the MRCPs, the thyroid 1285 was relocated to its typical position in the neck. The (ET \leftarrow thyroid) SAFs of the MRCPs tend 1286 to be greater than those of the P143 phantoms; this is because in the MRCPs, the larynx, the 1287 location of which is very close to the thyroid, was modelled as a part of the ET region.

1288 (120) Electron SAFs calculated using the MRCPs are close to those obtained using the P143 phantoms for the self-irradiation cases (e.g. thyroid \leftarrow thyroid), while for the cross-fire-1289 irradiation cases, the differences are very large (i.e. up to more than four orders of magnitude) 1290 1291 in some cases. The pattern of differences is similar to that for low-energy photons for most 1292 cases, but the differences are much larger for most cases. For example, the (muscle \leftarrow cortical 1293 bone) SAFs of the newborn MRCPs are smaller than those of the P143 newborn phantoms by 1294 up to a factor of ~2 for photons but by up to a factor of ~80 for electrons. Nevertheless, the 1295 committed effective DCs are not expected to be much different, which is due to the fact that 1296 the self-irradiation SAFs, not cross-fire-irradiation SAFs, dominantly affect the calculation of 1297 committed effective DCs due to the limited range of electrons for most radionuclides.

1298 (121) Electron SAFs calculated using the MRCPs for the alimentary tract were compared 1299 with the P1XX values (ICRP, 2022) calculated using the *Publication 100* (ICRP, 2006) stylised 1300 models (Choi et al., 2022a). Although the absorbed fractions (AFs) are in good agreement for 1301 most cases, some differences in SAFs are observed due mainly to differences in target masses 1302 between the MRCPs and the stylised models. However, for some cases (i.e. oral mucosa \leftarrow 1303 food; oral mucosa \leftarrow teeth surface; small intestine \leftarrow contents; and large intestine \leftarrow contents), 1304 significant differences in AFs, as well as in SAFs, are observed, which are attributed to the



differences in the inter-organ distances and organ dimensions. For example, for the small
intestine as target region and its contents as source region, the AFs obtained using the MRCPs
are larger than the P1XX values, resulting in even larger SAFs with the smaller target mass.
These differences result because the lumen diameter of the MRCPs is smaller than that of the
stylised models, leading to less energy being absorbed in the contents (i.e. self-absorption) and
thus more energy being deposited in the target region.

(122) Electron SAFs calculated using the MRCPs for the respiratory tract were compared 1311 1312 with the P1XX values calculated with the Publication 66 (ICRP, 1994a) stylised models (Choi 1313 et al., 2022b). The SAFs of the MRCPs are generally larger than the P1XX values, due mainly to the smaller target masses of the MRCPs. For the bronchiole (bb) region, when compared to 1314 1315 the P1XX values, the SAFs of the MRCPs are increased by not only the smaller target masses but also the electron cross-fire from other branches. For the AI source region, rather complex 1316 1317 differences are observed due mainly to differences in geometries and densities between the 1318 MRCPs and the stylised models.



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1606ANNEX A. LIST OF ORGAN ID, MEDIUM AND MASS OF EACH ORGAN/TISSUE

1607 Table A.1. List of organ ID, medium and mass of organs/tissues for the TM-version of the newborn, 1-year-old, 5-year-old, 10-year-old and 15-1608 year-old male and female phantoms.

Mass (g)												
Organ	Organ/tissue	Medium	New	born	1 ye	ear	5 ye	ears	10 y	ears	15 y	ears
ID			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
100	Adrenal, left	1	3.601	3.601	2.256	2.256	2.974	2.975	4.180	4.180	6.215	5.236
200	Adrenal, right	1	3.601	3.601	2.256	2.256	2.974	2.975	4.180	4.180	6.215	5.236
300	$ET_1, 0 \sim 8 \mu m$	2	0.000741	0.000738	0.00124	0.00125	0.00268	0.00259	0.00260	0.00259	0.0106	0.00194
301	ET_1 , 8 ~ 40 μm	2	0.00304	0.00303	0.00504	0.00510	0.0109	0.0105	0.0105	0.0105	0.0425	0.00790
302	$ET_1, 40 \sim 50 \ \mu m$	2	0.000976	0.000972	0.00160	0.00163	0.00345	0.00333	0.00334	0.00332	0.0134	0.00251
303	ET ₁ , 50 μm ~ surface	2	0.0968	0.0954	0.218	0.212	0.316	0.330	0.667	0.664	4.145	0.729
400	ET_2 , -15 ~ 0 μm	73	0.0327	0.0330	0.0692	0.0693	0.127	0.129	0.138	0.136	0.200	0.148
401	ET_2 , $0 \sim 40 \ \mu m$	2	0.0938	0.0945	0.198	0.197	0.364	0.367	0.395	0.387	0.572	0.422
402	ET_2 , 40 ~ 50 μm	2	0.0237	0.0239	0.0498	0.0496	0.0917	0.0925	0.0995	0.0973	0.144	0.106
403	ET_2 , 50 ~ 55 μm	2	0.0119	0.0120	0.0249	0.0249	0.0460	0.0463	0.0498	0.0488	0.0720	0.0531
404	ET_2 , 55 ~ 65 μm	2	0.0238	0.0240	0.0500	0.0498	0.0921	0.0928	0.100	0.098	0.144	0.106
405	ET ₂ , 65 μ m ~ surface	2	2.144	1.685	6.934	6.031	16.626	19.227	19.647	22.187	30.927	24.777
500	Oral mucosa, tongue	3	0.00810	0.00811	0.0187	0.0186	0.0311	0.0313	0.0509	0.0502	0.0767	0.0719
501	Oral mucosa, mouth floor	3	0.00980	0.00980	0.0143	0.0143	0.0190	0.0187	0.0245	0.0244	0.0317	0.0292
600	Oral mucosa, lips and cheeks	3	0.00649	0.00641	0.00450	0.00425	0.0133	0.0144	0.0211	0.0212	0.0212	0.0178
700	Trachea	2	0.542	0.542	1.561	1.561	2.600	2.583	4.701	4.677	7.930	6.212
800	$BB_1^*, -11 \sim -6 \ \mu m$	73	0.00159	0.00159	0.00302	0.00302	0.00220	0.00220	0.00499	0.00499	0.00916	0.00858
801	$BB_1^*, -6 \sim 0 \ \mu m$	2	0.00204	0.00203	0.00387	0.00385	0.00282	0.00281	0.00639	0.00636	0.0117	0.0109
802	$BB_{1}, 0 \sim 10 \ \mu m$	2	0.00342	0.00341	0.00648	0.00645	0.00473	0.00471	0.0107	0.0106	0.0196	0.0183
803	BB_1^* , 10 ~ 35 µm	2	0.00863	0.00860	0.0163	0.0163	0.0120	0.0119	0.0268	0.0267	0.0492	0.0458
804	BB_1^* , 35 ~ 40 µm	2	0.00174	0.00173	0.00329	0.00327	0.00243	0.00242	0.00539	0.00537	0.00987	0.00920
805	$BB_1, 40 \sim 50 \ \mu m$	2	0.00349	0.00348	0.00660	0.00657	0.00489	0.00487	0.0108	0.0108	0.0198	0.0184
806	$BB_1^*, 50 \sim 60 \ \mu m$	2	0.00352	0.00350	0.00663	0.00660	0.00493	0.00490	0.0109	0.0108	0.0198	0.0185
807	$BB_1^*, 60 \sim 70 \ \mu m$	2	0.00353	0.00352	0.00667	0.00663	0.00497	0.00494	0.0109	0.0108	0.0199	0.0185
808	BB ₁ , 70 μ m ~ surface	2	0.352	0.350	1.920	1.911	3.383	3.367	2.823	2.809	7.237	6.639
900	Blood in large arteries, head	4	0.0766	0.0766	0.153	0.155	0.282	0.285	0.625	0.644	1.333	0.722
910	Blood in large veins, head	4	0.280	0.281	0.507	0.511	1.850	1.830	1.913	1.923	3.474	3.320
1000	Blood in large arteries, trunk	4	9.296	9.251	14.943	14.921	37.204	37.063	58.078	58.644	103.887	85.067
1010	Blood in large veins, trunk	4	23.049	22.888	39.286	39.435	103.180	103.365	134.162	137.193	242.655	1/1./13
11100	Blood in large arteries, arms	4	1.826	1.849	3.24/	3.282	/.361	/.321	12.278	11./28	29.990	25.736
1110	Blood in large veins, arms	4	7.149	7.272	14.267	14.534	46.392	46.454	90.648	88.267	142.125	96.255
1200	Blood in large arteries, legs	4	6.200	6.223	13.469	13.455	45.100	45.278	/8.914	/8.8/2	152.559	98.425
1210	Blood in large veins, legs	4	21./20	21.760	41.378	40.957	118.413	118.1/4	222.953	222.299	4/4.985	358.632
1300	Humeri, upper, cortical	5	1.924	1.924	12.6/1	12.6/1	28.834	28.834	88.307	88.307	153.118	124.843
1400	Humeri, upper, spongiosa	6	3.545	3.545	8./30	8.730	20.156	20.156	52.648	52.648	1/2.915	133.66/
1500	Humeri, upper, medullary cavity	1	0.322	0.322	0.803	0.803	3.705	3.705	9.795	9.795	19.51/	13.042
1700	Humeri, lower, cortical	3	1.850	1.850	9.035	9.035	22.274	22.274	0/.303	07.303	10/.033	133.909
1/00	numeri, iower, spongiosa	8	2.708	2.708	4.519	4.519	11.020	2 564	20.203	20.203	/0./68	33.192
1800	numeri, iower, meduliary cavity	9	0.322	0.322	0.809	0.809	5.504	3.304	9.700	9.700	10.330	12./33
1900	Kaun, corneal	5	1.213	1.214	5.010	5.015	14.849	14.849	44.00/	44.007	97.396	84.248
1910	Uinae, cortical	5	1.551	1.551	/.415	/.415	18.778	18.//8	50.0/1	56.6/2	124.440	105.367



2000	Radii, spongiosa	10	1.697	1.698	1.117	1.117	3.314	3.314	7.239	7.239	37.902	28.355
2010	Ulnae, spongiosa	11	2.159	2.159	1.812	1.812	5.492	5.492	12.632	12.632	54.219	41.425
2100	Radii, medullary cavity	12	0.122	0.122	0.359	0.359	2.301	2.301	6.288	6.288	6.590	5.643
2110	Ulnae, medullary cavity	13	0.143	0.143	0.589	0.589	2.626	2.626	6.912	6.912	8.386	6.994
2200	Wrists and hand bones, cortical	5	0.841	0.841	5.399	5.399	9.335	9.335	32.585	32.585	130.632	108.276
2300	Wrists and hand bones, spongiosa	14	3.175	3.175	14.073	14.073	16.482	16.482	37.057	37.057	59.944	48.594
2400	Clavicles, cortical	5	0.915	0.915	1.368	1.368	6.181	6.181	14.383	14.383	43.288	56.937
2500	Clavicles, spongiosa	15	1.673	1.673	1.963	1.964	7.957	7.957	17.017	17.017	21.095	26.604
2600	Cranium, cortical	5	21.449	21.460	91.486	91.486	229.093	229.118	328.089	328.082	544.127	450.603
2700	Cranium, spongiosa	16	78.766	78.789	289.874	289.963	520.373	520.560	497.534	497.175	493.256	391.553
2800	Femora, upper, cortical	5	3.755	3.755	14.111	14.111	49.468	49.468	164.695	164.714	314.770	236.151
2900	Femora, upper, spongiosa	17	5.772	5.772	8.867	8.863	26.096	26.096	75.472	75.472	251.197	186.875
3000	Femora, upper, medullary cavity	18	0.737	0.737	0.994	0.994	8.215	8.215	25.189	25.189	49.294	34.927
3100	Femora, lower, cortical	5	5.511	5.511	20.536	20.536	48.062	48.062	152.121	152.143	243.605	255.040
3200	Femora, lower, spongiosa	19	4,777	4.777	8.765	8,769	28.737	28,737	90.514	90.514	308.417	271.337
3300	Femora, lower, medullary cavity	20	1.174	1.174	1.568	1.568	5,794	5,794	16,906	16,906	36.212	38.343
3400	Tibiae. cortical	5	4.503	4,503	26.332	26.331	73.040	73.040	240.889	240.889	381.346	325.556
3410	Fibulae, cortical	5	1,158	1.158	3.024	3.024	10.254	10.254	32.677	32.677	72.322	54.325
3420	Patellae cortical	5	0.0374	0.0374	0.162	0.162	1 189	1 189	2 595	2 595	21 420	17 537
3500	Tibiae, spongiosa	21	6.624	6.624	7.275	7.275	23.028	23.028	62.567	62.567	264.537	227.056
3510	Fibulae spongiosa	22	1 394	1 394	0.565	0.565	2 789	2 789	7 385	7 385	31.687	24 536
3520	Patellae spongiosa	23	0.171	0.171	0.575	0.575	5 569	5 569	12,630	12,630	22 257	17 825
3600	Tibiae medullary cavity	24	0.673	0.673	2 203	2 203	8 261	8 261	26 272	26 272	59 424	48 773
3610	Fibulae medullary cavity	25	0.107	0.107	0 204	0 204	1 871	1 871	5 576	5 576	8 185	5 809
3700	Ankles and foot cortical	5	1 289	1 289	7 235	7 235	33 249	33 249	93 863	93 863	217 341	176 948
3800	Ankles and foot, spongiosa	26	4 926	4 926	20 331	20.331	70 793	70 793	159.839	159.839	387 180	306 517
3000	Mandible cortical	5	1 700	1 700	7 164	7 164	10 280	10.795	24 010	24 000	50 285	47 273
4000	Mandible, contrain Mandible, spongiosa	27	5 603	5 603	13 005	13 005	20 / 05	20 477	27.505	27.504	37 750	28 847
4100	Palvia contical	5	6 147	6 1 4 7	21 200	21 202	29. 4 95 58 226	58 226	128 022	128 022	188 605	215 125
4200	Pelvis, contical	28	8 680	8 680	21.200	34 305	00.470	99.470	285 808	285 808	512 408	553 247
4200	Pibe cortical	20	6 3 8 0	6 280	20.410	20.410	29.470	28 511	205.090	205.090	160 281	186.406
4300	Ribs, contical	20	21 262	21 262	20.410	20.410	70 112	70 112	128 704	128 704	109.201	208 052
4400	Seemulee conticel	29	21.302	21.302	0.647	0.647	20 202	20 202	50.267	50 267	190.249	172 602
4500	Scapulae, conteal	20	2.447	2.447	9.047	14 962	29.302	42 710	00.282	00.282	124.479	1/2.002
4000	Scapulae, spongiosa	5	4.43/	4.437	14.805	2 275	42./19	42./19	90.282	90.282	22 755	147.408
4700	Cervical spine, conteal	21	7 125	7 125	0.102	0.102	14.092	14.082	20.740	20.740	56 402	42.943
4800	There is a spine, sponglosa	51	/.155	7.133	9.105	9.105	14.065	14.065	50.749	50.749	30.493	08.327
4900	Thoracic spine, cortical	22	8.331	8.338	11.501	28,110	33.105	33.105	08.38/	08.387	90.801	84.062
5100	I noracic spine, sponglosa	52	10.497	10.499	28.110	28.110	/4.390	/4.390	211.317	211.317	204.347	230.510
5200	Lumbar spine, corucai	22	2.720	2.720	7.075	7.075	10./90	10.790	30.732	30.732	33.328	41.247
5200	Lumbar spine, spongiosa	33	/.849	1.094	21.948	21.930	58.995	38.995	101.040	101.040	255.555	270.609
5300	Sacrum, cortical	5	1.084	1.084	5.455	5.455	11.090	11.090	10.00/	10.007	09.081	80.545
5400	Sacrum, spongiosa	34	3.140	3.140	15.116	15.116	34.521	34.521	55.236	55.236	118.649	140.213
5500	Sternum, cortical	5	0.168	0.168	0.630	0.630	2.469	2.469	5.282	5.282	22.161	15.6/1
5600	Sternum, spongiosa	35	0.677	0.677	2.103	2.103	8.505	8.505	20.823	20.823	42.389	28.431
5700	Cartilage, head	36	53.068	52.989	5.027	5.027						
5800	Cartilage, trunk	36	48.202	48.202	36.850	36.850	55.137	55.137	129.154	129.154	152.190	162.007
5900	Cartilage, arms	36	11.539	11.539								
6000	Cartilage, legs	36	15.378	15.378								
6100	Brain	37	395.660	395.660	978.101	978.101	1374.203	1244.203	1467.081	1287.082	1496.739	1348.990
6200	Breast, left, adipose tissue	38	0.0870	0.0870	0.571	0.572	1.178	1.171	2.038	2.028	4.758	77.618
6300	Breast, left, glandular tissue	39	0.0580	0.0580	0.381	0.381	0.785	0.781	1.359	1.352	3.172	51.751
6400	Breast, right, adipose tissue	38	0.0870	0.0870	0.571	0.572	1.178	1.171	2.038	2.028	4.758	77.616
6500	Breast, right, glandular tissue	39	0.0580	0.0580	0.381	0.381	0.785	0.781	1.359	1.352	3.172	51.751



6600	Eye lens, sensitive, left	40	0.0162	0.0162	0.0169	0.0169	0.0202	0.0202	0.0184	0.0184	0.0203	0.0203
6601	Eye lens, insensitive, left	41	0.0673	0.0673	0.0978	0.0978	0.114	0.114	0.113	0.113	0.117	0.117
6700	Cornea, left	42	0.582	0.582	0.629	0.629	0.870	0.870	0.941	0.941	0.996	0.996
6701	Aqueous, left	43	0.174	0.174	0.275	0.275	0.294	0.294	0.327	0.327	0.344	0.344
6702	Vitreous, left	44	2.413	2.413	2.624	2.624	4.403	4.403	4.853	4.853	5.322	5.322
6800	Eye lens, sensitive, right	40	0.0162	0.0162	0.0169	0.0169	0.0202	0.0202	0.0184	0.0184	0.0203	0.0203
6801	Eye lens, insensitive, right	41	0.0673	0.0673	0.0978	0.0978	0.114	0.114	0.113	0.113	0.117	0.117
6900	Cornea, right	42	0.582	0.582	0.629	0.629	0.870	0.870	0.942	0.941	0.996	0.996
6901	Aqueous, right	43	0.174	0.174	0.275	0.275	0.294	0.294	0.327	0.327	0.344	0.344
6902	Vitreous, right	44	2.413	2.413	2.624	2.624	4.403	4.403	4.853	4.853	5.322	5.322
7000	Gall bladder wall	45	0.542	0.542	1.457	1.458	2.704	2.686	4.597	4.576	8.141	7.555
7100	Gall bladder contents	46	2.800	2.800	8.000	8.000	15.000	15.000	26.000	26.000	45.000	42,000
7200	Stomach wall, $0 \sim 60 \text{ µm}$	47	0.408	0.408	0.814	0.814	0.745	0.745	0.998	0.998	2.407	1.602
7201	Stomach wall $60 \sim 100 \mu m$	47	0 273	0.273	0 407	0 407	0.489	0.489	0.667	0.667	1 605	1 070
7202	Stomach wall, $100 \sim 300 \text{ µm}$	47	1 384	1 384	2.056	2.056	2 469	2 469	3 361	3 361	8.068	5 385
7203	Stomach wall $300 \ \mu m \sim surface$	47	6 663	6 665	19 881	19 881	57.962	57 962	100 420	100 408	143 657	136 315
7300	Stomach contents	49	40 000	40,000	67.000	67.000	83,000	83 000	117 000	117 000	200.000	200.000
7400	Small intestine wall $0 \sim 130 \text{ µm}$	48	3 220	3 218	4 934	4 934	6 595	6 595	8 740	8 698	12 504	12 460
7401	Small intestine wall, $130 \sim 150 \mu m$	48	0.503	0.503	0.770	0.770	1 031	1 031	1 365	1 365	1 948	1 941
7402	Small intestine wall, $150 \sim 200 \ \mu m$	48	1 267	1 267	1 939	1 939	2 597	2 597	3 435	3 435	4 897	4 880
7403	Small intestine wall $200 \ \mu m \sim surface$	48	33 226	33 215	92 166	92.256	266 743	266 743	454 794	454 418	673 314	616 548
7500	Small intestine contents $-400/-500^{\dagger} \sim 0 \text{ um}$	40	9 275	9 273	14 320	14 320	19 024	19 024	31 330	31 371	45 272	45 187
7501	Small intestine contents, entre -, 400/ 500 [†] um	49	16 725	46 727	78 680	78 680	07.076	07.076	131.670	131.670	234 720	23/ 813
7600	Ascending colon wall 0 - 280 um	48	1 140	1 1 40	1 572	1 572	1 007	1 907	2 588	2 588	3 6/1	254.015
7601	Ascending colon wall, 0% 200 µm	40	0.0822	0.0822	0.114	0.114	0.120	0.120	2.500	2.300	0.264	0.265
7602	Ascending colon wall, 200 um . surface	40	0.0832	2 705	0.114	0.114	26 671	26 673	50.002	50.876	76 262	68 667
7002	Ascending colon wait, 500 µm ~ surface	40	15 504	2.795	26.017	26.017	20.071	20.073	30.903	15 292	70.302	77.810
7800	Transverse color well right 0 280 um	49	15.594	13.394	20.017	20.017	1 5 8 0	1 590	43.265	43.265	2.662	2 672
7800	Transverse colon wall, right, $0 \sim 280 \ \mu m$	48	0.842	0.842	1.200	1.200	1.580	1.580	1.924	1.924	2.002	2.0/3
7801	Transverse colon wall, right, 280 ~ 300 µm	48	0.0018	2 080	0.0878	0.08/8	0.110	0.110	0.140	0.140	0.193	72 890
7002	Transverse colon wan, right, 500 µm ~ surface	40	5.969	5.969	11.155	11.150	31.214	31.220	31.087	24.717	/9.8//	/2.880
/900	Transverse colon contents, right	49	8.406	8.406	13.983	13.983	18.654	18.654	24./1/	24./1/	42.190	42.190
8000	Transverse colon wall, left, $0 \sim 280 \ \mu m$	48	0.651	0.651	1.029	1.029	1.101	1.101	1.486	1.486	2.191	2.14/
8001	Transverse colon wall, left, $280 \sim 300 \ \mu m$	48	0.0481	0.0481	0.0757	0.0757	0.0808	0.0808	0.109	0.109	0.160	0.157
8002	Transverse colon wall, left, 300 μ m ~ surface	48	3.802	3.802	10.300	10.300	27.086	27.083	45.608	45.608	74.084	67.632
8100	Transverse colon contents, left	49	5.418	5.418	8.933	8.933	10.920	10.920	15.054	15.054	27.012	27.012
8200	Descending colon wall, $0 \sim 280 \ \mu m$	48	0.780	0.780	1.232	1.232	1.504	1.504	2.013	2.013	2.693	2.687
8201	Descending colon wall, $280 \sim 300 \ \mu m$	48	0.0575	0.0575	0.0906	0.0906	0.110	0.110	0.148	0.148	0.197	0.196
8202	Descending colon wall, 300 µm ~ surface	48	3.572	3.572	10.753	10.753	31.744	31.746	58.010	58.063	83.743	75.444
8300	Descending colon contents	49	6.582	6.582	11.067	11.067	14.081	14.081	19.946	19.946	32.988	32.988
8400	Sigmoid colon wall, 0 ~ 280 µm	48	0.965	0.965	1.558	1.568	1.811	1.811	2.452	2.452	3.260	3.220
8401	Sigmoid colon wall, 280 ~ 300 µm	48	0.0710	0.0710	0.115	0.115	0.133	0.133	0.180	0.180	0.238	0.235
8402	Sigmoid colon wall, 300 µm ~ surface	48	2.223	2.223	7.999	7.987	22.780	22.776	42.083	42.101	61.660	55.580
8500	Sigmoid colon contents	49	8.521	8.521	13.983	13.983	17.992	17.992	24.519	24.519	41.771	41.771
8600	Rectum wall, 0 ~ 280 µm	48	0.418	0.418	0.657	0.657	0.717	0.717	1.033	1.033	1.492	1.440
8601	Rectum wall, 280 ~ 300 µm	48	0.0309	0.0309	0.0484	0.0484	0.0527	0.0527	0.0758	0.0758	0.109	0.105
8602	Rectum wall, 300 µm ~ surface	48	0.111	0.111	1.363	1.363	2.176	2.175	4.708	4.710	8.110	7.527
8603	Rectum contents	49	3.479	3.479	6.017	6.017	7.008	7.008	10.481	10.481	18.229	18.229
8700	Heart wall	50	23.157	23.157	55.043	55.043	97.696	97.617	161.495	161.495	269.653	251.488
8800	Blood in heart chamber	4	26.000	26.000	48.000	48.000	134.999	134.999	230.000	230.000	430.000	320.000
8900	Kidney, left, cortex	51	9.460	9.460	27.763	27.763	49.837	49.847	82.031	82.031	119.394	105.694
9000	Kidney, left, medulla	51	3.379	3.379	9.915	9.915	17.799	17.810	29.299	29.299	42.641	37.747
9100	Kidney, left, pelvis	51	0.676	0.676	1.983	1.983	3.560	3.561	5.859	5.859	8.528	7.550
9200	Kidney, right, cortex	51	9.460	9.460	27.763	27.763	49.852	49.848	82.031	82.031	119.394	105.694



9400 Klandy, right, pelvix 51 0.676 1.676 1.983 1.580 3.561 5.859 5.859 8.282 7.283 9700 Lang (A), Irft 53 25.689 25.680 66.837 66.837 66.843 139.441 139.441 122.216 222.16 222.18 339.31 331.31 31.31	9300	Kidney, right, medulla	51	3.379	3.379	9.915	9.915	17.784	17.810	29.299	29.299	42.641	37.747
9900 Liver 22 167.410 97.410 972.445 724.407 723.37 1099.764 1099.773 1707.819 177.876 309.571 309.776 1099.764 1099.778 177.876 510.848 394.941 330.576 9900 Lung (A). right 53 3.3.11 3.1.310 81.163	9400	Kidney, right, pelvis	51	0.676	0.676	1.983	1.983	3,560	3.561	5.859	5.859	8.528	7.550
9700 Lung (A), Inft 53 28.680 28.680 68.877 68.87 139.448 193.441 222.219 222.218 339.811 330.71 10000 Lymphatic nodes, IT 54 1.243 2.176 2.176 4.310 4.311 7.157 7.157 1.273 1.132 10201 Lymphatic nodes, IT 54 1.243 1.247 1.130 4.310 4.311 7.157 7.157 1.273 1.132 10201 Lymphatic nodes, Indic node	9500	Liver	52	167.410	167.410	390.445	390.445	724.407	723.337	1059.764	1059.773	1707.819	1628.966
9990Lmg (A), right5331,31131,31081,163160,652160,552277,781277,762510,489419,4231000Lymphatic nodes, Inducic541.2431.2432.1762.1764.3104.3117,1577,1571.27331.13221010Lymphatic nodes, Inducic541.2431.2432.1764.1404.3117,1577,1571.27331.13231010Lymphatic nodes, Inducic540.4590.4590.7520.7521.4801.4592.4774.4958.797706110500Lymphatic nodes, Iaps540.04580.04581.5031.5032.9783.9484.4458.797706110500Muscle, Indu55125.222111.243263.9041.5031.5032.2784.3454.91.9090.1080420.42810600Muscle, Indu55125.2221.01.01260.9452.02.1451.61.131.144543.26704.937155.36610600Muscle, Indu1.012.01.880.02.860.03.980.04860.04830.08580.01.80420.42810600Cosophage will, 109 - 200 µm470.01880.02.660.03.980.04860.04830.01880.02.660.03.880.04860.04.930.01880.01880.02.660.04.830.01880.01880.02.660.04.830.01880.01880.02.660.03.980.04.830.01880.018	9700	Lung (AI), left	53	28.689	28.690	68.837	68.832	139.438	139.441	222.219	222.238	389.511	330.576
1000 Lymphatic nodes, FT 54 1.243 2.176 2.176 4.310 4.311 7.157 7.157 12.733 11.522 1020 Lymphatic nodes, Incak 54 0.429 0.752 1.480 1.489 2.473 2.472 4.399 3.380 1030 Lymphatic nodes, Incak 54 0.0429 0.752 0.752 1.489 2.478 2.472 4.399 3.804 10400 Lymphatic nodes, Incak 54 0.058 0.889 1.503 2.578 2.978 4.945 4.945 8.77 7.901 10600 Mixele, Incak 55 40.447 400.177 9.38124 489.801 2.292.725 541.1443 501.020 7.972.55.56 10700 Musele, Incak 55 209.857 2.22.675 5.32.16 0.995 1.598 1.569 2.144.78 1010.207 7.234.8 7.248 2.26.14 1.503 0.0458 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 0.0483 <td< td=""><td>9900</td><td>Lung (AI), right</td><td>53</td><td>31.311</td><td>31.310</td><td>81.163</td><td>81.163</td><td>160.562</td><td>160.559</td><td>277.781</td><td>277.762</td><td>510.489</td><td>419.425</td></td<>	9900	Lung (AI), right	53	31.311	31.310	81.163	81.163	160.562	160.559	277.781	277.762	510.489	419.425
$ \begin{array}{c} 10100 \\ Umphatic nodes, homaic \\ Umphatic nodes, homaic \\ Umphatic nodes, homaic \\ Umphatic nodes, trank \\ Umphatic no$	10000	Lymphatic nodes, ET	54	1.243	1.243	2,176	2,176	4.310	4.311	7.157	7.157	12.733	11.522
12000 Lymphatic nodes, tnaal. 54 0.429 0.429 0.722 1.489 1.489 2.473 2.472 4.399 3080 10400 Lymphatic nodes, rans 54 0.0358 0.859 1.503 2.978 2.978 4.945 4.945 8.797 7.561 10500 Lymphatic nodes, rans 55 1252.22 111.243 263.504 249.21 44.945 8.797 7.561 10600 Muscle, tnak 55 404.474 40.177 9.81.24 44.848 402.31 459.190 49.454 8.797 7.561 10800 Muscle, trank 55 80.200 85.671 203.971 201.814 44.548.07 402.318 78.061 44.04.318 78.078 78.078 78.06 78.01 78.06 78.01 78.06 78.01 78.06 78.01 78.0	10100	Lymphatic nodes, thoracic	54	1.243	1.243	2.176	2.176	4.310	4.311	7.157	7.157	12.733	11.522
	10200	Lymphatic nodes head	54	0 429	0.429	0.752	0.752	1 489	1 489	2 473	2 472	4 399	3 980
	10300	Lymphatic nodes, neue	54	10 144	10 145	17 763	17 763	35 189	35 193	58 429	58 429	103 944	94.065
	10400	Lymphatic nodes, arms	54	0.858	0.859	1 503	1 503	2 978	2 978	4 945	4 945	8 797	7 961
	10500	Lymphatic nodes, leas	54	0.858	0.859	1.503	1.503	2.978	2.978	4 945	4 945	8 797	7.961
	10600	Muscle head	55	125 222	111 243	263 904	237 341	410 315	451 105	402 331	459 190	501.080	420 428
	10700	Muscle, trunk	55	404 474	400 177	938 124	845 801	2429.028	2352 725	5411 448	5432 564	11448 780	7993 776
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	10800	Muscle, arms	55	80 200	85 671	203 070	220.014	516 123	515.041	1174 835	1081 028	2704 037	1525 566
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	10000	Musele, lags	55	200.857	222.675	203.970	626.048	2272 207	2407 881	11/4.033	1081.028	2/04.93/	7420.028
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	11000	Oosonhagua wall 0. 100 um	47	0.344	0.344	0.545	020.048	0.019	0.805	1 508	1 560	2 160	1 784
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	11000	Occophagus wall, $0 \sim 190 \mu m$	47	0.344	0.344	0.345	0.307	0.916	0.893	1.390	0.0842	2.109	0.006
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	11001	Occophagus wall, 190 ~ 200 µm	47	0.0100	0.0188	5 214	5 102	0.0490	11 200	20,600	0.0643	26.640	24 107
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	11002	Oesophagus wan, 200 µm ~ surface	47	2.132	2.132	3.214	3.192	7 125	7 125	20.009	20.037	21.842	34.197
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	111003	Oesophagus contents	49	2.022	2.022	3./80	5./80	/.135	/.135	11.908	11.908	21.842	21.033
11200Ovary, right560.1680.4231.0381.581.593.1933.19311300Pancreas577.2487.24822.65124.6314.89241.88072.126136.661117.63111500Prostate580.0880.1560.1560.2600.2590.3660.3640.5290.51811600RST, head59169.932182.852546.567568.696469.432531.111476.102572.644426.945714.52211700RST, trunk59638.601626.472262.911273.3593373.6393432.3056672.482662.969826.8771079.5221778.73611800RST, legs5956.99953.600209.725225.132667.281608.369597.727678.0471079.5221778.73611900Salivary glands, left453.2543.25312.48512.49417.66617.57122.98122.86235.94733.64712200Skin, head, isensitive602.9772.9795.4915.4906.8336.80970.587.03862.3962.3312300Skin, trunk, isensitive602.5479118.49011.558173.732173.809274.960661.73312.54412.54512401Skin, arms, insensitive602.6579118.49017.57122.98122.86235.94733.64712200Skin, trunk, isensitive, 40/50 ¹ - 100 μ m	11200	Ovary, left	50		0.168		0.423		1.058		1.839		3.193
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	11200	Ovary, right	56	7.240	0.168	22 (51	0.423	41.000	1.058	72.10/	1.839	126 (61	3.193
1400Prutary gland450.1080.1080.1260.2000.2090.3660.3640.3290.0200.20911500Prostate580.8681.0401.2471.6724.54611700RST, trank59669.01626.4722629.91273.5593432.305667.2816629.6098266.87711800RST, arms5956.99953.600209.725225.132667.281608.369597.727678.0471079.5221778.73611900RST, legs5958.69993.600209.725225.132667.281608.369597.727678.0471079.5221778.73612000Salivary glands, left453.2543.25312.48512.49417.66617.57122.98122.86235.94733.64712100Salivary glands, right453.2543.25312.48512.49417.66617.57122.98122.86235.94733.64712200Skin, head, insensitive603.919238.82667.22867.95919.91880.6336.8097.0587.0386.2396.23712300Skin, trunk, issensitive, $40.50^{1} - 100 \ \mu m$ 602.6279118.490117.558173.372173.80927.644401.730318.65712401Skin, arms, sensitive, $40.50^{1} - 100 \ \mu m$ 602.0552.0774.3204.4278.3288.17112.67312.53417.19515.2051240	11300	Pancreas	57	/.248	/.248	22.651	22.651	41.892	41.880	/2.126	/2.126	136.661	11/.631
11500Prostate580.8681.0401.2471.6721.6724.23611600RST, Irank59638.601626.4722629.911273.559327.6393432.3056672.4826629.6908266.87710427.27811800RST, arms5956.99953.600209.722225.13667.281608.6959597.777678.0471079.5221778.73611900RST, legs59138.552138.785906.740766.6381839.9621806.9111822.6731870.0862565.0015471.85712000Salivary glands, left453.2543.25312.48512.49417.66617.57122.98122.86235.94733.64712000Skin, head, insensitive6039.1923.882667.22867.95679.91879.68480.63482.635146.485132.43912201Skin, head, sensitive, 40/50 ¹ ~ 100 μ m602.677118.490117.558173.372173.809276.681274.960661.735548.78012301Skin, arms, sensitive, 40/50 ¹ ~ 100 μ m602.0552.0774.3204.4278.3288.17112.67312.53411.71918.56912400Skin, arms, sensitive, 40/50 ¹ ~ 100 μ m602.0552.0774.3204.4278.3288.17112.67312.53417.19515.20512401Skin, arms, sensitive, 40/50 ¹ ~ 100 μ m603.2203.2697.9977.789<	11400	Pituitary gland	45	0.108	0.108	0.156	0.156	0.260	0.259	0.366	0.364	0.529	0.518
11000RS1, head59169.922182.852546.567508.696409.452531.111476.102572.644426.949826.877142.7311800RST, trunk59638.601 626.472 262.912 273.539 323.205 667.2482 6622.9690 8266.877 10427.278 11800RST, arms5953.600 209.725 225.132 667.281 608.369 597.727 678.047 1079.527 12000Salivary glands, left45 3.254 3.253 12.485 12.494 17.665 17.571 22.981 22.862 35.947 33.647 12100Salivary glands, right45 3.254 3.253 12.485 12.494 17.665 17.571 22.981 22.862 35.947 33.647 12200Skin, head, insensitive60 3.9192 38.826 67.228 67.956 79.918 79.684 80.634 82.635 146.485 132.439 12301Skin, trunk, sensitive, $40/50^2 \sim 100 \mu$ m60 2.977 2.979 5.491 5.300 6.333 6.809 7.058 7.038 62.39 62.55 12400Skin, arms, sensitive, $40/50^2 \sim 100 \mu$ m60 2.055 2.077 4.320 4.427 8.328 8.171 12.673 $18.774.960$ 661.753 548.780 12301Skin, trunk, sensitive, $40/50^2 \sim 100 \mu$ m60 2.055 2.077 4.320 4.427 8.228 8.171 12.634 <	11500	Prostate	58	0.868		1.040		1.247		1.672		4.546	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	11600	RST, head	59	169.932	182.852	546.567	568.696	469.432	531.111	476.102	572.644	426.945	741.522
11800RST, arms5956.99953.600209.725225.132667.281608.369597.727678.0471079.5221778.73612000Salivary glands, irght453.2543.25312.48512.49417.66617.57122.98122.86235.94733.64712100Salivary glands, right453.2543.25312.48512.49417.66517.57122.98122.86235.94733.64712200Skin, head, insensitive603.919238.82667.22867.95679.91879.68480.63482.635146.485132.43912201Skin, head, insensitive602.9772.9795.4915.4906.8336.8097.0587.03862.3962.55912301Skin, trunk, insensitive40.50 ¹ ~ 100 µm602.6279118.490117.558173.372173.809276.681274.906661.753548.78012401Skin, arms, sensitive, 40/50 ¹ ~ 100 µm602.625226.30251.83753.75795.9194.607145.191145.694401.730318.65512502Skin, legs, insensitive6041.71943.11896.05394.424199.966201.347287.831287.273807.546697.55712503Skin, legs, sensitive, 40/50 ¹ ~ 100 µm603.2203.2697.9077.78917.19617.22024.97552.0763.42.5133.01112600Spinal cord60<	11700	RST, trunk	59	638.601	626.472	2629.911	2733.559	32/3.639	3432.305	6672.482	6629.690	8266.877	10427.278
11900RST, legs59138,785906,740766,638R39,962R806,911R22,673R70,0862565,0015471,85712000Salivary glands, right453.2543.25312.48512.49417.66517.57122.98122.86235.94733.64712100Salivary glands, right453.2543.25312.48512.49417.66517.57122.98122.86235.94733.64712201Skin, head, ensensitive6039.19238.82667.22867.95679.91879.68480.63482.635146.485132.43912300Skin, trunk, insensitive, $40/50^{1} \sim 100 \mu m$ 602.9772.9795.4915.49068.336.8097.0587.0386.23512300Skin, trunk, sensitive, $40/50^{1} \sim 100 \mu m$ 602.6522.630251.83753.75795.99194.607145.191145.694401.730318.65512401Skin, arms, sensitive, $40/50^{1} \sim 100 \mu m$ 602.0552.0774.3204.4278.3288.17112.67312.53417.19515.20512500Skin, legs, sensitive, $40/50^{1} \sim 100 \mu m$ 603.2203.2697.9077.78917.19617.22024.97525.07634.25133.01112600Spinal cord456.1076.06510.64110.66923.82523.12345.69545.33840.21754.21812700Spleen6113.865	11800	RST, arms	59	56.999	53.600	209.725	225.132	667.281	608.369	597.727	678.047	1079.522	1778.736
12000Salivary glands, left45 3.254 3.253 12.485 12.494 17.666 17.571 22.981 22.862 35.947 33.647 12100Skin rang, insensitive60 39.192 38.826 67.228 67.956 79.918 79.684 80.634 82.635 146.485 132.439 12200Skin, head, insensitive60 39.192 38.826 67.228 67.956 79.918 79.684 80.634 82.635 146.485 132.439 12300Skin, trunk, insensitive60 63.649 62.579 118.490 17.575 173.320 276.87 274.960 661.735 548.780 12401Skin, trunk, sensitive, $40/50^{2} \sim 100 \mu m$ 60 26.522 26.302 51.837 53.757 95.991 94.607 145.191 145.694 401.730 318.655 12401Skin, trunk, insensitive60 21.252 2.077 4.320 4.427 8.328 8.171 12.673 807.546 97.557 12501Skin, legs, sensitive, $40/50^{2} \sim 100 \mu m$ 60 3.220 3.269 7.907 7.789 17.196 17.220 247.953 28.723 807.546 697.557 12600Spinal cord45 61.07 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 54.218 12700Spleen61 13.865 13.865 13.352 37.352 71.306 71.262 <td>11900</td> <td>RST, legs</td> <td>59</td> <td>138.552</td> <td>138.785</td> <td>906.740</td> <td>766.638</td> <td>1839.962</td> <td>1806.911</td> <td>1822.673</td> <td>1870.086</td> <td>2565.001</td> <td>5471.857</td>	11900	RST, legs	59	138.552	138.785	906.740	766.638	1839.962	1806.911	1822.673	1870.086	2565.001	5471.857
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	12000	Salivary glands, left	45	3.254	3.253	12.485	12.494	17.666	17.571	22.981	22.862	35.947	33.647
12200Skin, head, insensitive6039.19238.826 67.228 67.956 79.918 79.684 80.634 82.635 146.485 132.439 12201Skin, head, sensitive, $40/50^{+} \sim 100 \mu\text{m}$ 60 2.977 2.979 5.491 5.490 6.833 6.809 7.058 7.038 6.239 6.255 12300Skin, trunk, insensitive60 63.649 62.579 118.490 117.558 173.372 173.809 27.681 27.4960 661.753 548.780 12301Skin, trunk, sensitive, $40/50^{+} \sim 100 \mu\text{m}$ 60 4.830 4.746 9.626 9.550 14.799 14.767 23.849 23.689 27.877 26.467 12400Skin, arms, sensitive, $40/50^{+} \sim 100 \mu\text{m}$ 60 2.055 2.077 4.320 4.427 8.328 8.171 12.673 12.534 17.195 15.205 12500Skin, legs, insensitive60 41.719 43.118 96.053 94.424 199.966 201.347 287.831 287.273 807.546 697.557 12501Skin, legs, sensitive, $40/50^{+} \sim 100 \mu\text{m}$ 60 3.220 3.269 7.907 7.789 17.196 17.220 24.975 25.076 34.251 33.011 12600Spinal cord45 61.07 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 45.218 12802Erupted, upper, front, buccal, permanent, enamel <td>12100</td> <td>Salivary glands, right</td> <td>45</td> <td>3.254</td> <td>3.253</td> <td>12.485</td> <td>12.494</td> <td>17.665</td> <td>17.571</td> <td>22.981</td> <td>22.862</td> <td>35.947</td> <td>33.647</td>	12100	Salivary glands, right	45	3.254	3.253	12.485	12.494	17.665	17.571	22.981	22.862	35.947	33.647
12201Skin, head, sensitive, $40/50^3 \sim 100 \mu m$ 60 2.977 2.979 5.491 5.490 6.833 6.809 7.058 7.038 6.239 6.252 12300Skin, trunk, insensitive60 63.649 62.579 118.490 117.558 173.372 173.809 276.681 274.960 661.753 548.780 12301Skin, trunk, sensitive60 4.830 4.746 9.626 9.550 14.799 14.767 23.849 23.689 27.877 26.467 12400Skin, arms, isensitive60 26.252 26.302 51.837 53.757 95.991 94.607 145.191 145.694 401.730 318.655 12401Skin, legs, insensitive $40/50^4 \sim 100 \mu m$ 60 2.055 2.077 4.320 44.27 8.328 8.171 12.633 17.195 15.205 12500Skin, legs, sensitive, $40/50^4 \sim 100 \mu m$ 60 3.220 3.269 7.907 7.789 17.196 17.220 24.975 25.076 34.251 33.011 12600Spinal cord45 6.107 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 54.218 12700Spleen61 13.865 13.865 37.352 37.352 71.306 71.262 114.975 18.77 198.771 12801Erupted, upper, front, lingual, permanent, enamel62 0.0799 0.0689 0.193 0.193 <	12200	Skin, head, insensitive	60	39.192	38.826	67.228	67.956	79.918	79.684	80.634	82.635	146.485	132.439
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	12201	Skin, head, sensitive, $40/50^{\text{``}} \sim 100 \ \text{\mu m}$	60	2.977	2.979	5.491	5.490	6.833	6.809	7.058	7.038	6.239	6.255
12301Skin, trunk, sensitive, $40/50^{\circ} \sim 100 \ \mu\text{m}$ 60 4.830 4.746 9.626 9.550 14.799 14.767 23.849 23.689 27.877 26.467 12400Skin, arms, insensitive 60 26.252 26.302 51.837 53.757 95.991 94.607 145.191 145.694 401.730 318.655 12401Skin, arms, sensitive, $40/50^{\circ} \sim 100 \ \mu\text{m}$ 60 2.055 2.077 4.320 4.427 8.328 8.171 12.673 12.534 17.195 15.205 12500Skin, legs, sensitive, $40/50^{\circ} \sim 100 \ \mu\text{m}$ 60 3.220 3.269 7.907 7.789 17.196 17.220 24.975 25.076 34.251 33.011 12600Spinal cord45 6.107 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 54.218 12700Spleen61 13.865 13.865 37.352 37.352 71.306 71.262 114.975 198.771 179.324 12800Erupted, upper, front, buccal, permanent, enamel62 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12802Erupted, upper, front, lingual, permanent, enamel62 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12804Erupted, upper, front-left, buccal, permanent, enamel62 0.0706 0.0873 0.0903 0.224 0.201 12805Erupted, upper	12300	Skin, trunk, insensitive	60	63.649	62.579	118.490	117.558	173.372	173.809	276.681	274.960	661.753	548.780
12400Skin, arms, insensitive60 26.252 26.302 51.837 53.757 95.991 94.607 145.191 145.694 401.730 318.655 12401Skin, arms, sensitive, $40/50^{\ddagger} \sim 100 \ \mum$ 60 2.055 2.077 4.320 4.427 8.328 8.171 12.673 12.534 17.195 15.205 12500Skin, legs, issensitive60 41.719 43.118 96.053 94.424 199.966 201.347 287.831 287.273 807.546 697.557 12501Skin, legs, sensitive, $40/50^{\ddagger} \sim 100 \ \mum$ 60 3.220 3.269 7.907 7.789 17.196 17.220 24.975 25.076 34.251 33.011 12600Spinal cord45 6.107 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 54.218 12700Spleen61 13.865 13.865 37.352 37.352 71.306 71.262 114.975 114.975 198.771 179.324 12801Erupted, upper, front, buccal, permanent, enamel62 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12802Erupted, upper, front, lingual, deciduous, enamel62 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12804Erupted, upper, front-left, buccal, permanent, enamel62 0.0709 0.0689 0.193 0.193 0.0680 0.0617 0.118 0.0755 </td <td>12301</td> <td>Skin, trunk, sensitive, $40/50^{\ddagger} \sim 100 \ \mu m$</td> <td>60</td> <td>4.830</td> <td>4.746</td> <td>9.626</td> <td>9.550</td> <td>14.799</td> <td>14.767</td> <td>23.849</td> <td>23.689</td> <td>27.877</td> <td>26.467</td>	12301	Skin, trunk, sensitive, $40/50^{\ddagger} \sim 100 \ \mu m$	60	4.830	4.746	9.626	9.550	14.799	14.767	23.849	23.689	27.877	26.467
12401Skin, arms, sensitive, $40/50^{\ddagger} \sim 100 \mu\text{m}$ 602.0552.0774.3204.4278.3288.17112.67312.53417.19515.20512500Skin, legs, insensitive6041.71943.11896.05394.424199.966201.347287.831287.273807.546697.55712501Skin, legs, sensitive, $40/50^{\ddagger} \sim 100 \mu\text{m}$ 603.2203.2697.9077.78917.19617.22024.97525.07634.25133.01112600Spinal cord456.1076.06510.64110.66923.82523.12345.69545.33840.21754.21812700Spleen6113.86513.86537.35237.35271.30671.262114.975198.771179.32412801Erupted, upper, front, buccal, permanent, enamel62 0.0709 0.06890.1930.1930.06800.064912802Erupted, upper, front, lingual, deciduous, enamel63 0.0709 0.06890.1930.1930.06800.064912804Erupted, upper, front-left, buccal, permanent, enamel62 0.0756 0.08730.0903 0.117 0.1080.3170.21912805Erupted, upper, front-left, lingual, permanent, enamel62 0.0756 0.08590.2240.20112805Erupted, upper, front-left, lingual, permanent, enamel62 0.0755 0.1250.3170.20112806Erupted, upper, front-left, lingual, permanent, enamel <td>12400</td> <td>Skin, arms, insensitive</td> <td>60</td> <td>26.252</td> <td>26.302</td> <td>51.837</td> <td>53.757</td> <td>95.991</td> <td>94.607</td> <td>145.191</td> <td>145.694</td> <td>401.730</td> <td>318.655</td>	12400	Skin, arms, insensitive	60	26.252	26.302	51.837	53.757	95.991	94.607	145.191	145.694	401.730	318.655
12500Skin, legs, insensitive60 41.719 43.118 96.053 94.424 199.966 201.347 287.831 287.273 807.546 697.557 12501Skin, legs, sensitive, $40/50^{\ddagger} \sim 100 \mu m$ 60 3.220 3.269 7.907 7.789 17.196 17.220 24.975 25.076 34.251 33.011 12600Spinal cord61 13.865 13.865 10.641 10.669 23.825 23.123 45.695 45.338 40.2171 54.218 12700Spleen61 13.865 13.865 37.352 37.352 71.306 71.262 114.975 114.975 198.711 79.324 12800Erupted, upper, front, buccal, permanent, enamel62 0.354 0.356 0.823 0.560 12801Erupted, upper, front, buccal, deciduous, enamel63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12802Erupted, upper, front-left, buccal, permanent, enamel62 0.0598 0.0617 0.165 0.0873 0.9003 12804Erupted, upper, front-left, buccal, permanent, enamel62 0.0799 0.0689 0.193 0.193 0.0680 0.0649 12805Erupted, upper, front-left, buccal, permanent, enamel62 0.0755 0.125 0.317 0.219 12805Erupted, upper, front-left, lingual, permanent, enamel62 0.0755 0.125 0.317 0.201 12806Erupted, upper, front-left	12401	Skin, arms, sensitive, 40/50 [‡] ~ 100 μm	60	2.055	2.077	4.320	4.427	8.328	8.171	12.673	12.534	17.195	15.205
12501Skin, legs, sensitive, $40/50^{\ddagger} \sim 100 \ \mu m$ 60 3.220 3.269 7.907 7.789 17.196 17.220 24.975 25.076 34.251 33.011 12600Spinal cord45 6.107 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 54.218 12700Spleen61 13.865 13.865 13.865 37.352 37.352 71.306 71.262 114.975 119.975 198.771 79.324 12800Erupted, upper, front, buccal, permanent, enamel62 0.352 0.350 0.650 0.564 12801Erupted, upper, front, buccal, deciduous, enamel63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12802Erupted, upper, front-left, buccal, permanent, enamel62 0.0598 0.0617 0.165 0.0873 0.0903 12804Erupted, upper, front-left, buccal, permanent, enamel62 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12805Erupted, upper, front-left, buccal, permanent, enamel62 0.0598 0.0617 0.165 0.0873 0.9003 12804Erupted, upper, front-left, buccal, permanent, enamel62 0.0755 0.125 0.317 0.219 12805Erupted, upper, front-left, buccal, permanent, enamel62 0.0755 0.125 0.317 0.201 12805Erupted, upper, front-left, buccal, permanent, enamel62 0	12500	Skin, legs, insensitive	60	41.719	43.118	96.053	94.424	199.966	201.347	287.831	287.273	807.546	697.557
12600 Spinal cord 45 6.107 6.065 10.641 10.669 23.825 23.123 45.695 45.338 40.217 54.218 12700 Spleen 61 13.865 13.865 37.352 37.352 71.306 71.262 114.975 114.975 198.771 179.324 12800 Erupted, upper, front, buccal, permanent, enamel 62 0.352 0.350 0.650 0.564 12801 Erupted, upper, front, buccal, deciduous, enamel 62 0.0709 0.0689 0.193 0.193 0.0560 0.0649 12802 Erupted, upper, front, lingual, deciduous, enamel 63 0.0709 0.0689 0.193 0.193 0.0903 0.903 12804 Erupted, upper, front, lingual, deciduous, enamel 62 0.0598 0.0617 0.165 0.0873 0.0903 12804 Erupted, upper, front-left, buccal, permanent, enamel 62 0.0598 0.0617 0.165 0.0873 0.0903 12805 Erupted, upper, front-left, lingual, permanent, enamel 62 0.0598 0.0617 0.165 0.107 0.117 0.108	12501	Skin, legs, sensitive, $40/50^{\ddagger} \sim 100 \ \mu m$	60	3.220	3.269	7.907	7.789	17.196	17.220	24.975	25.076	34.251	33.011
12700 Spleen 61 13.865 13.865 37.352 37.352 71.306 71.262 114.975 114.975 198.771 179.324 12800 Erupted, upper, front, buccal, permanent, enamel 62 37.352 37.352 71.306 71.262 114.975 114.975 198.771 179.324 12801 Erupted, upper, front, lingual, permanent, enamel 62 0.354 0.356 0.823 0.560 12802 Erupted, upper, front, lingual, deciduous, enamel 63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12803 Erupted, upper, front, lingual, deciduous, enamel 63 0.0598 0.0617 0.165 0.165 0.0873 0.0903 12804 Erupted, upper, front-left, buccal, permanent, enamel 62 0.0598 0.0617 0.165 0.0873 0.0903 12805 Erupted, upper, front-left, lingual, permanent, enamel 62 0.017 0.105 0.165 0.0873 0.0903 12806 Erupted, upper, front-left, lingual, permanent, enamel 62 0.017 0.105 0.117 0.108 0.317 0.214	12600	Spinal cord	45	6.107	6.065	10.641	10.669	23.825	23.123	45.695	45.338	40.217	54.218
12800Erupted, upper, front, buccal, permanent, enamel62 0.352 0.350 0.650 0.564 12801Erupted, upper, front, lingual, permanent, enamel62 0.354 0.356 0.823 0.580 12802Erupted, upper, front, buccal, deciduous, enamel63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12803Erupted, upper, front-left, buccal, permanent, enamel63 0.0598 0.0617 0.165 0.0873 0.0903 12804Erupted, upper, front-left, buccal, permanent, enamel62 0.0709 0.0689 0.193 0.0766 0.0859 0.214 12805Erupted, upper, front-left, lingual, permanent, enamel62 0.0755 0.125 0.317 0.219 12806Erupted, upper, front-right, buccal, permanent, enamel62 0.0755 0.125 0.317 0.201 12807Erupted, upper, front-right, lingual, permanent, enamel62 0.303 0.224 0.201 12808Erupted, upper, front-right, lingual, permanent, enamel62 0.0755 0.125 0.317 0.201 12808Erupted, upper, front-right, lingual, permanent, enamel62 0.303 0.250 0.513 0.426 12808Erupted, upper, front-right, lingual, permanent, enamel62 0.118 0.0693 0.224 0.211 12808Erupted, upper, front-right, lingual, permanent, enamel62 0.303 0.250 0.513 0.426 12808Erupted, upper, f	12700	Spleen	61	13.865	13.865	37.352	37.352	71.306	71.262	114.975	114.975	198.771	179.324
12801Erupted, upper, front, lingual, permanent, enamel 62 0.354 0.356 0.823 0.580 12802Erupted, upper, front, buccal, deciduous, enamel 63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12803Erupted, upper, front-left, buccal, permanent, enamel 63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12804Erupted, upper, front-left, buccal, permanent, enamel 62 0.0598 0.0617 0.165 0.0873 0.0903 12805Erupted, upper, front-left, lingual, permanent, enamel 62 0.0766 0.0859 0.224 0.201 12806Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.219 12807Erupted, upper, front-right, lingual, permanent, enamel 62 0.0755 0.125 0.317 0.219 12808Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.201 12808Erupted, upper, front-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.274 12808Erupted, upper, front-right, buccal, permanent, enamel 62 0.303 0.250 0.513 0.274 12808Erupted, upper, front-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.274 12808Erupted, upper, front-right, buccal permanent 0.202 0.201 0.303 0.250 0.513	12800	Erupted, upper, front, buccal, permanent, enamel	62							0.352	0.350	0.650	0.564
12802 Erupted, upper, front, buccal, deciduous, enamel 63 0.0709 0.0689 0.193 0.193 0.0680 0.0649 12803 Erupted, upper, front, lingual, deciduous, enamel 63 0.0598 0.0617 0.165 0.165 0.0873 0.0903 12804 Erupted, upper, front-left, buccal, permanent, enamel 62 0.117 0.108 0.317 0.219 12805 Erupted, upper, front-left, lingual, permanent, enamel 62 0.0766 0.0859 0.224 0.201 12806 Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.219 12807 Erupted, upper, front-right, lingual, permanent, enamel 62 0.0755 0.125 0.317 0.219 12808 Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.201 12808 Erupted, upper, front-right, lingual, permanent, enamel 62 0.118 0.0693 0.224 0.219 12808 Erupted, upper, lfont-right, lingual, permanent, enamel 62 0.303 0.2550 0.513 0.496 12808	12801	Erupted, upper, front, lingual, permanent, enamel	62							0.354	0.356	0.823	0.580
12803 Erupted, upper, front, lingual, deciduous, enamel 63 0.0598 0.0617 0.165 0.0873 0.0903 12804 Erupted, upper, front-left, buccal, permanent, enamel 62 0.117 0.108 0.317 0.219 12805 Erupted, upper, front-left, lingual, permanent, enamel 62 0.0766 0.0859 0.224 0.201 12806 Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.201 12807 Erupted, upper, front-right, lingual, permanent, enamel 62 0.0755 0.252 0.317 0.201 12808 Erupted, upper, front-right, lingual, permanent, enamel 62 0.018 0.0693 0.224 0.201 12808 Erupted, upper, front-right, lingual, permanent, enamel 62 0.118 0.0693 0.224 0.219 12808 Erupted, upper, lfont-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.496 12808 Erupted, upper, lfont-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.496	12802	Erupted, upper, front, buccal, deciduous, enamel	63			0.0709	0.0689	0.193	0.193	0.0680	0.0649		
12804 Erupted, upper, front-left, buccal, permanent, enamel 62 0.117 0.108 0.317 0.219 12805 Erupted, upper, front-left, lingual, permanent, enamel 62 0.0766 0.0859 0.224 0.201 12806 Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.201 12807 Erupted, upper, front-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.201 12808 Erupted, upper, front-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.406	12803	Erupted, upper, front, lingual, deciduous, enamel	63			0.0598	0.0617	0.165	0.165	0.0873	0.0903		
12805 Erupted, upper, front-left, lingual, permanent, enamel 62 0.0766 0.0859 0.224 0.201 12806 Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.201 12807 Erupted, upper, front-right, lingual, permanent, enamel 62 0.118 0.0693 0.224 0.219 12808 Erupted, upper, front-right, lingual, permanent, enamel 62 0.303 0.250 0.513 0.496 12808 Erupted, upper, lift, buccal permanent, enamel 62 0.303 0.250 0.513 0.496	12804	Erupted, upper, front-left, buccal, permanent, enamel	62							0.117	0.108	0.317	0.219
12806 Erupted, upper, front-right, buccal, permanent, enamel 62 0.0755 0.125 0.317 0.201 12807 Erupted, upper, front-right, lingual, permanent, enamel 62 0.118 0.0693 0.224 0.219 12808 Erupted, upper, left, buccal permanent enamel 62 0.303 0.250 0.513 0.496	12805	Erupted, upper, front-left, lingual, permanent, enamel	62							0.0766	0.0859	0.224	0.201
12807Erupted, upper, front-right, lingual, permanent, enamel 62 0.118 0.0693 0.224 0.219 12808Frupted upper left buccal permanent enamel 62 0.303 0.250 0.513 0.426	12806	Erupted, upper, front-right, buccal, permanent, enamel	62							0.0755	0.125	0.317	0.201
12808 Erinted upper left buccal permanent enamel 62 0.303 0.250 0.513 0.426	12807	Erupted, upper, front-right, lingual, permanent, enamel	62							0.118	0.0693	0.224	0.219
	12808	Erupted, upper, left, buccal, permanent, enamel	62							0.303	0.250	0.513	0.426
12809 Frupted upper left lingual permanent enamel 62 0145 0.198 0.494 0.356	12809	Erupted, upper, left, lingual, permanent, enamel	62							0.145	0.198	0.494	0.356
12810 Erupted, upper, left, buccal, deciduous, enamel 63 0.149 0.149 0.0983 0.0804	12810	Erupted, upper, left, buccal, deciduous, enamel	63					0.149	0.149	0.0983	0.0804		
12811 Fruited upper left lingual deciduous enamel 63 0.159 0.159 0.0569 0.0749	12811	Erupted, upper, left, lingual, deciduous, enamel	63					0.159	0.159	0.0569	0.0749		
12812 Erupted, upper, right, buccal, permanent, enamel 62 0.216 0.218 0.477 0.381	12812	Erupted, upper, right, buccal, permanent, enamel	62							0.216	0.218	0.477	0.381



12813 12814	Erupted, upper, right, lingual, permanent, enamel Erupted, upper, right, buccal, deciduous, enamel	62 63					0.149	0.149	0.232 0.0760	0.229 0.0705	0.531	0.400
12815	Erupted upper right lingual deciduous enamel	63					0.158	0.158	0.0792	0.0848		
12816	Erupted lower front buccal permanent enamel	62							0.532	0.516	0.605	0 444
12817	Erupted lower front lingual permanent enamel	62							0.412	0.427	0 541	0 445
12818	Frupted lower front buccal deciduous enamel	63			0.0453	0.0506	0.135	0.135	02	01127	010 11	01110
12819	Frunted lower front lingual deciduous enamel	63			0.0425	0.0373	0.138	0.138				
12820	Frunted lower front-left buccal permanent enamel	62			0.0125	0.0575	0.150	0.150			0.239	0.181
12821	Frunted lower front-left lingual permanent enamel	62									0.239	0.182
12822	Frunted lower front-right buccal permanent enamel	62									0.220	0.200
12823	Frunted lower front-right lingual permanent enamel	62									0.211	0.163
12824	Erupted, lower, left, buccal, permanent, enamel	62							0.176	0.270	0.536	0.105
12825	Frunted lower left lingual permanent enamel	62							0.302	0.278	0.330	0.354
12826	Erupted, lower, left, huggal, deciduous, enamel	63					0.175	0.175	0.146	0.141	0.474	0.400
12820	Erupted, lower, left, buccal, deciduous, channel	63					0.175	0.175	0.140	0.141		
12828	Erupted, lower, right buccal permanent enamel	62					0.254	0.234	0.232	0.237	0 503	0 306
12820	Erupted, lower, right lingual permanent, enamel	62							0.232	0.237	0.393	0.390
12829	Erupted, lower, right, huggal, deciduous, enamel	63					0 107	0 107	0.240	0.121	0.437	0.404
12830	Erupted, lower, right, lingual, deciduous, enamel	63					0.197	0.197	0.140	0.126		
12831	Erupted, lower, fight, hingual, deciduous, enamer	64					0.215	0.215	2 387	2 3 8 5	1 944	3 8 3 5
12832	Erupted, upper, front, deciduous, dentin	65			0 200	0.300	0.821	0.820	0.350	0.350	4.944	5.855
12833	Erupted, upper, front-left permanent dentin	64			0.299	0.500	0.021	0.820	0.550	0.654	1 809	1 406
12034	Erupted, upper, front-fight permanent, dentin	64							0.653	0.653	1.816	1 410
12836	Frunted upper left permanent dentin	64							1 518	1 511	3 391	2 625
12837	Erupted, upper, left, deciduous, dentin	65					0.708	0.708	0.350	0.354	5.571	2.025
12838	Erupted, upper, right permanent dentin	64					0.708	0.708	1 513	1 512	3 302	2 636
12830	Erupted, upper, right, deciduous, dentin	65					0.708	0.708	0.355	0.352	5.592	2.050
12839	Erupted, upper, fight, accidatous, acitin	64					0.708	0.708	3 140	3 160	3 764	2 035
12841	Erupted, lower, front, deciduous, dentin	65			0 100	0.200	0.617	0.617	5.140	5.100	5.704	2.955
12842	Erupted, lower, front-left permanent dentin	64			0.199	0.200	0.017	0.017			1 559	1 213
12843	Frunted lower front-right permanent dentin	64									1.559	1 213
12844	Frunted lower left permanent dentin	64							1.628	1 627	3 465	2 690
12845	Erupted, lower, left, deciduous, dentin	65					0.948	0.948	0.591	0.590	5.405	2.070
12846	Frunted lower right permanent dentin	64					0.910	0.910	1.624	1.630	3 462	2 681
12847	Frunted lower right deciduous dentin	65					0.948	0.948	0.595	0.593	5.402	2.001
12848	Unerupted, nermanent, enamel	62			0.146	0.146	1.626	1.626	1 926	1.926	1 218	0.945
12840	Unerupted, deciduous, enamel	63	0.190	0.190	0.952	0.952	1.020	1.020	1.920	1.920	1.210	0.745
12850	Unerupted, accordious, channel	64	0.170	0.190	0.486	0.489	5 402	5 430	6 4 4 3	6.436	4 115	3 1 8 3
12851	Unerupted, deciduous, dentin	65	0.425	0.426	2 204	2 205	5.402	5.450	0.445	0.450	4.115	5.105
12852	Permanent cementum	64	0.425	0.420	0.0239	0.0203	0 284	0.256	0.786	0.779	1 450	1 138
12853	Deciduous cementum	65	0.0337	0.0323	0.125	0.122	0.204	0.242	0.125	0.128	1.450	1.150
12854	Permanent pulp	66	0.0557	0.0525	0.0146	0.0146	0.163	0.163	0.582	0.582	0.993	0 771
12855	Deciduous pulp	66	0.0607	0.0607	0 374	0 374	0.661	0.661	0.313	0.313	0.775	0.771
12856	Teeth retention region	67	0.0007	0.0007	0.00345	0.00345	0.0211	0.0212	0.0382	0.0386	0.0505	0.0412
12000	Testis left	56	0 443		0.773	0.00545	0.0211	0.0212	1 090	0.0500	8 518	0.0412
12000	Testis, right	56	0.443		0.773		0.907		1.090		8 518	
13100	Thymus	68	14 101	14 096	31 212	31 228	31 203	31.014	41 791	36 392	37.004	31.049
13200	Thymus	60	1 400	1 400	1 967	1 968	3 871	3 871	0.022	9.022	14.036	13 505
13200	Tongue upper (food)	3	3 054	3 053	5 973	5 973	9 1 4 8	9.116	12 989	12.950	19.029	18 085
13301	Tongue lower	3	0.736	0.736	4 422	4 422	10 582	10 502	20 408	20.286	40.045	36 742
13400	Tonsils	45	0.108	0.108	0.521	0.521	2 080	2.068	3 134	3 120	3 172	3 107
13500	Ureter left	45	0.418	0.418	1 145	1 145	2.184	2.172	3 658	3 641	6 344	6 210
13600	Ureter, right	45	0.418	0.418	1.145	1.145	2.184	2.172	3.658	3.641	6.344	6.210
	, 0								2.020			0.210



13700	Urinary bladder wall, insensitive	70	3.571	3.576	8.158	8.169	15.418	15.416	24.211	24.206	39.000	33.933
13701	Urinary bladder wall, sensitive, $\alpha^{\$} \sim \beta^{\parallel} \mu m$	70	0.510	0.505	0.948	0.947	0.882	0.884	1.288	1.294	1.871	1.656
13800	Urinary bladder contents	71	12.400	12.400	32.900	32.900	64.700	64.700	103.000	103.000	160.000	140.000
13900	Uterus	58		4.337		1.562		3.100		4.158		31.064
14000	Air inside body	72	0.00261	0.00192	0.00925	0.00736	0.0240	0.0229	0.0529	0.0513	0.384	0.127

ET, extrathoracic; AI, alveolar-interstitium; RST, residual soft tissue.

* Only the main bronchi (BB₁) was defined in the TM-version phantoms. The other generations of the bronchi (BB) and all generations of the bronchioles (bb) were modelled in constructive solid geometry format. [†] Newborn, 1 year, 5 years/10 years, 15 years.

[‡] Newborn, 1 year, 5 years, 10 years/15 years.

[§] Newborn: 54, 1 year: 71, 5 years: 86, 10 years: 99, 15 years male: 116, 15 years female: 111.

[¶]Newborn: 232, 1 year: 238, 5 years: 193, 10 years: 212, 15 years male: 238, 15 years female: 227.

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1616Table A.2. List of organ ID, medium and mass of organs/tissues for the PM-version of the newborn, 1-year-old, 5-year-old, 10-year-old and 15-1617year-old male and female phantoms.

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	0							Mass	(g)				
	Organ	Organ/tissue	Medium	New	born	1-year	r-old	5-year	-old	10-yea	r-old	15-yea	ur-old
	Ш			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
200Adrenal, right1 3.601 3.261 2.256 2.276 2.978 2.193 4.180 4.180 6.215 5.256 301ET, $40 \ \mu m$ 2 0.00073 0.0073 0.00160 0.0018 0.00250 0.00250 0.0053 0.00150 0.00160 0.00160 0.00160 0.00160 0.00160 0.00160 0.00130 0.00331 0.00331 0.00331 0.00150 0.00133 0.00170 0.00160 0.00160 0.00160 0.00130 0.00331 0.00331 0.00331 0.00130 0.0671 0.0141 0.00131 0.00131 0.00331 0.00531 0.00331 0.00131 0.00131 0.0131 0.0131 0.0164 4.144 0.0171 401ET, $50 \ \mu m$ 2 0.00231 0.0230 0.0498 0.0991 0.0321 0.0395 0.0371 0.0144 0.0171 402ET, $50 \ \mu m$ 2 0.0233 0.0230 0.0498 0.0981 0.0971 0.144 0.0171 403ET, $50 \ \mu m$ 2 0.0233 0.0230 0.0492 0.0981 0.0971 0.144 0.0171 403ET, $50 \ \mu m$ 2 0.0031 0.0498 0.0981 0.0981 0.0981 0.0187 0.0245 0.0172 0.0727 403Cal maces, nonga can can ducas 0.00980 0.00980 0.0143 0.0143 0.0133 0.0492 0.00921 0.00252 0.00172 0.00172 0.00172 <td>100</td> <td>Adrenal, left</td> <td>1</td> <td>3.601</td> <td>3.601</td> <td>2.256</td> <td>2.256</td> <td>2.974</td> <td>2.975</td> <td>4.180</td> <td>4.180</td> <td>6.215</td> <td>5.236</td>	100	Adrenal, left	1	3.601	3.601	2.256	2.256	2.974	2.975	4.180	4.180	6.215	5.236
	200	Adrenal, right	1	3.601	3.601	2.256	2.256	2.974	2.975	4.180	4.180	6.215	5.236
301 ET, 40 µm 2 0.00304 0.00332 0.00169 0.01049 0.0105 0.0145 0.0425 0.00751 303 ET, surface 2 0.000976 0.00160 0.00163 0.00334 0.00332 0.00334 0.00321 304 ET, 60 µm 73 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0137 0.0148 0.0193 0.0114 0.0119 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0111 0.0117	300	ET ₁ , 8 μm	2	0.000741	0.000738	0.00124	0.00125	0.00268	0.00259	0.00260	0.00259	0.0106	0.00194
302 ET, 50 µm 2 0.000972 0.00163 0.00333 0.00332 0.00332 0.0134 0.00321 400 ET, 9 µm 73 0.0327 0.0330 0.0692 0.0693 0.127 0.129 0.138 0.136 0.200 0.154 400 ET, 6 µm 2 0.0338 0.0942 0.0496 0.0496 0.0497 0.025 0.0995 0.0973 0.0144 0.0157 402 ET, 55 µm 2 0.019 0.0124 0.0494 0.0440 0.0463 0.0498 0.0197 0.0114 0.0137 404 ET, 55 µm 2 0.0124 0.0249 0.0490 0.0461 0.0491 0.0197 0.0141 0.0137 404 ET, sinfac 2 0.0144 1.0168 0.9171 0.0131 0.0131 0.0141 0.0111 0.0121 0.0214 0.0101 0.0131 0.0141 0.0214 0.0171 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172 0.0172	301	ET ₁ , 40 μm	2	0.00304	0.00303	0.00504	0.00510	0.01088	0.01049	0.0105	0.0105	0.0425	0.00790
303 ET, surface 2 0.0954 0.024 0.016 0.316 0.067 0.664 4.145 0.729 040 ET, opum 2 0.0337 0.0139 0.0493 0.0493 0.0493 0.0367 0.325 0.337 0.572 0.424 2 0.0237 0.0239 0.0498 0.0449 0.0460 0.0463 0.0498 0.0498 0.0460 0.0498 0.0498 0.0463 0.0498 0.0498 0.0461 0.0498 0.0498 0.0461 0.0498 0.0498 0.0461 0.0498 0.0498 0.0461 0.0498 0.0498 0.0461 0.0463 0.0498 0.0498 0.0461 0.0461 0.0461 0.0461 0.0461 0.0471 0.0245 0.0247 0.0317 0.0372 0.0373 0.0372 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245 0.0245	302	ET ₁ , 50 µm	2	0.000976	0.000972	0.00160	0.00163	0.00345	0.00333	0.00334	0.00332	0.0134	0.00251
	303	ET ₁ , surface	2	0.0968	0.0954	0.218	0.212	0.316	0.330	0.667	0.664	4.145	0.729
	400	ET ₂ , 0 μm	73	0.0327	0.0330	0.0692	0.0693	0.127	0.129	0.138	0.136	0.200	0.150
	401	ET ₂ , 40 μm	2	0.0938	0.0945	0.198	0.197	0.364	0.367	0.395	0.387	0.572	0.426
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	402	ET ₂ , 50 μm	2	0.0237	0.0239	0.0498	0.0496	0.0917	0.0925	0.0995	0.0973	0.144	0.107
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	403	ET ₂ , 55 μm	2	0.0119	0.0120	0.0249	0.0249	0.0460	0.0463	0.0498	0.0488	0.0720	0.0537
405 ETs, surface 2 2.1.44 1.6.85 6.934 6.031 1.6.626 19.227 19.647 22.187 30.927 24.770 500 Oral nuccosa, inpand checks 3 0.00980 0.00981 0.0143 0.0143 0.0190 0.0187 0.0245 0.0244 0.0317 0.0292 600 Oral nuccosa, inpand checks 3 0.00649 0.00641 0.0045 0.0012 0.0022 0.0020 0.00240 0.00242 0.0171 0.0116 0.0187 700 Trachea 2 0.542 0.561 1.561 2.600 2.583 4.701 4.677 7.930 6.212 801 Bh ⁺ , 0 µm 2 0.00244 0.00287 0.00282 0.00281 0.00639 0.00636 0.0160 0.0163 0.0123 0.00173 0.0029 0.00234 0.00242 0.00236 0.00267 0.00242 0.00268 0.00267 0.00248 0.00164 0.00667 0.00449 0.00178 0.00173 0.0027 0.00243 0.0018 0.0188 0.0184 0.0184 0.0184 0.0164	404	ET ₂ , 65 μm	2	0.0238	0.0240	0.0500	0.0498	0.0921	0.0928	0.100	0.0977	0.144	0.108
500 Oral mucosa, notumi floor 3 0.00810 0.00811 0.0187 0.0213 0.0590 0.0502 0.0772 0.0719 600 Oral mucosa, notumi floor 3 0.00980 0.0043 0.0143 0.0187 0.0245 0.0214 0.0212 0.00172 0.00178 0.00178 0.0023 0.00322 0.00230 0.00439 0.00646 0.0163 0.0163 0.0163 0.0163 0.0163 0.0163 0.0163 0.0163 0.0163 0.0163 0.0163 0.00431 0.00648 0.00641 0.00431 0.00431 0.00539 0.00537 0.00337 0.00337 0.00341 0.00648 0.00442 0.00430 0.00441 0.0108 0.0188 0.0188 0.0188 0.0188 0.0050 0.00431 0.00431 0.00431 0.00431 0.00431 0.00431 </td <td>405</td> <td>ET₂, surface</td> <td>2</td> <td>2.144</td> <td>1.685</td> <td>6.934</td> <td>6.031</td> <td>16.626</td> <td>19.227</td> <td>19.647</td> <td>22.187</td> <td>30.927</td> <td>24.770</td>	405	ET ₂ , surface	2	2.144	1.685	6.934	6.031	16.626	19.227	19.647	22.187	30.927	24.770
501 Oral mucosa, lips and checks 3 0.00980 0.00431 0.0143 0.0190 0.0187 0.0245 0.0244 0.0317 0.0212 0.0121 0.0212 0.0121 0.0212 0.0121 0.0212 0.0121 0.0212 0.0121 0.0212 0.0113 0.0144 0.0211 0.0211 0.0212 0.0121 0.0212 0.0121 0.0212 0.0121 0.0212 0.0121 0.0212 0.0123 0.00130 0.00320 0.00220 0.00499 0.00499 0.00490 0.00490 0.00490 0.00490 0.00490 0.00190 0.0183 801 BB1, 0 µm 2 0.00341 0.00340 0.00451 0.00451 0.00471 0.0017 0.0106 0.0196 0.0183 804 BB1, 50 µm 2 0.00351 0.00348 0.00661 0.00447 0.00481 0.00491 0.0018 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198 0.0198	500	Oral mucosa, tongue	3	0.00810	0.00811	0.0187	0.0186	0.0311	0.0313	0.0509	0.0502	0.0772	0.0719
600 Oral mucosa, lips and checks 3 0.00649 0.00445 0.00425 0.0133 0.0144 0.0211 0.0212 0.0212 0.0213 000 Trackea 2 0.542 0.542 1.561 1.561 2.600 2.583 4.701 4.677 7.930 6.212 800 BB1, 'o µm 2 0.0024 0.00385 0.00220 0.00221 0.00639 0.00636 0.00636 0.00636 0.00636 0.00163 0.00174 0.00174 0.00173 0.00221 0.00421 0.00379 0.00261 0.00369 0.00537 0.00492 0.0448 804 BB1, 'A µm 2 0.00517 0.00437 0.00471 0.0108 0.0198 0.0198 0.0198 0.0198 0.0188 0.0188 0.0188 0.01849 0.00447 0.0018 0.0198 0.0188 0.0188 0.0188 0.0198 0.0198 0.0198 0.0188 0.0188 0.0188 0.00447 0.00447 0.00440 0.0109 0.0108 0.0	501	Oral mucosa, mouth floor	3	0.00980	0.00980	0.0143	0.0143	0.0190	0.0187	0.0245	0.0244	0.0317	0.0292
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	600	Oral mucosa, lips and cheeks	3	0.00649	0.00641	0.00450	0.00425	0.0133	0.0144	0.0211	0.0212	0.0212	0.0178
800 BB ⁺ , -6 µm 73 0.00159 0.00302 0.00302 0.00220 0.00499 0.00499 0.00496 0.00498 801 BB ⁺ , 10 µm 2 0.00240 0.000341 0.00645 0.00473 0.00471 0.0106 0.0163 0.0183 803 BB ⁺ , 10 µm 2 0.00340 0.00329 0.00327 0.00243 0.00242 0.00539 0.00537 0.00987 0.00987 804 BB ⁺ , 40 µm 2 0.00174 0.00173 0.00229 0.00237 0.00449 0.00487 0.0108 0.0198 0.0198 0.0183 806 BB ⁺ , 50 µm 2 0.00352 0.00352 0.00667 0.00489 0.00497 0.0108 0.0198 0.0188 807 BB ⁺ , 70 µm 2 0.00352 0.00667 0.00463 0.00497 0.0108 0.0198 0.0183 808 BB ⁺ , surface 2 0.352 0.350 1.920 1.911 3.383 3.367 2.823 2.899 7.37 6.639 900 Blood in large verins 4 5.1.24	700	Trachea	2	0.542	0.542	1.561	1.561	2.600	2.583	4.701	4.677	7.930	6.212
801 BB; 0 µm 2 0.00204 0.00235 0.00385 0.00282 0.00281 0.00636 0.0163 0.0163 802 BB; 1, 10 µm 2 0.00384 0.00648 0.00645 0.00171 0.0107 0.00636 0.0163 0.0163 0.0120 0.0119 0.0268 0.0267 0.00987 0.00987 0.00920 805 BB; 50 µm 2 0.00350 0.00350 0.00327 0.00243 0.00247 0.0018 0.0108 0.0198 0.0184 806 BB; 50 µm 2 0.00350 0.00350 0.00663 0.00667 0.00487 0.0108 0.0198 0.0184 807 BB; 70 µm 2 0.00352 0.00667 0.00663 0.00497 0.00494 0.0199 0.0188 0.0188 808 BB; straftee 2 0.0352 0.00350 0.0351 1.920 1.911 3.383 3.367 2.823 2.809 7.237 6.639 910 Blood in large veins 4 5.1.97 52.00 9.437 9.54.38 269.837 269.829 449.4	800	BB ₁ [*] , -6 μm	73	0.00159	0.00159	0.00302	0.00302	0.00220	0.00220	0.00499	0.00499	0.00916	0.00858
802 BB ⁺ , 10 µm 2 0.00342 0.00448 0.00645 0.00471 0.017 0.016 0.0168 0.0185 803 BB ⁺ , 40 µm 2 0.00174 0.00132 0.00232 0.00134 0.000487 0.0113 0.00242 0.0037 0.00987 0.00987 0.00987 0.00987 0.00987 0.0018 0.0108 0.0198 0.0184 806 BB ⁺ , 60 µm 2 0.00350 0.00363 0.00660 0.00667 0.00493 0.0109 0.0108 0.0198 0.0184 806 BB ⁺ , surface 2 0.0352 0.00667 0.00663 0.00497 0.00494 0.0109 0.0108 0.0198 0.0188 807 BB ⁺ , surface 2 0.352 0.350 1.920 1.911 3.333 3.367 2.829 2.809 7.237 6.639 900 Blod in large arteries 4 71.398 17.400 31.812 31.812 89.946 149.648 449.633 86.307 62.99.36 1300 Humeri, upper, cortical 5 1.924 1.2671 12.	801	BB ₁ , 0 μm	2	0.00204	0.00203	0.00387	0.00385	0.00282	0.00281	0.00639	0.00636	0.0117	0.0109
803 BB ⁺ , 35 µm 2 0.00860 0.0163 0.0163 0.0120 0.0119 0.0268 0.0267 0.00492 0.00458 804 BB ⁺ , 50 µm 2 0.00350 0.00329 0.00243 0.00424 0.0018 0.0199 0.0108 0.0199 0.0198 0.0198 0.0199 0.0198 0.0198 0.0184 0.0199 0.0198 0.0198 0.0198 0.0198 0.0198 0.0184 0.0199 0.0198 0.0199 0.0198 0.0199 0.0198 0.0199 0.0198 0.0184 0.0199 0.0198 0.0193 0.00497 0.00437 0.0493 0.00497 0.00433 0.0493 0.0493 <td>802</td> <td>BB₁[*], 10 μm</td> <td>2</td> <td>0.00342</td> <td>0.00341</td> <td>0.00648</td> <td>0.00645</td> <td>0.00473</td> <td>0.00471</td> <td>0.0107</td> <td>0.0106</td> <td>0.0196</td> <td>0.0183</td>	802	BB ₁ [*] , 10 μm	2	0.00342	0.00341	0.00648	0.00645	0.00473	0.00471	0.0107	0.0106	0.0196	0.0183
804 BB ⁺ , 40 µm 2 0.00173 0.00232 0.00243 0.00242 0.00539 0.00957 0.00987 0.00867 0.00667 0.00663 0.00497 0.00494 0.0109 0.0108 0.0198 0.0188 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0198 0.0184 0.0198 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184 0.0184	803	BB_1^* , 35 µm	2	0.00863	0.00860	0.0163	0.0163	0.0120	0.0119	0.0268	0.0267	0.0492	0.0458
805 BB ⁺ , 50 µm 2 0.00350 0.00489 0.00487 0.0108 0.0108 0.0198 0.0185 806 BB ⁺ , 70 µm 2 0.00350 0.00663 0.00497 0.00494 0.0109 0.0108 0.0198 0.0185 807 BB ⁺ , 70 µm 2 0.0352 0.00350 0.00663 0.00497 0.00494 0.0109 0.0108 0.0198 0.0185 808 BB ⁺ , surface 2 0.0352 0.0350 1.920 1.911 3.383 3.367 2.823 2.809 7.237 6.639 900 Blood in large arteries 4 51.797 52.200 95.437 95.438 269.827 249.648 449.633 863.307 629.936 100 Humeri, upper, cortical 5 1.924 1.924 1.2671 2.883 2.88.307 88.307 153.118 12.4843 1400 Humeri, upper, medullary cavity 7 0.322 0.322 0.863 3.765 3.765 9.795 19.317 15.042 1500 Humeri, upper, medullary cavity 7 0.322	804	BB ₁ [*] , 40 μm	2	0.00174	0.00173	0.00329	0.00327	0.00243	0.00242	0.00539	0.00537	0.00987	0.00920
806 BB; 60 µm 2 0.00352 0.00350 0.00663 0.00497 0.00490 0.0109 0.0108 0.0198 0.0185 807 BB; 70 µm 2 0.0352 0.0352 0.00663 0.00497 0.00494 0.0108 0.0199 0.01185 808 BB; 7, 70 µm 2 0.352 0.350 1.920 1.911 3.383 3.367 2.823 2.809 7.237 6.639 910 Blood in large veins 4 7.398 17.400 31.812 31.812 89.946 149.891 149.633 863.307 629.936 1300 Humeri, upper, cortical 5 1.924 1.924 12.671 28.834 28.834 88.307 88.307 153.118 124.843 1400 Humeri, upper, spongiosa 6 3.545 3.700 8.730 20.156 20.448 52.648 12.915 133.607 1500 Humeri, upper, medullary cavity 7 0.322 0.803 9.035 22.274 22.74 67.363 67.655 15.192 1600 Humeri, lower, spongiosa	805	BB_1 , 50 µm	2	0.00350	0.00348	0.00660	0.00657	0.00489	0.00487	0.0108	0.0108	0.0198	0.0184
807 Bb1, 7, 0 µm 2 0.00535 0.00522 0.00667 0.00697 0.00494 0.0108 0.0108 0.0199 0.0188 808 Bb1, surface 2 0.352 0.350 1.920 1.911 3.383 3.367 2.823 2.809 7.237 6.639 900 Blood in large arteries 4 17.398 17.400 31.812 31.812 89.946 89.946 149.891 149.895 287.770 209.978 910 Blood in large veins 4 52.197 52.200 95.437 95.438 269.837 269.829 449.648 449.633 863.307 629.936 1300 Humeri, upper, cortical 5 1.924 1.2671 12.671 28.834 88.34 88.37 863.307 153.118 124.843 1400 Humeri, upper, cortical 5 1.826 9.035 9.22.274 62.156 52.648 172.915 133.667 1500 Humeri, upper, medullary cavity 9 0.322 0.322 0.863 0.863 3.765 3.765 9.795 19.317 15.0	806	BB_1 , 60 μm	2	0.00352	0.00350	0.00663	0.00660	0.00493	0.00490	0.0109	0.0108	0.0198	0.0185
808Bbi, surface20.3520.3501.9201.9113.3833.3672.2832.8097.2576.639900Blood in large arteries47.39817.40031.81231.81289.94689.946149.891149.895287.770209.978910Blood in large veins452.19752.20095.43795.438269.837269.829449.648449.633863.307629.9361300Humeri, upper, spongiosa63.5453.5458.7308.73020.15652.64852.648172.915133.6671500Humeri, upper, medullary cavity70.3220.3220.8630.8633.7653.7659.7959.79519.31715.0421600Humeri, lower, cortical51.8501.8509.0359.03522.27422.27462.63362.66370.76855.1921800Humeri, lower, spongiosa82.7684.5194.51911.02611.02626.26326.26370.76855.1921800Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.5111.74157.41518.77818.77856.67156.67124.24944.00797.59684.2481910Ulnac, cortical51.511.5117.41518.77818.77856.67156.672124.44	807	BB_1 , 70 µm	2	0.00353	0.00352	0.00667	0.00663	0.00497	0.00494	0.0109	0.0108	0.0199	0.0185
900Blood in large arteries417.39817.40031.81231.81238.94689.946149.891149.895287.70209.976910Blood in large veins452.19752.20095.43795.438269.829449.648449.643863.307629.9361300Humeri, upper, cortical51.9241.267112.67128.83428.83428.83488.30788.307153.118124.8431400Humeri, upper, spongiosa63.5453.5458.7308.73020.15652.64852.648172.915133.6671500Humeri, upper, cortical51.8501.8509.0359.03522.27422.27467.36367.363167.65519.991600Humeri, lower, cortical51.8501.8509.0359.03522.27422.27467.36367.363167.6551.9291700Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55512.7531800Humeri, lower, cortical51.2131.2145.6165.1514.84914.84944.00797.76684.2481910Ulnae, cortical51.5511.5517.4157.41518.77818.77856.67156.672124.440105.3672000Radii, medullary cavity120.1220.1220.3590.3592.3012.3012.62254.219	808	BB ₁ , surface	2	0.352	0.350	1.920	1.911	3.383	3.367	2.823	2.809	7.237	6.639
910Blood in large veins452.19752.20095.43795.438209.827449.648449.643849.633865.307859.301829.9361300Humeri, upper, cortical51.9241.92412.67112.67128.83428.83488.30785.307153.118124.8431400Humeri, upper, spongiosa63.5453.5458.7308.73020.15652.64852.648172.915133.6671500Humeri, upper, medullary cavity70.3220.3220.8630.8633.7653.7659.7959.79519.31715.0421600Humeri, lower, cortical51.8501.8509.0359.03522.27422.27426.26326.26370.76851.1921700Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.2131.2145.6165.61514.84914.84944.00744.00797.59684.2481910Ulnae, cortical51.5511.5517.4157.41518.77818.77856.67156.672124.440105.3672000Radii, songiosa101.6971.6981.1171.1173.3143.7147.2397.23937.90228.3552110Ulnae, spongiosa112.1592.1591.8121.8125.4925.49212.632 <td>900</td> <td>Blood in large arteries</td> <td>4</td> <td>17.398</td> <td>17.400</td> <td>31.812</td> <td>31.812</td> <td>89.946</td> <td>89.946</td> <td>149.891</td> <td>149.895</td> <td>287.770</td> <td>209.978</td>	900	Blood in large arteries	4	17.398	17.400	31.812	31.812	89.946	89.946	149.891	149.895	287.770	209.978
1300Humeri, upper, cortical51.9241.92412.67112.67112.8.83428.83488.30788.307133.118124.8431400Humeri, upper, spongiosa63.5453.5458.7308.73020.15620.15652.64852.648172.915133.6671500Humeri, upper, medullary cavity70.3220.3220.8630.8633.7653.7659.7959.79519.31715.0421600Humeri, lower, cortical51.8501.8509.0359.03522.27422.27467.36367.363167.635133.9091700Humeri, lower, medullary cavity90.3220.8099.0359.03522.27422.27467.36367.661.67651.921800Humeri, lower, medullary cavity90.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.2131.2145.6165.61514.84914.84944.00744.00797.59684.2481910Ulnae, cortical51.5517.4157.41518.77818.77856.67156.672124.440105.3672010Ulnae, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnae, medullary cavity120.1220.1220.3590.3592.3012.3016.2886.288	910	Blood in large veins	4	52.197	52.200	95.437	95.438	269.837	269.829	449.648	449.633	863.307	629.936
Humeri, upper, spongiosa63.5453.5458.7308.73020.15620.15652.64852.648172.915133.6671500Humeri, upper, medullary cavity70.3220.3220.8630.8633.7653.7659.7959.7959.79519.31715.0421600Humeri, lower, cortical51.8501.8509.03520.27467.36367.36367.363167.65133.9091700Humeri, lower, spongiosa82.7682.7684.5194.51911.02611.02626.26326.26370.76855.1921800Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.2131.2145.6165.61514.84914.40744.00797.59448.2481910Ulnae, cortical51.5517.4157.41518.77856.67156.672124.440105.3672000Radii, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnae, spongiosa112.1592.1591.8121.8125.4925.49212.63212.63254.21941.4252100Radii, medullary cavity120.1220.3590.3592.3012.3016.2886.2886.5905.6432110Ulnae, medul	1300	Humeri, upper, cortical	5	1.924	1.924	12.6/1	12.6/1	28.834	28.834	88.307	88.307	153.118	124.843
Humeri, lover, medullary cavity70.3220.3220.8650.8653.7655.7659.7959.79519.31715.0421600Humeri, lower, cortical51.8501.8509.0359.03522.27422.7467.36367.363167.65555.1921700Humeri, lower, spongiosa82.7682.7684.5194.51911.02611.02626.26326.26370.76855.1921800Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.2131.2145.6165.61514.84914.84944.00744.00797.59684.2481910Ulnae, cortical51.5511.5517.4157.41518.77818.77856.67156.672124.440105.3672000Radii, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnae, spongiosa112.1592.1591.8121.8125.4925.49212.63212.63254.21941.4252100Radii, medullary cavity120.1220.1220.3590.3592.3012.3016.2886.2886.5905.6432110Ulnae, medullary cavity130.1430.1430.5895.3999.33532.58532.585130.63210.8276 </td <td>1400</td> <td>Humeri, upper, spongiosa</td> <td>6</td> <td>3.545</td> <td>3.545</td> <td>8.730</td> <td>8./30</td> <td>20.156</td> <td>20.156</td> <td>52.648</td> <td>52.648</td> <td>1/2.915</td> <td>133.66/</td>	1400	Humeri, upper, spongiosa	6	3.545	3.545	8.730	8./30	20.156	20.156	52.648	52.648	1/2.915	133.66/
1000Humeri, lower, cortical51.8501.8501.8509.0539.05322.2/422.2/467.36567.36561.655155.9051700Humeri, lower, spongiosa82.7682.7684.51911.02611.02626.26326.26370.76855.1921800Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.2131.2145.6165.61514.84914.84944.00744.00797.59684.2481910Ulnae, cortical51.5511.5517.4157.41518.77818.77856.67156.672124.440105.3672000Radii, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnae, spongiosa112.1592.1591.8121.8125.4925.49212.63212.63254.21941.4252100Radii, medullary cavity130.1430.1430.5890.5892.6262.6266.9126.9128.3866.9942200Wrists and hand bones, cortical50.8410.8415.3995.3999.3359.33532.58532.585130.632108.2762300Wrists and hand bones, spongiosa143.1753.17514.07314.07316.48237.05737.057 <td>1500</td> <td>Humeri, upper, medullary cavity</td> <td>/</td> <td>0.322</td> <td>0.322</td> <td>0.803</td> <td>0.803</td> <td>3.703</td> <td>3.705</td> <td>9.795</td> <td>9.795</td> <td>19.31/</td> <td>13.042</td>	1500	Humeri, upper, medullary cavity	/	0.322	0.322	0.803	0.803	3.703	3.705	9.795	9.795	19.31/	13.042
1000Humeri, lower, spongiosa62.7082.7084.3194.3191.02011.02012.02020.20320.20370.70835.1921800Humeri, lower, medullary cavity90.3220.3220.8090.8093.5643.5649.7669.76616.55612.7531900Radii, cortical51.2131.2145.6165.61514.84914.84944.00744.00797.59684.2481910Ulnae, cortical51.5511.5517.4157.41518.77818.77856.67156.672124.440105.3672000Radii, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnae, spongiosa112.1592.1591.8121.8125.4925.49212.63212.63254.21941.4252100Radii, medullary cavity130.1430.1430.5890.5892.6266.9126.9128.3866.5902200Wrists and hand bones, cortical50.8410.8415.3995.3999.3359.33532.58530.632108.2762300Wrists and hand bones, spongiosa143.1753.17514.07316.48216.48237.05737.05759.94448.5942400Clavicles, cortical50.9150.9151.3681.3686.1816.18114.38314.38343.28856.	1700	Humeri, lower, cortical	2	1.850	1.850	9.035	9.035	22.274	11.026	07.303	07.303	10/.033	55 102
1000Hullerl, lower, inclutinary cavity90.3220.3220.3090.3093.3643.3649.7669.7669.76610.35612.7331900Radii, cortical51.2131.2145.6165.61514.84914.00744.00797.59612.7351910Ulnac, cortical51.5511.5517.4157.41518.77818.77856.67156.672124.440105.3672000Radii, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnac, spongiosa112.1592.1591.8121.8125.4925.49212.63212.63254.21941.4252100Radii, medullary cavity120.1220.1220.3590.3592.3012.3016.2886.2886.5905.6432110Ulnae, medullary cavity130.1430.1430.5890.5892.6266.9126.9128.3866.9942200Wrists and hand bones, cortical50.8410.8415.3995.3999.33532.58532.585130.632108.2762300Wrists and hand bones, spongiosa143.1753.17514.07314.07316.48237.05737.05759.94448.5942400Clavicles, cortical50.9150.9151.3681.3686.1816.18114.38314.38343.28856.937 <tr< td=""><td>1200</td><td>Humeri, lower, sponglosa</td><td>0</td><td>2.708</td><td>2.708</td><td>4.519</td><td>4.319</td><td>2 564</td><td>2 564</td><td>20.203</td><td>20.205</td><td>16.556</td><td>12 752</td></tr<>	1200	Humeri, lower, sponglosa	0	2.708	2.708	4.519	4.319	2 564	2 564	20.203	20.205	16.556	12 752
1910Italia131.2131.2143.6103.61314.64914.64914.64714.60744.60744.60791.39664.2461910Ulnac, cortical51.5511.5517.4157.41518.77856.67156.67212.440105.3672000Radii, spongiosa101.6971.6981.1171.1173.3143.3147.2397.23937.90228.3552010Ulnae, spongiosa112.1592.1591.8121.8125.4925.49212.63212.63254.21941.4252100Radii, medullary cavity120.1220.1220.3590.3592.3012.3016.2886.2886.5905.6432110Ulnae, medullary cavity130.1430.1430.5890.5892.6262.6266.9126.9128.3866.9942200Wrists and hand bones, cortical50.8410.8415.3995.3999.3359.33532.58532.585130.63210.82762300Wrists and hand bones, spongiosa143.1753.17514.07314.07316.48216.48237.05737.05759.94448.5942400Clavicles, cortical50.9150.9151.3681.3686.1816.18114.38314.38343.28856.9372400Clavicles, cortical50.9150.9151.3681.3686.1816.18114.38314.383<	1000	Padii conticol	9	0.322	0.322	0.809	0.809	3.304	3.304	9.700	9.700	10.330	12.735
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	1900	Illnae cortical	5	1.213	1.214	7 415	7 415	14.049	18 778	44.007 56.671	56 672	124 440	105 367
2010Radii, spingiosa101.0971.0971.0971.1171.1175.3147.2597.25957.90228.3532010Ulnae, spongiosa112.1592.1591.8121.8125.49212.63212.63212.63254.21941.4252100Radii, medullary cavity120.1220.1220.3590.3592.3012.3016.2886.2886.5905.6432110Ulnae, medullary cavity130.1430.1430.5890.5892.6262.6266.9126.9128.3866.9942200Wrists and hand bones, cortical50.8410.8415.3995.3999.3359.33532.58532.585130.632108.2762300Wrists and hand bones, spongiosa143.1753.17514.07314.07316.48216.48237.05737.05759.94448.5942400Clavicles, cortical50.9150.9151.3681.3686.1816.18114.38314.38343.28856.937	2000	Padii mongiasa	10	1.551	1.551	7.415	1 117	2 214	2 214	7 220	7 220	27.002	28 255
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	2000	Lunae spongiosa	10	2 150	2 150	1.117	1.117	5.014	5.014	12 632	12 632	54 210	20.335
2100 Radii, includinary cavity 12 0.122 0.122 0.135 0.135 0.136 0.266 0.166 0.166 0.569 0.569 2110 Ulnae, medullary cavity 13 0.143 0.143 0.589 2.589 2.626 6.912 6.912 8.386 6.994 2200 Wrists and hand bones, cortical 5 0.841 0.841 5.399 5.399 9.335 9.335 32.585 32.585 130.632 108.276 2300 Wrists and hand bones, spongiosa 14 3.175 3.175 14.073 16.482 16.482 37.057 59.944 48.594 2400 Clavicles, cortical 5 0.915 0.915 1.368 1.368 6.181 6.181 14.383 14.383 43.288 56.937	2100	Padii medullary cavity	12	0.122	0.122	0.350	0.350	2 301	2 301	6 288	6 288	6 5 9 0	5 643
2100 Wrists and hand bones, cortical 5 0.145 0.145 0.305 2.000 0.305 0.312 0	2110	Illnae medullary cavity	12	0.122	0.122	0.539	0.539	2.501	2.501	6.912	6.912	8 386	6 994
2200 Wrists and hand bones, spongiosa 14 3.175 3.175 14.073 14.073 16.482 16.482 37.057 37.057 59.944 48.594 2400 Clavicles, cortical 5 0.915 0.368 1.368 6.181 6.181 14.383 14.383 43.288 56.957	2200	Wrists and hand hones, cortical	5	0.841	0.145	5 3 9 9	5 399	9 3 3 5	9 3 3 5	32 585	32 585	130.632	108 276
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2200	Wrists and hand bones, control	14	3 175	3 175	14 073	14 073	16 482	16.482	37.057	37.057	59 944	48 594
	2400	Clavicles cortical	5	0.915	0.915	1 368	1 368	6 181	6 181	14 383	14 383	43 288	56 937
2500 Clavicles spongiosa 15 1673 1673 1963 1964 7957 7957 17.017 17.017 21.095 26.604	2500	Clavicles, contour	15	1 673	1 673	1 963	1 964	7 957	7 957	17 017	17 017	21 095	26 604
2600 Cranium critical 5 21 449 21 460 91 486 91 486 229 093 229 118 328 089 328 082 544 127 450 594	2600	Cranium cortical	5	21 449	21 460	91 486	91 486	229 093	229 118	328 089	328 082	544 127	450 594
2700 Cranium songiosa 16 78.766 78.789 289.874 289.963 520.373 520.560 497.534 497.175 493.327 301.553	2700	Cranium, spongiosa	16	78.766	78,789	289.874	289.963	520.373	520.560	497.534	497.175	493.237	391.553
2800 Femora, upper, cortical 5 3.755 3.755 14.111 14.111 49.468 49.468 164.619 164.717 315.080 236.162	2800	Femora, upper, cortical	5	3.755	3.755	14.111	14.111	49.468	49.468	164.619	164.717	315.080	236.162



2900	Femora upper spongiosa	17	5 772	5 772	8 867	8 863	26.096	26.096	75 472	75 472	251 197	186 875
2000	Femore upper, sponglosa	19	0.727	0.727	0.007	0.005	20.090	20.090	25.180	25 180	40 204	24.027
2100	Femore lower conticel	10	5.511	5.511	20.526	20.536	48.062	48.062	152 142	152 142	49.294	255.040
2200	Femore lever energiese	10	3.311	4 777	20.330	20.330	48.002	48.002	00.514	00.514	243.003	233.040
2200	Femora, lower, spongiosa	19	4.///	4.///	0.703	0.709	28.757	20.757	90.314	90.314	26 212	2/1.33/
2400	remora, lower, medunary cavity	20	1.1/4	1.1/4	1.508	1.308	5./94	5./94	10.900	10.900	201.246	36.343
3400	libiae, cortical	2	4.503	4.503	26.332	26.331	/3.040	/3.040	240.889	240.889	381.346	325.554
3410	Fibulae, cortical	5	1.158	1.158	3.024	3.024	10.254	10.254	32.677	32.677	72.322	54.325
3420	Patellae, cortical	5	0.0374	0.0374	0.162	0.162	1.189	1.189	2.595	2.595	21.420	17.537
3500	Tibiae, spongiosa	21	6.624	6.624	7.275	7.275	23.028	23.028	62.567	62.567	264.537	227.056
3510	Fibulae, spongiosa	22	1.394	1.394	0.565	0.565	2.789	2.789	7.385	7.385	31.687	24.536
3520	Patellae, spongiosa	23	0.171	0.171	0.575	0.575	5.569	5.569	12.630	12.630	22.257	17.825
3600	Tibiae, medullary cavity	24	0.673	0.673	2.203	2.203	8.261	8.261	26.272	26.272	59.424	48.773
3610	Fibulae, medullary cavity	25	0.107	0.107	0.204	0.204	1.871	1.871	5.576	5.576	8.185	5.809
3700	Ankles and foot, cortical	5	1.289	1.289	7.235	7.235	33.249	33.249	93.863	93.863	217.341	176.948
3800	Ankles and foot, spongiosa	26	4.926	4.926	20.331	20.331	70.793	70.793	159.839	159.839	387.180	306.517
3900	Mandible, cortical	5	1.700	1.700	7.164	7.164	19.289	19.282	24.910	24,909	59.285	47.273
4000	Mandible, spongiosa	27	5.693	5,693	13.095	13.095	29.495	29.477	27.505	27,504	37.750	28.847
4100	Pelvis, cortical	5	6.147	6.147	21.202	21,202	58,226	58.226	128,933	128,933	188.606	215,135
4200	Pelvis spongiosa	28	8 689	8 689	34 395	34 395	99 470	99 470	285 898	285 898	512 498	553 247
4300	Ribs cortical	5	6 389	6 389	20 409	20.410	38 511	38 511	70 415	70 415	169 281	186 406
4400	Ribs, contear Bibs, spongiosa	20	21 362	21 362	58 121	58 121	70 112	70 112	138 704	138 704	109.201	208 053
4500	Scapulae cortical	5	21.302	21.302	9.647	9.647	20 302	20 302	50 267	50 267	124 470	172 602
4600	Seapulae, conteau	20	2.447	4.457	14.962	14.962	42,502	42 710	00.282	00.282	110 814	1/2.002
4000	Scapulae, sponglosa	50	4.437	4.437	14.805	14.805	42./19	42./19	90.282	90.282	22 755	147.408
4/00	Cervical spine, cortical	5	5.774	5.774	5.270	3.275	0.992	0.992	14.127	14.127	55./55	42.945
4800	Cervical spine, spongiosa	31	/.135	/.135	9.103	9.103	14.083	14.083	30.749	30.749	56.493	68.327
4900	Thoracic spine, cortical	5	8.531	8.538	11.501	11.501	33.105	33.105	68.387	68.387	90.861	84.062
5000	Thoracic spine, spongiosa	32	10.497	10.499	28.110	28.110	74.596	74.596	211.317	211.317	264.347	230.516
5100	Lumbar spine, cortical	5	2.728	2.728	7.073	7.073	16.796	16.796	36.752	36.752	35.528	41.247
5200	Lumbar spine, spongiosa	33	7.849	7.849	21.948	21.936	58.995	58.995	161.646	161.646	255.535	270.609
5300	Sacrum, cortical	5	1.084	1.084	5.453	5.453	11.696	11.696	16.667	16.667	69.681	86.543
5400	Sacrum, spongiosa	34	3.140	3.140	15.116	15.116	34.521	34.521	55.236	55.236	118.649	140.213
5500	Sternum, cortical	5	0.168	0.168	0.630	0.630	2.469	2.469	5.282	5.281	22.161	15.671
5600	Sternum, spongiosa	35	0.677	0.677	2.103	2.103	8.505	8.505	20.823	20.823	42.389	28.431
5700	Cartilage, head	36	53.069	52.989	5.027	5.027						
5800	Cartilage, trunk	36	48.202	48.202	36.850	36.850	55.137	55.137	129.154	129.154	152.190	162.007
5900	Cartilage, arms	36	11.539	11.539								
6000	Cartilage, legs	36	15.378	15.378								
6100	Brain	37	395 660	395 660	978 101	978 101	1374 203	1244 203	1467 081	1287 082	1496 739	1348 990
6200	Breast left adipose tissue	38	0.0870	0.0870	0 571	0.572	1 178	1 171	2.038	2.028	4 758	77.618
6300	Breast left glandular tissue	39	0.0580	0.0580	0 381	0.381	0.785	0.781	1 359	1 352	3 172	51 751
6400	Breast right adipose tissue	38	0.0500	0.0870	0.571	0.572	1 178	1 171	2 038	2 028	4 758	77.616
6500	Breast, right, alapdular tissue	30	0.0580	0.0580	0.381	0.381	0.785	0.781	1 3 5 0	1 352	3 172	51 751
6600	Eve long consistive left	40	0.0380	0.0380	0.0160	0.0160	0.785	0.0202	0.0184	0.0184	0.0203	0.0203
6601	Eye lens, sensitive, left	40	0.0102	0.0102	0.0109	0.0109	0.0202	0.0202	0.0104	0.0164	0.0203	0.0203
6700	Corres left	41	0.0075	0.0075	0.0978	0.0978	0.114	0.114	0.115	0.115	0.117	0.117
6700	Cornea, left	42	0.582	0.582	0.629	0.629	0.870	0.870	0.941	0.941	0.996	0.996
6/01	Aqueous, left	43	0.174	0.1/4	0.275	0.275	0.294	0.294	0.327	0.327	0.344	0.344
6702	vitreous, ien	44	2.413	2.415	2.624	2.624	4.403	4.403	4.853	4.853	5.322	5.322
6800	Eye lens, sensitive, right	40	0.0162	0.0162	0.0169	0.0169	0.0202	0.0202	0.0184	0.0184	0.0203	0.0203
6801	Eye lens, insensitive, right	41	0.0673	0.0673	0.0978	0.0978	0.114	0.114	0.113	0.113	0.117	0.117
6900	Cornea, right	42	0.582	0.582	0.629	0.629	0.870	0.870	0.942	0.941	0.996	0.996
6901	Aqueous, right	43	0.174	0.174	0.275	0.275	0.294	0.294	0.327	0.327	0.344	0.344
6902	Vitreous, right	44	2.413	2.413	2.624	2.624	4.403	4.403	4.853	4.853	5.322	5.322
7000	Gall bladder wall	45	0.542	0.542	1.457	1.458	2.704	2.686	4.597	4.576	8.141	7.555



7100	Gall bladder contents	46	2.800	2.800	8.000	8.000	15.000	15.000	26.000	26.000	45.000	42.000
7200	Stomach wall, 60 um	47	0.408	0.408	0.814	0.814	0.745	0.745	0.998	0.998	2.407	1.602
7201	Stomach wall, 100 µm	47	0.273	0.273	0.407	0.407	0.489	0.489	0.667	0.667	1.605	1.070
7202	Stomach wall, 300 µm	47	1.384	1.384	2.056	2.056	2.469	2.469	3.361	3.361	8.068	5.385
7203	Stomach wall, surface	47	6.663	6.665	19.881	19.881	57,962	57,962	100.420	100.408	143.657	136.315
7300	Stomach contents	49	40,000	40,000	67 000	67 000	83 000	83 000	117 000	117 000	200.000	200.000
7400	Small intestine wall 130 um	48	3 220	3 218	4 934	4 934	6 595	6 595	8 740	8 698	12 504	12 460
7401	Small intestine wall, 150 µm	48	0.503	0.503	0.770	0.770	1.031	1.031	1 365	1 365	1 948	1 941
7401	Small intestine wall, 200 µm	48	1 267	1 267	1 939	1 939	2 597	2 597	3 435	3 435	4 897	4 880
7402	Small intestine wall, surface	48	33 226	33 215	92 155	92 304	266 743	266 743	454 781	454 493	673 314	616 548
7500	Small intestine contents 0 um	40	0 275	0 273	14 320	14 320	10 024	10 024	31 330	31 370	45 272	45 187
7501	Small intestine contents, $0 \mu m$	40	46 725	16 727	79.690	78 680	07.024	07.024	121.670	121 670	234 720	224 812
7600	Ascending colon wall 280 um	49	1 140	1 140	1 572	1 572	1 907	1 907	2 588	2 5 8 8	3 6/1	3 658
7600	Assending colon wall, 280 µm	40	0.0822	0.0822	0.114	0.114	0.120	0.120	2.300	2.300	0.264	0.265
7601	Ascending colon wall, 500 µm	40	0.0832	0.0852	0.114	0.114	0.139	0.139	50.002	50.976	76.262	0.203
7002	Ascending colon wall, surface	40	2.795	2.793	9.304	9.570	20.0/1	20.075	30.903	30.870	70.302	08.007
7900	Ascending colon contents	49	15.594	15.594	20.017	20.017	51.540	51.540	45.285	45.285	//.810	//.810
7800	Transverse colon wall, right, 280 µm	48	0.842	0.842	1.200	1.200	1.580	1.580	1.924	1.924	2.002	2.0/3
7801	Transverse colon wall, right, 300 µm	48	0.0018	0.0618	0.0878	0.0878	0.110	0.110	0.140	0.140	0.193	0.194
/802	Transverse colon wall, right, surface	48	3.989	3.989	11.135	11.138	31.214	31.228	51.687	51.707	/9.8//	/2.880
/900	Transverse colon contents, right	49	8.406	8.406	13.983	13.983	18.654	18.654	24./1/	24./1/	42.190	42.190
8000	Transverse colon wall, left, 280 µm	48	0.651	0.651	1.029	1.029	1.101	1.101	1.486	1.486	2.191	2.147
8001	Transverse colon wall, left, 300 µm	48	0.0481	0.0481	0.0757	0.0757	0.0808	0.0808	0.109	0.109	0.160	0.157
8002	Transverse colon wall, left, surface	48	3.802	3.802	10.300	10.300	27.086	27.083	45.608	45.608	74.084	67.632
8100	Transverse colon contents, left	49	5.418	5.418	8.933	8.933	10.920	10.920	15.054	15.054	27.012	27.012
8200	Descending colon wall, 280 µm	48	0.780	0.780	1.232	1.232	1.504	1.504	2.013	2.013	2.693	2.687
8201	Descending colon wall, 300 µm	48	0.0575	0.0575	0.0906	0.0906	0.110	0.110	0.148	0.148	0.197	0.196
8202	Descending colon wall, surface	48	3.572	3.572	10.753	10.753	31.744	31.746	58.010	58.063	83.743	75.444
8300	Descending colon contents	49	6.582	6.582	11.067	11.067	14.081	14.081	19.946	19.946	32.988	32.988
8400	Sigmoid colon wall, 280 µm	48	0.965	0.965	1.558	1.568	1.811	1.811	2.452	2.452	3.260	3.220
8401	Sigmoid colon wall, 300 µm	48	0.0710	0.0710	0.115	0.115	0.133	0.133	0.180	0.180	0.238	0.235
8402	Sigmoid colon wall, surface	48	2.223	2.223	7.999	7.987	22.780	22.776	42.083	42.103	61.660	55.580
8500	Sigmoid colon contents	49	8.521	8.521	13.983	13.983	17.992	17.992	24.519	24.519	41.771	41.771
8600	Rectum wall, 280 µm	48	0.418	0.418	0.657	0.657	0.717	0.717	1.033	1.033	1.492	1.440
8601	Rectum wall, 300 µm	48	0.0309	0.0309	0.0484	0.0484	0.0527	0.0527	0.0758	0.0758	0.109	0.105
8602	Rectum wall, surface	48	0.111	0.111	1.363	1.363	2.176	2.175	4.708	4.710	8.110	7.527
8603	Rectum contents	49	3.479	3.479	6.017	6.017	7.008	7.008	10.481	10.481	18.229	18.229
8700	Heart wall	50	23.157	23.157	55.043	55.043	97.696	97.617	161.495	161.495	269.653	251.488
8800	Blood in heart chamber	4	26.000	26.000	48.000	48.000	134.999	134.999	230.000	230.000	430.000	320.000
8900	Kidney, left, cortex	51	9.460	9.460	27.763	27.763	49.837	49.847	82.031	82.031	119.394	105.694
9000	Kidney, left, medulla	51	3.379	3.379	9.915	9.915	17.799	17.810	29.299	29.299	42.641	37.747
9100	Kidney, left, pelvis	51	0.676	0.676	1.983	1.983	3.560	3.561	5.859	5.859	8.528	7.550
9200	Kidney, right, cortex	51	9.460	9.460	27.763	27.763	49.852	49.848	82.031	82.031	119.394	105.694
9300	Kidney, right, medulla	51	3.379	3.379	9.915	9.915	17.784	17.810	29.299	29.299	42.641	37.747
9400	Kidney, right, pelvis	51	0.676	0.676	1.983	1.983	3.560	3.561	5.859	5.859	8.528	7.550
9500	Liver	52	167.410	167.410	389.892	390.399	724.407	723.337	1059.764	1059.773	1707.819	1628.966
9700	Lung (AI), left	53	28.689	28.690	68.837	68.837	139.438	139.441	222.219	222.238	389.511	330.576
9900	Lung (AI), right	53	31.311	31.310	81.163	81.163	160.562	160.559	277.781	277.762	510.489	419.425
10000	Lymphatic nodes, ET	54	1.243	1.243	2.176	2.176	4.310	4.311	7.157	7.157	12.733	11.522
10100	Lymphatic nodes, thoracic	54	1.243	1.243	2.176	2.176	4.310	4.311	7.157	7.157	12.733	11.522
10200	Lymphatic nodes, head	54	0.429	0.429	0.752	0.752	1.489	1.489	2.473	2.472	4.399	3.980
10300	Lymphatic nodes, trunk	54	10.144	10.145	17.763	17.763	35.189	35.193	58.429	58.429	103.944	94.065
10400	Lymphatic nodes, arms	54	0.858	0.859	1.503	1.503	2.978	2,978	4,945	4.945	8,797	7,961
10500	Lymphatic nodes, legs	54	0.858	0.859	1.503	1.503	2.978	2.978	4.945	4.945	8.797	7.961



10600	Muscle	55	819.752	819.765	1929.207	1929.207	5727.750	5726.753	11257.260	11257.050	24657.360	17360.700
11000	Oesophagus wall, 190 µm	47	0.344	0.344	0.545	0.567	0.918	0.895	1.598	1.569	2.169	1.784
11001	Oesophagus wall, 200 µm	47	0.0188	0.0188	0.0296	0.0308	0.0496	0.0483	0.0858	0.0843	0.116	0.0957
11002	Oesophagus wall, surface	47	2.132	2.132	5.214	5.192	11.370	11.395	20.609	20.657	36.640	34,197
11003	Oesophagus contents	49	2.022	2.022	3.786	3.786	7.135	7.135	11.908	11.908	21.842	21.033
11100	Ovary left	56		0.168		0.423	,	1.058		1 839		3 193
11200	Overy right	56		0.168		0.423		1.058		1.839		3 193
11200	Pancreas	57	7 248	7 248	22 651	22 651	41 892	41.880	72 126	72 126	136 661	117 631
11/00	Pituitary gland	15	0.108	0.108	0.156	0.156	0.260	0.250	0.366	0.364	0.520	0.518
11500	Prostate	58	0.100	0.100	1.040	0.150	1 247	0.257	1 672	0.504	4 546	0.510
11600	DST	50	1004.080	1001 707	4202 561	4204 021	6250 208	6278 606	0560 542	0750 656	12242 442	19424 622
12000	KSI Seliyang elende left	15	2 254	2 252	4293.301	4294.031	17 666	17 571	22 091	9730.030	12343.443	22 647
12100	Salivary glands, left	45	2.254	3.235	12.465	12.400	17.000	17.571	22.961	22.802	25.047	22 647
12100	Salivary glands, right	45	3.234	3.253	12.485	12.494	17.005	1/.5/1	22.981	22.802	35.947	33.04/
12200	Skin, insensitive, surface	60	8.741	8./32	18.255	18.201	31.0/1	31.014	45.776	45.59/	85.650	80.996
12201	Skin, insensitive, 100 µm	60	162.072	162.092	315.357	315.493	518.800	518.943	/44.559	/44.994	1931.860	1616.4/8
12300	Skin, sensitive, 40/50* µm	60	13.083	13.071	27.340	27.259	46.543	46.458	68.581	68.320	85.566	80.917
12600	Spinal cord	45	6.107	6.065	10.641	10.669	23.825	23.123	45.695	45.338	40.217	54.218
12700	Spleen	61	13.865	13.865	37.352	37.352	71.306	71.262	114.975	114.975	198.771	179.324
12800	Erupted, upper, front, buccal, permanent, enamel	62							0.352	0.350	0.650	0.564
12801	Erupted, upper, front, lingual, permanent, enamel	62							0.354	0.356	0.823	0.580
12802	Erupted, upper, front, buccal, deciduous, enamel	63			0.0709	0.0689	0.193	0.193	0.0680	0.0649		
12803	Erupted, upper, front, lingual, deciduous, enamel	63			0.0598	0.0617	0.165	0.165	0.0873	0.0903		
12804	Erupted, upper, front-left, buccal, permanent, enamel	62							0.117	0.108	0.317	0.219
12805	Erupted, upper, front-left, lingual, permanent, enamel	62							0.0766	0.086	0.224	0.201
12806	Erupted, upper, front-right, buccal, permanent, enamel	62							0.0755	0.125	0.317	0.201
12807	Erupted, upper, front-right, lingual, permanent, enamel	62							0.118	0.0693	0.224	0.219
12808	Erupted, upper, left, buccal, permanent, enamel	62							0.303	0.250	0.513	0.426
12809	Erupted, upper, left, lingual, permanent, enamel	62							0.145	0.198	0.494	0.356
12810	Erupted, upper, left, buccal, deciduous, enamel	63					0.149	0.149	0.0983	0.0804		
12811	Erupted, upper, left, lingual, deciduous, enamel	63					0.159	0.159	0.0569	0.0749		
12812	Erupted, upper, right, buccal, permanent, enamel	62							0.216	0.218	0.477	0.381
12813	Erupted, upper, right, lingual, permanent, enamel	62							0.232	0.229	0.531	0.400
12814	Erupted, upper, right, buccal, deciduous, enamel	63					0.149	0.149	0.0760	0.0705		
12815	Erupted upper right lingual deciduous enamel	63					0.158	0.158	0.0792	0.0848		
12816	Erupted lower front buccal permanent enamel	62					01120	01120	0.532	0.516	0.605	0 444
12817	Frupted lower front lingual permanent enamel	62							0.412	0.427	0.541	0.445
12017	Erupted, lower, front, higual, permanent, enamel	63			0.0453	0.0506	0.135	0.135	0.412	0.427	0.541	0.445
12810	Frupted, lower, front, lingual, deciduous, enamel	63			0.0435	0.0300	0.135	0.135				
12819	Erupted, lower, front left buccal permanent enamel	62			0.0425	0.0375	0.156	0.158			0.230	0 181
12020	Erupted, lower, front-left, buccal, permanent, enamel	62									0.239	0.181
12021	Erupted, lower, front-feit, fingual, permanent, enamel	62									0.228	0.182
12022	Erupted, lower, front-right, buccal, permanent, enamer	62									0.244	0.200
12823	Erupted, lower, front-right, lingual, permanent, enamel	62							0.176	0.270	0.224	0.105
12824	Erupted, lower, left, buccal, permanent, enamel	62							0.1/6	0.270	0.536	0.334
12825	Erupted, lower, left, lingual, permanent, enamel	62					0.155	0.155	0.302	0.208	0.494	0.466
12826	Erupted, lower, left, buccal, deciduous, enamel	63					0.175	0.175	0.146	0.141		
12827	Erupted, lower, left, lingual, deciduous, enamel	63					0.234	0.234	0.111	0.116		
12828	Erupted, lower, right, buccal, permanent, enamel	62							0.232	0.237	0.593	0.396
12829	Erupted, lower, right, lingual, permanent, enamel	62							0.246	0.241	0.437	0.404
12830	Erupted, lower, right, buccal, deciduous, enamel	63					0.197	0.197	0.140	0.121		
12831	Erupted, lower, right, lingual, deciduous, enamel	63					0.213	0.213	0.117	0.136		
12832	Erupted, upper, front, permanent, dentin	64							2.387	2.385	4.944	3.835
12833	Erupted, upper, front, deciduous, dentin	65			0.299	0.300	0.821	0.820	0.350	0.350		
12834	Erupted, upper, front-left, permanent, dentin	64							0.655	0.654	1.809	1.406



12835	Erupted, upper, front-right, permanent, dentin	64							0.653	0.653	1.816	1.410
12836	Erupted, upper, left, permanent, dentin	64							1.518	1.511	3.391	2.625
12837	Erupted, upper, left, deciduous, dentin	65					0.708	0.708	0.350	0.354		
12838	Erupted, upper, right, permanent, dentin	64							1.513	1.512	3.392	2.636
12839	Erupted, upper, right, deciduous, dentin	65					0.708	0.708	0.355	0.352		
12840	Erupted, lower, front, permanent, dentin	64							3.140	3.160	3.764	2.935
12841	Erupted, lower, front, deciduous, dentin	65			0.199	0.200	0.617	0.617				
12842	Erupted, lower, front-left, permanent, dentin	64									1.559	1.213
12843	Erupted, lower, front-right, permanent, dentin	64									1.558	1.211
12844	Erupted, lower, left, permanent, dentin	64							1.628	1.627	3.465	2.690
12845	Erupted, lower, left, deciduous, dentin	65					0.948	0.948	0.591	0.590		
12846	Erupted, lower, right, permanent, dentin	64							1.624	1.630	3.462	2.681
12847	Erupted, lower, right, deciduous, dentin	65					0.948	0.948	0.595	0.593		
12848	Unerupted, permanent, enamel	62			0.146	0.146	1.626	1.626	1.926	1.926	1.218	0.945
12849	Unerupted, deciduous, enamel	63	0.190	0.190	0.952	0.952						
12850	Unerupted, permanent, dentin	64			0.486	0.489	5.402	5.430	6.443	6.436	4.115	3.183
12851	Unerupted, deciduous, dentin	65	0.425	0.426	2.204	2.205						
12852	Permanent, cementum	64			0.0239	0.0203	0.284	0.256	0.786	0.779	1.450	1.138
12853	Deciduous, cementum	65	0.0337	0.0323	0.125	0.122	0.242	0.242	0.125	0.128		
12854	Permanent, pulp	66			0.0146	0.0146	0.163	0.163	0.582	0.582	0.993	0.771
12855	Deciduous, pulp	66	0.0607	0.0607	0.374	0.374	0.661	0.661	0.313	0.313		
12856	Teeth, retention region	67			0.00345	0.00345	0.0211	0.0212	0.0382	0.0386	0.0505	0.0412
12900	Testis, left	56	0.443		0.773		0.907		1.090		8.518	
13000	Testis, right	56	0.443		0.773		0.907		1.090		8.518	
13100	Thymus	68	14.101	14.096	31.212	31.214	31.203	31.014	41.791	36.392	37.004	31.049
13200	Thyroid	69	1.490	1.490	1.967	1.968	3.871	3.871	9.022	9.022	14.036	13.505
13300	Tongue, upper (food)	3	3.054	3.053	5.973	5.973	9.148	9.116	12.989	12.950	19.029	18.085
13301	Tongue, lower, -200 μm	3	0.574	0.574	4.058	4.060	9.981	9.899	19.428	19.319	38.572	35.361
13301	Tongue, lower, surface	3	0.162	0.162	0.364	0.362	0.601	0.604	0.979	0.967	1.473	1.381
13400	Tonsils	45	0.108	0.108	0.521	0.521	2.080	2.068	3.134	3.120	3.172	3.107
13500	Ureter, left	45	0.418	0.418	1.145	1.145	2.184	2.172	3.658	3.641	6.344	6.210
13600	Ureter, right	45	0.418	0.418	1.145	1.145	2.184	2.172	3.658	3.641	6.344	6.210
13700	Urinary bladder wall, insensitive, surface	70	3.419	3.426	7.760	7.771	14.714	14.711	23.091	23.080	37.233	32.360
13700	Urinary bladder wall, insensitive, $\alpha^{\delta} \mu m$	70	0.152	0.151	0.398	0.398	0.703	0.705	1.121	1.125	1.767	1.574
13701	Urinary bladder wall, sensitive, β [¶] μm	70	0.510	0.505	0.948	0.947	0.882	0.884	1.288	1.294	1.871	1.656
13800	Urinary bladder contents	71	12.400	12.400	32.900	32.900	64.700	64.700	103.000	103.000	160.000	140.000
13900	Uterus	58		4.337		1.562		3.100		4.158		31.064
14000	ET ₁ contents (air)	72	0.0000380	0.0000309	0.0000894	0.0000940	0.000224	0.000209	0.000240	0.000240	0.00120	0.000117
14000	ET ₂ contents, -15 μm (air)	72	0.00202	0.00130	0.00638	0.00449	0.0150	0.0140	0.0179	0.0163	0.0303	0.0183
14000	Trachea contents (air)	72	0.000239	0.000267	0.000440	0.000433	0.000164	0.000165	0.00187	0.00187	0.00285	0.00624
14000	BB ₁ contents [*] , -11 μm (air)	72	0.000312	0.000312	0.000655	0.000655	0.000277	0.000277	0.00163	0.00163	0.00375	0.00366
14000	Stomach contents (air)	72			0.00169	0.00169	0.00833	0.00833	0.0313	0.0313	0.346	0.0984

ET, extrathoracic; AI, alveolar-interstitium; RST, residual soft tissue.

 $\frac{9}{100}$ * Only the main bronchi (BB₁) was defined in the PM-version phantoms. The other generations of the bronchi (BB) and all generations of the bronchioles (bb) were modelled in constructive solid geometry format.

[†] Newborn, 1 year, 5 years/10 years, 15 years.

⁺ Newborn, 1 year, 5 years, 10 years/15 years.

[§] Newborn: 54, 1 year: 71, 5 years: 86, 10 years: 99, 15 years male: 116, 15 years female: 111.

[¶]Newborn: 232, 1 year: 238, 5 years: 193, 10 years: 212, 15 years male: 238, 15 years female: 227.



ANNEX B. LIST OF MEDIA AND THEIR ELEMENTAL COMPOSITIONS

1626	Table B.1. List of media, their elemental com	positions (per	rcent by mass) and their mass	s densities for the newborn male phanton)m.
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Medium		TT	C	N	0	No	Ma	D	c	Cl	V	Ca	Ea	т	Density
no.		н	C	IN	0	INa	Mg	Р	3	CI	ĸ	Ca	Fe	1	(g/cm ³)
1	Adrenal	10.5	15.8	2.4	71.2				0.1						1.036
2	ET, Trachea, BB, bb	10.1	13.1	2.3	72.6	0.2		1.0	0.5	0.2					1.065
3	Oral mucosa, Tongue	10.4	10.5	2.5	75.9	0.1		0.1	0.1	0.2	0.2				1.052
4	Blood	10.0	13.1	4.0	72.0	0.1		0.1	0.2	0.2	0.2		0.1		1.070
5	Cortical bone	5.3	15.8	4.2	53.9		0.3	6.6	0.3			13.6			1.544
6	Humeri, upper, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.266
7	Humeri, upper, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.038
8	Humeri lower spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	61	0.1		1 266
ğ	Humeri lower medullary cavity	10.4	33 3	3.4	52.1		0.1	0.1	0.2	0.2	0.2	0.1	0.1		1.038
10	Radii spongiosa	81	24.8	3.8	53.5		0.1	3.0	0.2	0.1	0.1	62	0.1		1 267
11	Ulnae spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	61	0.1		1 265
12	Radii medullary cavity	10.4	33.3	3.4	52.1		0.1	0.1	0.2	0.2	0.1	0.1	0.1		1.038
13	Ulnae medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.038
14	Wrists and hand hones spongiosa	87	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.6	0.1		1 212
15	Clavicles spongiosa	8.6	26.5	3.7	53.2		0.1	2.5	0.2	0.1	0.1	4.0	0.1		1 222
16	Cranium enongiosa	7.0	20.5	3.0	54.2		0.1	2.5	0.2	0.1	0.1	0.1	0.1		1 377
17	Famora upper spongiosa	9.1	20.8	2.9	52.5		0.2	2.0	0.2	0.1	0.1	5.1	0.1		1.377
19	Femore upper, sponglosa	10.4	24.9	3.0	52.1		0.1	5.0	0.2	0.1	0.1	0.1	0.1		1.200
10	Femore lower enongiese	10.4 9.1	24.0	2.9	52.1		0.1	2.0	0.2	0.2	0.2	6.1	0.1		1.056
19	Femore, lower, sponglosa	0.1	24.9	5.0	53.5		0.1	5.0	0.2	0.1	0.1	0.1	0.1		1.200
20	Tibica anongioso	10.4	33.5	5.4	52.1		0.1	0.1	0.2	0.2	0.2	6.1	0.1		1.056
21	Fibeles sponglosa	0.1	24.9	5.0	55.5		0.1	5.0	0.2	0.1	0.1	0.1	0.1		1.200
22	Fibulae, sponglosa	8.1	24.9	3.8	55.5		0.1	5.0	0.2	0.1	0.1	0.1	0.1		1.20/
23	Patellae, sponglosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.212
24	Tibiae, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.038
25	Fibulae, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.038
26	Ankles and foot, spongiosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.212
27	Mandible, spongiosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.212
28	Pelvis, spongiosa	8.5	26.5	3.7	53.2		0.1	2.5	0.2	0.1	0.1	5.0	0.1		1.223
29	Ribs, spongiosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.212
30	Scapulae, spongiosa	8.5	26.5	3.7	53.2		0.1	2.5	0.2	0.1	0.1	5.0	0.1		1.224
31	Cervical spine, spongiosa	7.8	23.9	3.8	53.7		0.1	3.4	0.2	0.1	0.1	6.8	0.1		1.293
32	Thoracic spine, spongiosa	7.7	23.5	3.8	53.8		0.1	3.5	0.2	0.1	0.1	7.1	0.1		1.304
33	Lumbar spine, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.266
34	Sacrum, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.266
35	Sternum, spongiosa	8.6	26.8	3.7	53.2		0.1	2.4	0.2	0.1	0.1	4.7	0.1		1.215
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3					1.100
37	Brain	10.8	5.8	1.2	81.2	0.2		0.3	0.1	0.2	0.2				1.032
38	Breast, adipose tissue	11.0	28.4	1.2	59.1	0.1			0.1	0.1					0.996
39	Breast, glandular tissue	10.6	31.6	3.1	54.2	0.1		0.1	0.2	0.1					1.024
40	Eye lens, sensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.050
41	Eye lens, insensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.069
42	Cornea	10.1	12.7	3.7	73.0	0.1		0.1	0.2	0.1					1.076
43	Aqueous	11.1	1.0	0.3	87.6										1.008
44	Vitreous	11.1	1.0	0.3	87.6										1.013
	Gall bladder wall. Pituitary gland, Saliyary	10.6	1.6.0						0.1						1.000
45	glands, Tonsils, Spinal cord, Ureter	10.6	16.0	2.2	71.1				0.1						1.033
40	Gail bladder contents	10.6	16.5	2.0	/1.0	0.1		0.1	0.1	0.0	0.1				1.030
47	Stomach wall, Oesophagus	10.5	11.8	2.6	74.5	0.1		0.1	0.1	0.2	0.1				1.038
48	Small intestine wall, Colon wall	10.5	11.9	2.6	74.4	0.1		0.1	0.1	0.2	0.1				1.038
49	GI contents	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1.030
50	Heart wall	10.5	8.3	2.1	78.3	0.2		0.1	0.1	0.2	0.2				1.044
51	Kidney	10.6	6.9	1.8	79.8	0.2		0.2	0.1	0.2	0.2				1.033
52	Liver	10.4	10.0	2.5	76.2	0.2		0.2	0.1	0.2	0.2				1.047



53 54 55 56	Lung Lymphatic nodes Muscle Gonads	10.3 10.8 10.4 10.6	10.3 4.4 10.4 16.2	2.9 1.2 2.4 2.1	75.6 82.8 76.1 71.0	0.1 0.3 0.1		0.1 0.1	0.2 0.1 0.1 0.1	0.2 0.4 0.2	0.2 0.2		0.1		0.618 1.031 1.050 1.041
57	Pancreas	10.5	16.2	2.5	69.9 71.1	0.2		0.2	0.1	0.2	0.2				1.045
59	RST	11.0	28.1	1.1	59.5	0.1			0.1	0.1					0.995
60	Skin	10.4	10.5	2.9	75.3	0.2		0.1	0.2	0.3	0.1				1.099
61 62	Spleen Permanent enamel [*]	10.4	10.0	2.9	/5.8	0.2		0.2	0.1	0.2	0.2				1.049
63 64	Deciduous, enamel Permanent, dentin and cementum [*]	0.4	0.7	0.2	43.4		0.3	18.0				37.0			2.840
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3			2.185
66 67	Pulp Teeth, retention region [*]	10.8	4.1	1.1	83.2	0.3			0.1	0.4					1.021
68	Thymus	10.6	16.0	2.2	71.1				0.1						1.070
69	Thyroid	10.3	12.1	2.6	74.2	0.2		0.1	0.1	0.2	0.1			0.1	1.053
70	Urinary bladder wall	10.5	9.7	2.6	76.0	0.2		0.2	0.2	0.3	0.3				1.041
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2				1.010
72	Air inside body			80.0	20.0										0.001
73	Water	11.2			88.8										1.000

ET, extrathoracic; BB, bronchi; bb, bronchioles; RST, residual soft tissue. * The permanent enamel, dentin, cementum and teeth retention region are not included in the newborn phantoms.


Table B.2. List of media, their elemental compositions (percent by mass) and their mass densities for the newborn female phantom.

Medium no.		Н	С	Ν	0	Na	Mg	Р	S	Cl	Κ	Ca	Fe	Ι	Density (g/cm ³)
1	Adrenal	10.5	15.8	2.4	71.2				0.1						1.028
2	ET, Trachea, BB, bb	10.1	13.1	2.3	72.6	0.2		1.0	0.5	0.2	0.0				1.061
3	Oral mucosa, Tongue	10.4	10.5	2.5	75.9	0.1		0.1	0.1	0.2	0.2		0.1		1.052
4	Blood Continue home	10.0	13.1	4.0	72.0	0.1	0.2	0.1	0.2	0.2	0.2	126	0.1		1.070
5	Humeri upper spongiosa	3.5 8.1	24.0	4.2	53.5		0.5	0.0	0.5	0.1	0.1	15.0	0.1		1.342
7	Humeri upper, medullary cavity	10.4	33.3	3.4	52.1		0.1	0.1	0.2	0.1	0.1	0.1	0.1		1.037
8	Humeri lower spongiosa	81	24.9	3.8	53.5		0.1	3.0	0.2	0.2	0.2	61	0.1		1.057
ğ	Humeri, lower, medullary cavity	10.4	33.3	3.4	52.1		0.1	0.1	0.2	0.2	0.2	0.1	0.1		1.037
10	Radii, spongiosa	8.1	24.8	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.2	0.1		1.266
11	Ulnae, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.264
12	Radii, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.037
13	Ulnae, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.037
14	Wrists and hand bones, spongiosa	8.7	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.6	0.1		1.211
15	Clavicles, spongiosa	8.5	26.5	3.7	55.5		0.1	2.5	0.2	0.1	0.1	4.9	0.1		1.221
10	Econora, upper spongiosa	7.0	20.8	3.9	54.2		0.2	4.4	0.2	0.1	0.1	9.1	0.1		1.375
18	Femora upper, medullary cavity	10.4	24.9	3.0	52.1		0.1	0.1	0.2	0.1	0.1	0.1	0.1		1.203
19	Femora lower spongiosa	81	24.9	3.8	53.5		0.1	3.0	0.2	0.2	0.2	61	0.1		1.057
20	Femora, lower, medullary cavity	10.4	33.3	3.4	52.1		0.1	0.1	0.2	0.2	0.2	0.1	0.1		1.037
21	Tibiae, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.265
22	Fibulae, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.266
23	Patellae, spongiosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.211
24	Tibiae, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.037
25	Fibulae, medullary cavity	10.4	33.3	3.4	52.1			0.1	0.2	0.2	0.2		0.1		1.037
26	Ankles and foot, sponglosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.211
27	Mandible, spongiosa Polyis, spongiosa	8.6	26.9	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.7	0.1		1.211
20	Ribs spongiosa	8.5	20.5	3.7	53.2		0.1	2.3	0.2	0.1	0.1	4.9	0.1		1.222
30	Scapulae spongiosa	8.5	26.5	3.7	53.3		0.1	2.5	0.2	0.1	0.1	5.0	0.1		1 223
31	Cervical spine, spongiosa	7.8	23.9	3.8	53.7		0.1	3.4	0.2	0.1	0.1	6.8	0.1		1.292
32	Thoracic spine, spongiosa	7.7	23.5	3.8	53.8		0.1	3.5	0.2	0.1	0.1	7.1	0.1		1.303
33	Lumbar spine, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.265
34	Sacrum, spongiosa	8.1	24.9	3.8	53.5		0.1	3.0	0.2	0.1	0.1	6.1	0.1		1.265
35	Sternum, spongiosa	8.6	26.8	3.7	53.2		0.1	2.4	0.2	0.1	0.1	4.7	0.1		1.213
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3	0.2				1.100
37	Dialli Breast adipose tissue	10.8	28.4	1.2	61.2 50.1	0.2		0.5	0.1	0.2	0.2				1.052
30	Breast, dandular tissue	10.6	20.4	3.1	54.2	0.1		0.1	0.1	0.1					1.024
40	Eve lens sensitive	9.6	19.5	57	64.6	0.1		0.1	0.2	0.1					1.024
41	Eve lens, insensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.069
42	Cornea	10.1	12.7	3.7	73.0	0.1		0.1	0.2	0.1					1.076
43	Aqueous	11.1	1.0	0.3	87.6										1.008
44	Vitreous	11.1	1.0	0.3	87.6										1.013
45	Gall bladder wall, Pituitary gland, Salivary	10.6	16.0	2.2	71.1				0.1						1.024
46	Gall bladder contents	10.6	16.3	2.0	71.0				0.1						1.020
47	Stomach wall. Oesophagus	10.5	11.8	2.6	74.5	0.1		0.1	0.1	0.2	0.1				1.038
48	Small intestine wall, Colon wall	10.5	11.9	2.6	74.4	0.1		0.1	0.1	0.2	0.1				1.038
49	GI contents	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1.030
50	Heart wall	10.5	8.3	2.1	78.3	0.2		0.1	0.1	0.2	0.2				1.044
51	Kidney	10.6	6.9	1.8	79.8	0.2		0.2	0.1	0.2	0.2				1.033
52	Liver	10.4	10.0	2.5	76.2	0.2		0.2	0.1	0.2	0.2		0.1		1.047
53	Lung Lymphatic podes	10.3	10.3	2.9	/5.6	0.1		0.1	0.2	0.2	0.2		0.1		0.618
54 55	Lymphauc noues Muscle	10.8	4.4	1.2	02.0 76 1	0.5		0.1	0.1	0.4	0.2				1.052
56	Gonads	10.4	16.0	2.2	71.1	0.1		0.1	0.1	0.2	0.2				1.052



57 58 59 60 61 62	Pancreas Uterus RST Skin Spleen Parmanant enamel*	10.5 10.6 11.0 10.4 10.4	16.2 16.0 28.1 10.5 10.0	2.5 2.2 1.1 2.9 2.9	69.9 71.1 59.5 75.3 75.8	0.2 0.1 0.2 0.2		0.2 0.1 0.2	0.1 0.1 0.1 0.2 0.1	0.2 0.1 0.3 0.2	0.2 0.1 0.2			1.045 1.052 0.994 1.099 1.049
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum*													
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region*													
68	Thymus	10.6	16.0	2.2	71.1				0.1					1.070
69	Thyroid	10.3	12.1	2.6	74.2	0.2		0.1	0.1	0.2	0.1		0.1	1.053
70	Urinary bladder wall	10.5	9.7	2.6	76.0	0.2		0.2	0.2	0.3	0.3			1.041
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000

* The permanent enamel, dentin, cementum and teeth retention region are not included in the newborn phantoms.



1634 <u>Table B.3. List of media, their elemental compositions (percent by mass) and their mass densities for the 1-year-old male phantom.</u>

Medium		Н	С	Ν	0	Na	Mg	Р	S	Cl	K	Ca	Fe	Ι	Density
no.		10.5	22.0	2.0	(1.0	0.1	8	0.2	0.2	0.0	0.2				(g/cm ³)
1	Adrenal	10.5	23.9	2.8	61.8	0.1		0.2	0.3	0.2	0.2				1.033
2	E1, Ifachea, BB, bb	10.0	17.5	2.5	07.0	0.5		1.2	0.6	0.2	0.1				1.065
5	Plood	10.2	14.2	2.4	71.1	0.1		0.2	0.5	0.1	0.4		0.1		1.050
5	Cortical hope	10.2	16.5	3.3 4 3	51.2	0.1	0.3	7.5	0.2	0.5	0.2	15.0	0.1		1.000
6	Humeri upper spongiosa	7.5	25.3	3.8	50.7		0.5	4.1	0.3	0.1	0.1	8.0			1 329
7	Humeri upper, sponglosa Humeri upper, medullary cavity	10.5	38.0	3.0	47.5		0.1	0.1	0.3	0.1	0.1	0.0	0.1		1.031
8	Humeri lower spongiosa	7.5	26.0	3.8	49.9		0.1	4 1	0.2	0.1	0.1	8.1	0.1		1 332
9	Humeri, lower, medullary cavity	10.6	38.4	3.1	47.1		0.1	0.1	0.2	0.2	0.2	0.1	0.1		1.030
10	Radii, spongiosa	7.2	25.1	3.8	50.2		0.2	4.4	0.3	0.1	0.1	8.6			1.352
11	Ulnae, spongiosa	6.8	23.0	3.9	50.8		0.2	5.0	0.3	0.1	0.1	9.8			1.396
12	Radii, medullary cavity	10.5	38.7	3.1	46.9			0.1	0.2	0.2	0.2		0.1		1.029
13	Ulnae, medullary cavity	10.6	38.7	3.1	46.8			0.1	0.2	0.2	0.2		0.1		1.029
14	Wrists and hand bones, spongiosa	8.3	33.3	3.2	44.9		0.1	3.3	0.2	0.1	0.1	6.5			1.262
15	Clavicles, spongiosa	8.1	27.8	3.7	50.1		0.1	3.3	0.2	0.1	0.1	6.4	0.1		1.269
16	Cranium, spongiosa	6.8	22.8	3.9	51.1		0.2	4.9	0.3	0.1	0.1	9.8			1.395
17	Femora, upper, spongiosa	7.6	26.0	3.8	50.6		0.1	3.8	0.3	0.1	0.1	7.5	0.1		1.311
18	Femora, upper, medullary cavity	10.5	37.7	3.2	47.8			0.1	0.2	0.2	0.2		0.1		1.031
19	Femora, lower, spongiosa	8.0	28.3	3.6	49.3		0.1	3.4	0.3	0.1	0.1	6.7	0.1		1.279
20	Femora, lower, medullary cavity	10.5	38.3	3.2	47.2			0.1	0.2	0.2	0.2		0.1		1.030
21	Tibiae, spongiosa	7.6	26.5	3.7	49.9		0.1	3.9	0.3	0.1	0.1	7.7	0.1		1.318
22	Fibulae, spongiosa	7.5	26.3	3.7	49.8		0.1	4.1	0.3	0.1	0.1	8.0	0.1		1.327
23	Patellae, sponglosa	8.8	31.5	3.5	48.6		0.1	2.4	0.2	0.1	0.1	4.6	0.1		1.201
24	Libiae, medullary cavity	10.6	38.7	3.1	46.8			0.1	0.2	0.2	0.2		0.1		1.029
25	A place and fact appropriate	10.0	39.0	5.1	40.5	0.1	0.1	0.1	0.2	0.2	0.2	6.2	0.1		1.026
20	Mandible, spongiosa	8.5 7.0	22.5	3.1	44./ 50.0	0.1	0.1	5.2	0.2	0.1	0.1	0.5			1.233
28	Palvis spongiosa	7.0	23.5	3.9	10.9		0.2	4.7	0.3	0.1	0.1	9.3	0.1		1.370
20	Ribs spongiosa	8.5	29.5	3.6	49.4		0.1	2.3	0.2	0.2	0.1	53	0.1		1 228
30	Scapulae spongiosa	8 2	29.5	3.0	50.0		0.1	3.1	0.2	0.2	0.1	6.2	0.1		1 260
31	Cervical spine spongiosa	89	31.0	3.5	49.4		0.1	2.2	0.2	0.1	0.1	43	0.1		1 191
32	Thoracic spine, spongiosa	9.2	32.4	3 5	49.1		0.1	17	0.2	0.2	0.2	3 3	0.1		1 155
33	Lumbar spine, spongiosa	8.3	28.7	3.7	49.9		0.1	3.0	0.2	0.1	0.1	5.8	0.1		1.248
34	Sacrum, spongiosa	8.3	28.6	3.7	49.9		0.1	3.0	0.2	0.1	0.1	5.9	0.1		1.250
35	Sternum, spongiosa	8.5	29.5	3.6	49.7		0.1	2.7	0.2	0.2	0.1	5.3	0.1		1.227
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3					1.100
37	Brain	10.7	9.2	1.6	77.5	0.2		0.3	0.1	0.2	0.2				1.031
38	Breast, adipose tissue	11.3	43.2	0.7	44.5	0.1			0.1	0.1					0.964
39	Breast, glandular tissue	10.6	32.3	3.0	53.6	0.1		0.1	0.2	0.1					1.022
40	Eye lens, sensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.050
41	Eye lens, insensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.078
42	Cornea	10.2	12.5	3.7	73.1	0.1		0.1	0.2	0.1					1.075
43	Aqueous	11.2	0.4	0.1	88.3										1.005
44	Vitreous	11.2	0.4	0.1	88.3										1.011
45	Gall bladder wall, Pitultary gland, Sallvary	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2				1.031
16	Gall bladder contents	10.5	25.6	27	60.2	0.1		0.2	0.3	0.2	0.2				1.020
40	Stomach wall Oeconhague	10.5	23.0	2.7	75.0	0.1		0.2	0.3	0.2	0.2				1.030
47	Small intestine wall. Colon wall	10.0	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.034
40	GI contents	10.0	22.2	2.4	64.4	0.1		0.1	0.1	0.2	0.1	0.1			1.034
50	Heart wall	10.5	9.0	2.3	77.4	0.1		0.2	0.1	0.1	0.2	0.1			1.030
51	Kidney	10.6	9.6	2.2	76.7	0.2		0.2	0.1	0.2	0.2				1.042
52	Liver	10.3	12.3	2.8	73.5	0.1		0.3	0.2	0.2	0.3				1.052
53	Lung	10.2	10.7	3.2	74.7	0.2		0.2	0.3	0.3	0.2				0.400
54	Lymphatic nodes	10.8	4.3	1.2	82.9	0.3			0.1	0.4					1.031
55	Muscle	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
56	Gonads	10.6	9.9	2.1	76.5	0.2		0.1	0.2	0.2	0.2				1.041



57	Pancreas	10.6	16.2	2.3	70.0	0.2		0.2	0.1	0.2	0.2			1.042
58	Prostate	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2			1.031
59	RST	11.2	41.0	0.9	46.5	0.1		0.1	0.1	0.1				0.972
60	Skin	10.0	20.1	4.2	64.8	0.2		0.1	0.2	0.3	0.1			1.099
61	Spleen	10.3	11.2	3.2	74.2	0.1		0.3	0.2	0.2	0.3			1.060
62	Permanent, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		3.000
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1		1.030
68	Thymus	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2			1.026
69	Thyroid	10.4	11.8	2.5	74.5	0.2		0.1	0.1	0.2	0.1		0.1	1.051
70	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2		0.2	0.2	0.3	0.3			1.040
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000



Table B.4 List of media, their elemental compositions (percent by mass) and their mass densities for the 1-year-old female phantom.

Medium		Н	С	Ν	0	Na	Mg	Р	S	C1	K	Ca	Fe	Ι	Density
<u>no.</u>	A .l	10.0	20.2	25	560	0.1	e	0.2	0.2	0.1	0.2				(g/cm ³)
1	Adrenal ET Traches DD hh	10.0	29.2	2.5	50.9	0.1		0.2	0.2	0.1	0.2				1.024
23	Oral mucosa Tongua	10.1	20.5	2.5	03.0 71.1	0.5		1.2	0.3	0.2	0.1				1.000
4	Blood	10.2	14.2	3.4	74.5	0.1		0.2	0.3	0.1	0.4		0.1		1.050
5	Cortical hone	10.2	16.0	13	50.8	0.1	0.3	7.5	0.2	0.5	0.2	15.0	0.1		1.000
6	Humeri upper spongiosa	7.5	25.7	3.8	50.3		0.5	4.1	0.3	0.1	0.1	8.0			1 328
7	Humeri upper, sponglosa Humeri upper, medullary cavity	10.5	38.3	3.0	47.2		0.1	0.1	0.3	0.1	0.1	0.0	0.1		1.030
8	Humeri lower spongiosa	7.5	26.4	3.2	49.5		0.2	4.1	0.2	0.2	0.2	8.1	0.1		1 331
9	Humeri lower medullary cavity	10.5	38.8	3.1	46.8		0.2	0.1	0.2	0.1	0.1	0.1	0.1		1.029
10	Radii spongiosa	7 3	25.5	3.8	49.8		0.2	4.4	0.2	0.1	0.1	8.6	0.1		1 351
11	Ulnae, spongiosa	6.8	23.4	3.9	50.4		0.2	5.0	0.3	0.1	0.1	9.8			1.395
12	Radii, medullary cavity	10.5	39.1	3.1	46.5		•	0.1	0.2	0.2	0.2		0.1		1.029
13	Ulnae, medullary cavity	10.5	39.1	3.1	46.5			0.1	0.2	0.2	0.2		0.1		1.029
14	Wrists and hand bones, spongiosa	8.3	33.8	3.1	44.5		0.1	3.3	0.2	0.1	0.1	6.5			1.261
15	Clavicles, spongiosa	8.1	28.2	3.7	49.7		0.1	3.3	0.2	0.1	0.1	6.4	0.1		1.268
16	Cranium, spongiosa	6.8	23.2	3.9	50.7		0.2	4.9	0.3	0.1	0.1	9.8			1.394
17	Femora, upper, spongiosa	7.7	26.4	3.8	50.2		0.1	3.8	0.2	0.1	0.1	7.5	0.1		1.311
18	Femora, upper, medullary cavity	10.5	38.1	3.2	47.4			0.1	0.2	0.2	0.2		0.1		1.030
19	Femora, lower, spongiosa	8.0	28.8	3.6	48.9		0.1	3.4	0.2	0.1	0.1	6.7	0.1		1.278
20	Femora, lower, medullary cavity	10.5	38.7	3.1	46.9			0.1	0.2	0.2	0.2		0.1		1.029
21	Tibiae, spongiosa	7.6	26.9	3.7	49.5		0.1	3.9	0.3	0.1	0.1	7.7	0.1		1.317
22	Fibulae, spongiosa	7.5	26.7	3.7	49.4		0.1	4.1	0.3	0.1	0.1	8.0			1.326
23	Patellae, spongiosa	8.8	31.9	3.5	48.2		0.1	2.4	0.2	0.1	0.1	4.6	0.1		1.200
24	Tibiae, medullary cavity	10.6	39.1	3.1	46.4			0.1	0.2	0.2	0.2		0.1		1.028
25	Fibulae, medullary cavity	10.6	39.5	3.0	46.1			0.1	0.2	0.2	0.2		0.1		1.028
26	Ankles and foot, spongiosa	8.4	34.2	3.1	44.3		0.1	3.2	0.2	0.1	0.1	6.3			1.254
27	Mandible, spongiosa	7.0	24.0	3.9	50.5		0.2	4.7	0.2	0.1	0.1	9.3			1.375
28	Pelvis, spongiosa	8.9	31.2	3.5	49.0		0.1	2.3	0.2	0.2	0.1	4.4	0.1		1.194
29	Ribs, spongiosa	8.5	29.9	3.6	49.3		0.1	2.7	0.2	0.2	0.1	5.3	0.1		1.227
30	Scapulae, spongiosa	8.2	28.7	3.7	49.6		0.1	3.1	0.2	0.1	0.1	6.1	0.1		1.259
31	Cervical spine, sponglosa	8.9	31.4	3.5	49.0		0.1	2.2	0.2	0.2	0.1	4.5	0.1		1.191
32	I noracic spine, spongiosa	9.5	32.8	3.4	48.7		0.1	1.7	0.2	0.2	0.2	5.5	0.1		1.154
33	Lumbar spine, spongiosa	8.5	29.1	3.0 2.7	49.5		0.1	3.0	0.2	0.2	0.1	5.8	0.1		1.248
25	Sacrum, spongiosa	0.3 8 5	29.0	3.7	49.3		0.1	5.0	0.2	0.1	0.1	5.9	0.1		1.249
35	Cartilaga	0.5	29.9	3.0	49.4	0.5	0.1	2.7	0.2	0.1	0.1	5.5	0.1		1.220
30	Brain	10.7	9.9	1.6	74.4	0.3		0.3	0.9	0.3	0.2				1.00
38	Breast adipose tissue	11.3	43.2	0.7	44.5	0.2		0.5	0.1	0.2	0.2				0.964
30	Breast, alandular tissue	10.6	32.3	3.0	53.6	0.1		0.1	0.1	0.1					1.022
40	Eve lens sensitive	9.6	19.5	5.0	64.6	0.1		0.1	0.2	0.1					1.050
41	Eve lens, insensitive	9.6	19.5	57	64.6	0.1		0.1	0.3	0.1					1 078
42	Cornea	10.2	12.5	3.7	73.1	0.1		0.1	0.2	0.1					1.075
43	Aqueous	11.2	0.4	0.1	88.3										1.005
44	Vitreous	11.2	0.4	0.1	88.3										1.011
45	Gall bladder wall. Pituitary gland, Salivary	10 6	20.7	2.4		0.1		0.0	0.0	0.1	0.0				1.022
45	glands, Tonsils, Spinal cord, Ureter	10.6	30.7	2.4	55.5	0.1		0.2	0.2	0.1	0.2				1.022
46	Gall bladder contents	10.6	31.5	2.4	54.7	0.1		0.2	0.2	0.1	0.2				1.020
47	Stomach wall, Oesophagus	10.6	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.034
48	Small intestine wall, Colon wall	10.6	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.034
49	GI contents	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1.030
50	Heart wall	10.5	9.0	2.3	77.4	0.1		0.2	0.1	0.2	0.2				1.042
51	Kidney	10.6	9.6	2.2	76.7	0.2		0.2	0.1	0.2	0.2				1.042
52	Liver	10.3	12.3	2.8	73.5	0.1		0.3	0.2	0.2	0.3				1.052
53	Lung	10.2	10.7	3.2	74.7	0.2		0.2	0.3	0.3	0.2				0.400
54	Lymphatic nodes	10.8	4.3	1.2	82.9	0.3		0.0	0.1	0.4	0.4				1.031
55	Muscle	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
56	Gonads	10.5	9.4	2.4	76.7	0.2		0.2	0.2	0.2	0.2				1.051



57	Pancreas	10.6	16.2	2.3	70.0	0.2		0.2	0.1	0.2	0.2			1.042
58	Uterus	10.5	9.4	2.4	76.7	0.2		0.2	0.2	0.2	0.2			1.050
59	RSI	11.1	40.6	0.9	40.8	0.1		0.2	0.2	0.1				0.975
60	Skin	10.0	20.1	4.2	64.8	0.2		0.1	0.2	0.3	0.1			1.099
61	Spleen	10.3	11.2	3.2	74.2	0.1		0.3	0.2	0.2	0.3			1.060
62	Permanent, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		3.000
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1		1.030
68	Thymus	10.6	30.7	2.4	55.5	0.1		0.2	0.2	0.1	0.2			1.026
69	Thyroid	10.4	11.8	2.5	74.5	0.2		0.1	0.1	0.2	0.1		0.1	1.051
70	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2		0.2	0.2	0.3	0.3			1.040
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000



Table B.5. List of media, their elemental compositions (percent by mass) and their mass densities for the 5-year-old male phantom.

$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Medium		н	C	N	0	Na	Μσ	р	S	Cl	к	Ca	Fe	T	Density
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	no.		п	e	N	0	Iva	Mg	I	5	Ci	ĸ	Ca	10	1	(g/cm ³)
2 ET, Tacker, B, b) 00 17.5 2.5 67.6 0.3 1.2 0.6 0.2 0.1 1000 4 Bloom 10.2 1.0 3.7 73.5 0.1 0.1 0.2 0.2 0.2 0.2 0.2 0.2 0.1 0.2 0.1<	1	Adrenal	10.4	23.3	2.8	62.5	0.1		0.2	0.3	0.2	0.2				1.035
3 Ordi mucosa. Toragae 10.2 14.2 3.4 7,1 0.1 0.2 0.2 0.3 0.2 0.1 0.4 1.0 1.0 4 Book hore 8.8 3.0.1 3.3 4.7 7.8 0.1 0.3 0.2 0.1 0.5 0.1 1.0 1.0 1.0 0.0 0.0 0.1 0.5 0.1 1.0 1.0 0.0 <	2	ET, Trachea, BB, bb	10.0	17.5	2.5	67.6	0.3		1.2	0.6	0.2	0.1				1.065
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	3	Oral mucosa, Tongue	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	4	Blood	10.2	11.0	3.3	74.5	0.1		0.1	0.2	0.3	0.2		0.1		1.060
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	5	Cortical bone	4.6	16.1	4.4	48.8	0.1	0.2	8.2	0.3			17.3			1.642
1 Humer, inper, inschillary enviry 10.7 41.9 2.8 43.9 0.1 0.2 0.2 0.1 0.1 1.023 8 Humer, inver, inschlary enviry 18.7 45.4 0.1 0.1 2.6 0.2 0.1 0.1 5.3 0.1 1.210 10 Kaft, inochlary enviry 10.8 4.4.3 2.4 3.9 0 0.1 0.2 0.2 0.1 0.1 2.4.9 11 Ulns, spengiosa 8.8 2.4 3.8 0.1 0.2 0.2 0.1 0.1 2.4.9 14 Wrist in hand hores, spengiosa 8.8 2.6 3.3 47.1 0.1 2.1 0.2 0.1 0.1 8.4 0.1 1.01 2.2 0.1 0.1 8.4 0.1 1.01 2.2 0.1 0.1 8.4 0.1 1.01 2.2 0.1 0.1 8.4 0.1 1.01 2.2 0.1 0.1 8.4 0.1 1.03 1.01 1.03 1.01 1.03 1.01 1.01 1.03	6	Humeri, upper, spongiosa	8.3	30.1	3.5	47.7	0.1	0.1	3.2	0.2	0.1	0.1	6.5	0.1		1.259
$ \begin{array}{ $	7	Humeri, upper, medullary cavity	10.7	41.9	2.8	43.9			0.1	0.2	0.2	0.1		0.1		1.023
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	8	Humeri, lower, spongiosa	8.5	31.9	3.3	46.3	0.1	0.1	3.0	0.2	0.1	0.1	6.3	0.1		1.249
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	9	Humeri, lower, medullary cavity	10.7	42.4	2.7	43.4			0.1	0.2	0.2	0.2		0.1		1.022
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	10	Radii, spongiosa	8.9	35.6	3.0	44.0	0.1	0.1	2.6	0.2	0.1	0.1	5.3			1.210
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	11	Ulnae, spongiosa	8.5	33.5	3.1	44.8	0.1	0.1	3.1	0.2	0.1	0.1	6.4			1.248
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	12	Radii, medullary cavity	10.8	46.4	2.3	39.8			0.1	0.2	0.2	0.1		0.1		1.014
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	13	Ulnae medullary cavity	10.8	46.3	2.4	39.8			0.1	0.2	0.2	0.1		0.1		1 014
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	14	Wrists and hand hones spongiosa	9.0	41.0	2.5	38.5	0.1	0.1	27	0.2	0.1	0.1	5.8	0.1		1 213
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	15	Clavicles spongiosa	8.8	32.6	33	47.1	0.1	0.1	2.5	0.2	0.1	0.1	51	0.1		1 207
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	16	Cranium spongiosa	77	27.0	3.6	48 7	0.1	0.1	4.0	0.2	0.1	0.1	84	0.1		1 326
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	17	Femora upper spongiosa	83	30.2	3.5	47.7	0.1	0.1	3.1	0.2	0.1	0.1	6.5	0.1		1.258
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	18	Femora upper, medullary cavity	10.7	41.9	2.8	43.9	0.1	0.1	0.1	0.2	0.1	0.1	0.5	0.1		1.023
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	19	Femora lower spongiosa	87	33.0	3.2	46.0	0.1	0.1	2.8	0.2	0.2	0.1	57	0.1		1 228
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	20	Femora, lower, medullary cavity	10.7	42.4	27	43.5	0.1	0.1	0.1	0.2	0.1	0.1	5.7	0.1		1.022
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	20	Tibiae enongiosa	8.8	34.0	3 1	44.2	0.1	0.1	2.7	0.2	0.2	0.1	57	0.1		1 222
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	21	Fibulae, spongiosa	0.0	38.1	2.0	44.2	0.1	0.1	2.7	0.2	0.1	0.1	J.7 4 1	0.1		1.222
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	22	Patellae spongiosa	10.0	42.0	2.9	41.5	0.1		2.0	0.2	0.1	0.1	4.1	0.1		1.105
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	23	Tibiaa madullaru aavitu	10.0	42.0	2.0	20.8	0.1		0.1	0.2	0.2	0.1	2.2	0.1		1.094
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	24	Fibulae, medullary cavity	10.8	46.3	2.4	30.8			0.1	0.2	0.2	0.1		0.1		1.014
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	25	Ankles and foot spongiosa	10.8	40.5	2.4	30.0	0.1	0.1	2.0	0.2	0.2	0.1	6.1	0.1		1 225
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	20	Mandible spongiosa	8.0	28.4	2.5	18.3	0.1	0.1	2.9	0.2	0.1	0.1	7.5			1.225
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	28	Pelvis spongiosa	9.2	34.3	3.0	46.6	0.1	0.1	2.0	0.2	0.1	0.1	4.0	0.1		1.295
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	20	Ribs spongiosa	8.8	31.6	3.4	47.9	0.1	0.1	2.0	0.2	0.2	0.1	5.1	0.1		1 209
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	30	Scapulae enongiosa	8.6	31.5	3.4	47.5	0.1	0.1	2.5	0.2	0.1	0.1	5.6	0.1		1 228
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	31	Cervical spine spongiosa	8.8	31.5	3.4	47.9	0.1	0.1	2.7	0.2	0.1	0.1	5.0	0.1		1.220
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	32	Thoracic spine, spongiosa	9.3	33.9	3 3	47.4	0.1	0.1	1.8	0.2	0.2	0.1	3.6	0.1		1 1 5 8
34Earnin spin portion0.335.43.247.30.10.10.70.20.20.13.30.11.14935Stermun, spongiosa9.434.43.347.31.70.20.20.13.30.11.14936Cartilage9.69.92.271.40.52.20.40.20.3.11.09937Brain10.714.32.271.40.20.40.20.3.11.04138Breast, alipose tissue11.343.20.744.50.10.20.11.0540Eye lens, insensitive9.619.55.764.60.10.10.10.20.11.051.051.051.051.051.051.051.051.051.051.051.051.051.010.10.20.11.051.051.051.051.0311.051.051.0311.051.051.0311.051.0311.0311.0311.0311.051.040.10.20.30.20.21.0311.03141Otion wall10.51.42.57500.1 <td< td=""><td>33</td><td>Lumbar spine, spongiosa</td><td>8.8</td><td>31.7</td><td>3.4</td><td>47.9</td><td>0.1</td><td>0.1</td><td>2.4</td><td>0.2</td><td>0.2</td><td>0.1</td><td>5.0</td><td>0.1</td><td></td><td>1 206</td></td<>	33	Lumbar spine, spongiosa	8.8	31.7	3.4	47.9	0.1	0.1	2.4	0.2	0.2	0.1	5.0	0.1		1 206
35Sternum, borgiosa94343.347.31.70.20.20.13.30.11.14736Cartilage9.69.92.274.40.52.20.90.31.09937Brain10.714.32.271.40.20.40.20.30.31.04138Breast, glandular tissue11.343.20.744.50.10.10.10.10.439Breast, glandular tissue10.632.43.053.50.10.10.10.10.20.11.02140Eye lens, sensitive9.619.55.764.60.10.10.30.11.0521.05241Eye lens, insensitive9.619.55.764.60.10.10.20.11.0521.05242Cornea10.212.23.77.3.10.10.10.20.11.0521.05243Aqueous11.20.40.188.31.0131.0520.11.0131.0521.03145Gall bladder contents10.525.02.760.80.10.20.30.20.21.03146Gall bladder contents10.511.42.575.00.10.10.20.11.03247Stomach wall, Cesophagus10.611.42.575.00.10.10.20.11.03648<	34	Sacrum spongiosa	9.5	35.4	3.7	46.3	0.1	0.1	17	0.2	0.2	0.1	33	0.1		1 145
36Cartilage36392.27.30.52.20.40.50.71.0037Brain10.714.32.27.1.40.20.40.20.30.31.04138Breast, alipose tissue11.343.20.744.50.10.10.10.10.96439Breast, glandular tissue10.632.43.053.50.10.10.20.11.02140Eye lens, sensitive9.619.55.764.60.10.10.30.11.05041Eye lens, insensitive9.619.55.764.60.10.10.30.11.08242Cornea10.212.53.773.10.10.10.20.11.09244Vitreous11.20.40.188.31.0031.011.0320.11.03145Gall bladder contents10.525.02.760.20.10.20.30.20.21.03146Gall bladder contents10.511.42.475.00.10.10.10.20.11.03348Small intestine wall, Colon wall10.511.42.575.00.10.10.10.20.11.03044Stomach wall, Oesophagus10.511.42.575.00.10.10.10.20.11.03045Gall bladder contents10.	35	Sternum spongiosa	94	34.4	33	47.3			1.7	0.2	0.2	0.1	33	0.1		1 147
37Brain1071432.271.40.20.40.20.30.3100438Breast, adipose tissue11.343.20.744.50.10.10.10.10.139Breast, glandular tissue10.63.2.43.03.5.50.10.10.10.10.140Eye lens, sensitive9.619.55.764.60.10.10.30.110.8241Eye lens, insensitive9.619.55.764.60.10.10.30.110.8242Cornea10.212.53.773.10.10.10.20.110.9243Aqueous11.20.40.188.3100510.0510.0510.0544Vitreous11.20.40.188.31010.20.30.20.210.3145Gall bladder contents10.525.02.760.80.10.10.10.20.110.346Gall bladder contents10.525.02.760.20.10.20.30.20.210.3146Gall bladder contents10.511.42.575.00.10.10.10.20.110.3648Small intestine wall, Colon wall10.511.42.575.00.10.10.10.20.110.3649GI contents10.510.52.6 <td>36</td> <td>Cartilage</td> <td>9.6</td> <td>99</td> <td>2.2</td> <td>74.4</td> <td>0.5</td> <td></td> <td>2.2</td> <td>0.2</td> <td>0.2</td> <td>0.1</td> <td>5.5</td> <td>0.1</td> <td></td> <td>1.099</td>	36	Cartilage	9.6	99	2.2	74.4	0.5		2.2	0.2	0.2	0.1	5.5	0.1		1.099
38Breast, adipose tissue11.343.20.744.50.1<	37	Brain	10.7	14.3	2.2	71.4	0.2		0.4	0.2	0.3	03				1.041
39Breast, largeon indice11.0 12.2 3.7 12.5 0.1 <t< td=""><td>38</td><td>Breast adipose tissue</td><td>11.3</td><td>43.2</td><td>0.7</td><td>44.5</td><td>0.1</td><td></td><td>0</td><td>0.1</td><td>0.1</td><td>0.5</td><td></td><td></td><td></td><td>0.964</td></t<>	38	Breast adipose tissue	11.3	43.2	0.7	44.5	0.1		0	0.1	0.1	0.5				0.964
40Eye lens, sensitive 10.6 10.5 5.7 64.6 0.1 0.1 0.3 0.1 10.5 10.5 41 Eye lens, insensitive 9.6 19.5 5.7 64.6 0.1 0.1 0.3 0.1 10.5 42 Cornea 10.2 12.5 3.7 73.1 0.1 0.1 0.3 0.1 10.5 43 Aqueous 11.2 0.4 0.1 88.3 10.5 10.5 10.5 44 Vireous 11.2 0.4 0.1 88.3 10.5 10.5 10.5 45 Gall bladder outlet 10.5 25.0 2.7 60.8 0.1 0.2 0.3 0.2 0.2 10.31 46 Gall bladder contents 10.5 25.6 2.7 60.2 0.1 0.2 0.3 0.2 0.2 10.31 47 Stomach wall, Oesophagus 10.6 11.4 2.4 75.0 0.1 0.1 0.2 0.3 0.2 0.2 10.31 46 Gl contents 10.5 11.4 2.5 75.0 0.1 0.1 0.1 0.2 0.1 10.36 49 Gl contents 10.6 11.4 2.5 75.0 0.1 0.1 0.2 0.3 0.2 0.1 10.36 49 Gl contents 10.5 10.5 2.6 75.5 0.1 0.2 0.2 0.2 0.1 10.35 51 Kidney <td>39</td> <td>Breast, glandular tissue</td> <td>10.6</td> <td>32.4</td> <td>3.0</td> <td>53.5</td> <td>0.1</td> <td></td> <td>0.1</td> <td>0.1</td> <td>0.1</td> <td></td> <td></td> <td></td> <td></td> <td>1 021</td>	39	Breast, glandular tissue	10.6	32.4	3.0	53.5	0.1		0.1	0.1	0.1					1 021
41Eye lens, insensitive9.619.55.764.60.10.10.30.110.810.842Cornea10.212.53.773.10.10.10.20.11.00543Aqueous11.20.40.188.31.0151.051.0544Vitreous11.20.40.188.31.0131.01545Gall bladder wall, Pituitary gland, Salivary glands, Tonsils, Spinal cord, Ureter10.525.02.760.80.10.20.30.20.21.03146Gall bladder contents10.525.62.760.20.10.10.10.20.11.03647Stomach wall, Oesophagus10.611.42.475.00.10.10.10.20.11.03648Small intestine wall, Colon wall10.511.42.575.00.10.10.10.20.11.03649Gl contents10.02.0.22.22.464.40.10.20.30.10.41.03351Kidney10.312.73.072.90.20.20.20.20.11.04352Liver10.213.33.172.20.20.20.20.30.20.11.04352Liver10.84.41.282.80.30.10.40.11.03154Lymphatic nodes <t< td=""><td>40</td><td>Eve lens sensitive</td><td>9.6</td><td>19.5</td><td>57</td><td>64.6</td><td>0.1</td><td></td><td>0.1</td><td>0.2</td><td>0.1</td><td></td><td></td><td></td><td></td><td>1.021</td></t<>	40	Eve lens sensitive	9.6	19.5	57	64.6	0.1		0.1	0.2	0.1					1.021
41101012.53.7 613 611 611 613 611 611 613 611 <	41	Eve lens, insensitive	9.6	19.5	57	64.6	0.1		0.1	0.3	0.1					1.082
43 Aqueous 11.2 0.4 0.1 88.3 1005 44 Vireous 11.2 0.4 0.1 88.3 1005 45 Gall bladder wall, Pituitary gland, Salivary gland, Salivary 10.5 25.0 2.7 60.8 0.1 0.2 0.3 0.2 0.2 10.3 46 Gall bladder contents 10.5 25.6 2.7 60.2 0.1 0.2 0.3 0.2 0.2 10.3 47 Stomach wall, Oesophagus 10.6 11.4 2.4 75.0 0.1 0.1 0.2 0.3 0.2 0.2 10.30 48 Small intestine wall, Colon wall 10.5 11.4 2.5 75.0 0.1 0.1 0.2 0.3 0.1 0.4 0.1 1.030 50 Heart wall 10.5 11.4 2.5 75.0 0.1 0.2 0.3 0.1 0.4 0.1 1.030 50 Heart wall 10.5 10.5 2.6 75.5 0.1 0.2 0.3 0.1 0.4 0.1 1	42	Cornea	10.2	12.5	37	73.1	0.1		0.1	0.2	0.1					1.075
44Virrous11.20.10.188.3100345Gall bladder wall, Pituitary gland, Salivary glands, Tonsils, Spinal cord, Ureter10.525.02.7 60.8 0.10.20.30.20.21.03146Gall bladder contents10.525.62.7 60.2 0.10.20.30.20.21.03147Stomach wall, Oesophagus10.611.42.475.00.10.10.10.20.11.03248Small intestine wall, Colon wall10.511.42.575.00.10.10.10.20.11.03649GI contents10.022.22.264.40.10.20.30.10.40.11.03650Heart wall10.510.52.675.50.10.20.10.40.11.03051Kidney10.312.73.072.90.20.20.20.20.11.04351Liver10.310.83.274.70.10.10.20.30.20.11.05252Liver10.310.83.274.70.10.10.20.30.20.10.10.40154Lymphatic nodes10.84.41.282.80.30.10.40.10.10.40155Muscle10.214.23.471.10.10.20.30.1	43	Aqueous	11.2	0.4	0.1	88.3	0.1		0.1	0.2	0.1					1 005
45Gall bladder wall, Pituitary gland, Salivary glands, Tonsils, Spinal cord, Ureter10.525.02.760.80.10.20.30.20.210.346Gall bladder contents10.525.62.760.20.10.20.30.20.20.210.347Stomach wall, Oesophagus10.611.42.475.00.10.10.10.20.30.20.20.110.348Small intestine wall, Colon wall10.511.42.575.00.10.10.10.10.20.110.449GI contents10.510.52.67.50.10.10.20.30.10.40.110.3650Heart wall10.511.42.475.00.10.10.10.20.30.10.40.110.3651Kidney10.510.52.67.50.10.20.20.20.20.30.40.110.3652Liver10.312.73.072.90.20.20.20.20.20.30.20.110.453Lung10.310.213.33.172.20.20.20.20.20.20.10.10.254Lymphatic nodes10.84.41.282.80.30.10.10.40.10.10.410.3155Muscle10.2 <td>44</td> <td>Vitreous</td> <td>11.2</td> <td>0.4</td> <td>0.1</td> <td>88.3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1 013</td>	44	Vitreous	11.2	0.4	0.1	88.3										1 013
45bit of the spinal contrary glands, Tonsils, Spinal cond, Ureter10.525.02.760.80.10.20.30.20.21.03146Gall bladder contents10.525.62.760.20.10.20.30.20.20.21.03047Stomach wall, Oesophagus10.611.42.475.00.10.10.10.20.10.10.20.11.03648Small intestine wall, Colon wall10.022.22.264.40.10.20.30.10.40.11.03649GI contents10.022.22.264.40.10.20.30.10.40.11.03650Heart wall10.510.52.675.50.10.20.20.20.20.30.10.40.11.03351Kidney10.312.73.072.90.20.20.20.20.30.20.30.10.40.11.04353Lung10.310.83.274.70.10.10.20.30.20.10.10.40.10.40.10.40154Lymphatic nodes10.84.41.282.80.30.10.40.40.10.40.10.3155Muscle10.610.410.60.20.30.10.40.40.10.3356Goads		Gall bladder wall Pituitary gland Saliyary	11.2	0.1	0.1	00.5										1.015
46 Gall bladder contents 10.5 25.6 2.7 60.2 0.1 0.2 0.3 0.2 0.2 10.30 47 Stomach wall, Oesophagus 10.6 11.4 2.4 75.0 0.1 0.1 0.1 0.2 0.1 10.3 10.36 48 Small intestine wall, Colon wall 10.5 11.4 2.5 75.0 0.1 0.1 0.1 0.2 0.1 10.3 10.3 10.3 10.3 10.3 10.3 10.3 10.3 10.3 10.3 10.5 2.6 75.5 0.1 0.2 0.3 0.1 0.4 0.1 10.30 50 Heart wall 10.5 10.5 2.6 75.5 0.1 0.2 0.3 0.1 0.4 0.1 10.30 51 Kidney 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.1 0.4 0.1 10.5 10.5 2.6 75.5 0.1 0.2 0.3 0.2 0.3 10.4 10.4 10.4 10.4 10.4 <t< td=""><td>45</td><td>glands Tonsils Spinal cord Ureter</td><td>10.5</td><td>25.0</td><td>2.7</td><td>60.8</td><td>0.1</td><td></td><td>0.2</td><td>0.3</td><td>0.2</td><td>0.2</td><td></td><td></td><td></td><td>1.031</td></t<>	45	glands Tonsils Spinal cord Ureter	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2				1.031
47 Stomach wall, Oesophagus 10.6 11.4 2.4 75.0 0.1 0.1 0.2 0.1 10.5 48 Small intestine wall, Colon wall 10.5 11.4 2.5 75.0 0.1 0.1 0.1 0.2 0.1 10.36 49 GI contents 10.0 22.2 2.2 64.4 0.1 0.2 0.3 0.1 0.4 0.1 10.3 50 Heart wall 10.5 10.5 2.6 75.5 0.1 0.2 0.3 0.1 0.4 0.1 10.3 51 Kidney 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.1 0.43 52 Liver 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.2 0.1 0.43 53 Lung 10.3 10.3 3.1 72.2 0.2 0.2 0.2 0.2 0.1 0.401 1.052 54 Lymphatic nodes 10.3 10.8 3.2 74.7 0.1 </td <td>46</td> <td>Gall bladder contents</td> <td>10.5</td> <td>25.6</td> <td>27</td> <td>60.2</td> <td>0.1</td> <td></td> <td>0.2</td> <td>0.3</td> <td>0.2</td> <td>0.2</td> <td></td> <td></td> <td></td> <td>1.030</td>	46	Gall bladder contents	10.5	25.6	27	60.2	0.1		0.2	0.3	0.2	0.2				1.030
48 Small intestine wall, Cool wall 10.5 11.4 2.7 50 0.1 0.1 0.1 0.2 0.1 10.3 49 GI contents 10.0 22.2 2.2 64.4 0.1 0.2 0.3 0.1 0.4 0.1 10.30 50 Heart wall 10.5 10.5 2.6 75.5 0.1 0.2 0.3 0.1 0.4 0.1 10.30 50 Heart wall 10.5 10.5 2.6 75.5 0.1 0.2 0.1 0.2 0.3 10.4 1.030 51 Kidney 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.2 0.3 1.043 52 Liver 10.2 13.3 3.1 72.2 0.2 0.2 0.2 0.3 0.2 0.3 1.060 53 Lung 10.3 10.8 3.2 74.7 0.1 0.1 0.2 0.3 0.2 0.1 0.401 54 Lymphatic nodes 10.8 4.4 1.	47	Stomach wall Oesophagus	10.5	11.4	2.7	75.0	0.1		0.1	0.1	0.2	0.1				1.036
49 GI contents 10.0 22.2 2.2 64.4 0.1 0.2 0.3 0.1 0.4 0.1 10.30 50 Heart wall 10.5 10.5 2.6 75.5 0.1 0.2 0.3 0.1 0.4 0.1 10.30 51 Kidney 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.3 10.4 1.043 52 Liver 10.2 13.3 3.1 72.2 0.2 0.2 0.2 0.3 0.1 0.4 0.1 1.050 53 Lung 10.3 10.8 3.2 74.7 0.1 0.1 0.2 0.3 0.2 0.1 0.401 54 Lymphatic nodes 10.8 4.4 1.2 82.8 0.3 0.1 0.4 0.4 1.031 55 Muscle 10.6 10.0 2.1 76.4 0.2 0.1 0.4 0.4 1.031 56 Gonads 10.6 10.0 2.1 76.4 0.2 0.1	48	Small intestine wall Colon wall	10.5	11.4	2.5	75.0	0.1		0.1	0.1	0.2	0.1				1.036
50 Heart wall 10.5 10.5 2.2 0.1 0.1 0.2 0.1 0.7 0.1 10.5 51 Kidney 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.2 0.1 0.12 10.3 52 Liver 10.2 13.3 3.1 72.9 0.2 0.2 0.2 0.2 0.1 10.52 53 Lung 10.3 10.8 3.2 74.7 0.1 0.1 0.2 0.3 0.2 0.1 0.401 54 Lymphatic nodes 10.8 4.4 1.2 82.8 0.3 0.1 0.4 1.031 55 Muscle 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 0.2 0.1 0.4 56 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 0.2 1.041	49	GI contents	10.0	22.2	2.0	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1 030
50 Hear Wair 10.3 12.7 3.0 72.9 0.1 0.2 0.2 0.2 0.1 10.3 10.5 51 Kidney 10.3 12.7 3.0 72.9 0.2 0.2 0.2 0.2 0.2 0.1 10.55 52 Liver 10.2 13.3 3.1 72.2 0.2 0.2 0.3 0.2 0.3 10.60 53 Lung 10.3 10.8 3.2 74.7 0.1 0.1 0.2 0.3 0.2 0.1 0.401 54 Lymphatic nodes 10.8 4.4 1.2 82.8 0.3 0.1 0.4 1.031 1.031 55 Muscle 10.2 14.2 3.4 71.1 0.1 0.2 0.3 0.1 0.4 1.050 56 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 0.2 1.041	50	Heart wall	10.5	10.5	2.2	75.5	0.1		0.2	0.1	0.1	0.3	0.1			1.030
52 Liver 10.2 13.3 3.1 72.2 0.2 0.2 0.2 0.2 0.3 0.1 0.1 53 Lung 10.3 10.8 3.2 74.7 0.1 0.1 0.2 0.3 0.2 0.1 0.401 54 Lymphatic nodes 10.8 4.4 1.2 82.8 0.3 0.1 0.4 1.031 55 Muscle 10.2 14.2 3.4 71.1 0.1 0.2 0.3 0.1 0.4 1.031 55 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 0.1 0.4	51	Kidney	10.3	12.7	3.0	72.9	0.2		0.2	0.2	0.2	0.2	0.1			1.052
53 Lun 10.3 10.8 3.1 74.7 0.1 0.1 0.2 0.3 0.2 0.1 0.401 54 Lymphatic nodes 10.8 4.4 1.2 82.8 0.3 0.1 0.4 0.1 0.1 0.4 1.031 55 Muscle 10.6 10.2 3.4 71.1 0.1 0.2 0.3 0.1 0.4 1.031 55 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 1.041	52	Liver	10.2	13.3	31	72.2	0.2		0.2	0.3	0.2	0.2	0.1			1.052
54 Lymphatic nodes 10.8 4.4 1.2 82.8 0.3 0.1 0.4 1.031 55 Muscle 10.2 14.2 3.4 71.1 0.1 0.2 0.3 0.1 0.4 1.031 56 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 1.041	53	Lung	10.3	10.8	3.2	74 7	0.1		0.1	0.2	0.3	0.2		0.1		0.401
55 Muscle 10.2 14.2 3.4 71.1 0.1 0.2 0.3 0.1 0.4 1.050 56 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.1 0.4 1.050	54	Lymphatic nodes	10.8	44	1.2	82.8	03		0.1	0.1	0.5	0.2		0.1		1 031
56 Gonads 10.6 10.0 2.1 76.4 0.2 0.1 0.2 0.2 0.2 1.041	55	Muscle	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1 050
	56	Gonads	10.6	10.0	2.1	76.4	0.2		0.1	0.2	0.2	0.2				1.041



57	Pancreas	10.5	15.9	2.4	70.3	0.2		0.2	0.1	0.2	0.2			1.043
58	Prostate	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2			1.031
59	RST	11.1	39.1	1.0	48.2	0.1		0.2	0.2	0.1				0.979
60	Skin	10.0	20.0	4.2	64.9	0.2		0.1	0.2	0.3	0.1			1.098
61	Spleen	10.3	11.2	3.2	74.2	0.1		0.3	0.2	0.2	0.3			1.060
62	Permanent, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		3.000
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1		1.030
68	Thymus	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2			1.026
69	Thyroid	10.4	11.8	2.5	74.5	0.2		0.1	0.1	0.2	0.1		0.1	1.051
70	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2		0.2	0.2	0.3	0.3			1.040
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000



1643 Table B.6. List of media, their elemental compositions (percent by mass) and their mass densities for the 5-year-old female phantom.

Medium no.		Н	С	Ν	0	Na	Mg	Р	S	Cl	К	Ca	Fe	Ι	Density (g/cm ³)
1	Adrenal	10.5	28.2	2.6	57.9	0.1		0.2	0.2	0.1	0.2				1.026
2	ET, Trachea, BB, bb	10.1	20.4	2.3	64.9	0.3		1.2	0.5	0.2	0.1				1.060
3	Oral mucosa, Tongue	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4		0.1		1.050
4	Blood	10.2	11.0	3.3	74.5	0.1	0.2	0.1	0.2	0.3	0.2	17.2	0.1		1.060
5	Lumori upper epongiose	4.0	10.4	4.5	48.0	0.1	0.2	8.2	0.3	0.1	0.1	17.5	0.1		1.041
7	Humeri upper, medullary cavity	0.5 10.7	42.1	2.5	47.5	0.1	0.1	0.1	0.2	0.1	0.1	0.5	0.1		1.239
8	Humeri lower spongiosa	85	32.2	2.0	46.1	0.1	0.1	3.0	0.2	0.2	0.1	63	0.1		1.023
9	Humeri lower medullary cavity	10.7	42.6	2.7	43.2	0.1	0.1	0.1	0.2	0.1	0.2	0.5	0.1		1.022
10	Radii, spongiosa	8.9	35.8	3.0	43.8	0.1	0.1	2.6	0.2	0.1	0.1	5.3	0.1		1.209
11	Ulnae, spongiosa	8.5	33.7	3.1	44.6	0.1	0.1	3.1	0.2	0.1	0.1	6.4			1.248
12	Radii, medullary cavity	10.8	46.6	2.3	39.6			0.1	0.2	0.2	0.1		0.1		1.014
13	Ulnae, medullary cavity	10.8	46.5	2.4	39.6			0.1	0.2	0.2	0.1		0.1		1.014
14	Wrists and hand bones, spongiosa	9.0	41.2	2.4	38.3	0.1	0.1	2.8	0.2	0.1		5.8			1.212
15	Clavicles, spongiosa	8.8	32.8	3.3	46.9	0.1		2.5	0.2	0.1	0.1	5.1	0.1		1.207
16	Cranium, spongiosa	7.7	27.2	3.6	48.5	0.1	0.1	4.0	0.2	0.1	0.1	8.4			1.326
17	Femora, upper, spongiosa	8.3	30.4	3.5	47.5	0.1	0.1	3.1	0.2	0.1	0.1	6.5	0.1		1.257
18	Femora, upper, medullary cavity	10.7	42.1	2.8	43.7	0.1	0.1	0.1	0.2	0.2	0.1	57	0.1		1.023
19	Femore, lower, sponglosa	0.7 10.7	33.2 42.6	5.2	43.0	0.1	0.1	2.0	0.2	0.1	0.1	5.7	0.1		1.220
20	Tibiae spongiosa	10.7	42.0	2.7	43.3	0.1	0.1	2.7	0.2	0.2	0.1	57	0.1		1.022
22	Fibulae spongiosa	93	38.3	2.9	42.8	0.1	0.1	2.0	0.2	0.1	0.1	41	0.1		1 165
23	Patellae, spongiosa	10.0	42.2	2.6	41.3	0.1		1.1	0.2	0.1	0.1	2.2	0.1		1.093
24	Tibiae, medullary cavity	10.8	46.6	2.3	39.6			0.1	0.2	0.2	0.1		0.1		1.014
25	Fibulae, medullary cavity	10.8	46.5	2.3	39.6	0.1		0.1	0.2	0.2	0.1		0.1		1.014
26	Ankles and foot, spongiosa	8.8	40.3	2.5	38.8	0.1	0.1	2.9	0.2	0.1	0.1	6.1			1.225
27	Mandible, spongiosa	8.0	28.6	3.6	48.1	0.1	0.1	3.6	0.2	0.1	0.1	7.5			1.295
28	Pelvis, spongiosa	9.2	34.5	3.2	46.4	0.1		2.0	0.2	0.2	0.1	4.0	0.1		1.170
29	Ribs, spongiosa	8.8	31.8	3.4	47.7	0.1	0.1	2.5	0.2	0.1	0.1	5.1	0.1		1.209
30	Scapulae, spongiosa	8.6	31.7	3.4	47.3	0.1	0.1	2.7	0.2	0.1	0.1	5.6	0.1		1.227
31	Cervical spine, spongiosa	8.8	31.9	3.4	47.7	0.1	0.1	2.5	0.2	0.1	0.1	5.0	0.1		1.207
32	Lumber spine, spongiosa	9.5	21.0	3.5	47.2	0.1	0.1	1.0	0.2	0.2	0.1	5.0	0.1		1.137
33	Sacrum spongiosa	0.0 9.5	35.6	3.4	46.1	0.1	0.1	2.4	0.2	0.2	0.1	3.0	0.1		1.200
35	Sternum spongiosa	94	34.6	3 3	47.1			1.7	0.2	0.2	0.1	33	0.1		1 146
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3	0.1	010	0.1		1.099
37	Brain	10.7	14.3	2.2	71.4	0.2		0.4	0.2	0.3	0.3				1.041
38	Breast, adipose tissue	11.3	43.4	0.7	44.3	0.1			0.1	0.1					0.963
39	Breast, glandular tissue	10.6	32.5	3.0	53.4	0.1		0.1	0.2	0.1					1.021
40	Eye lens, sensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.050
41	Eye lens, insensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.082
42	Cornea	10.2	12.5	3.7	73.1	0.1		0.1	0.2	0.1					1.075
43	Aqueous	11.2	0.4	0.1	88.3										1.005
44	Call bladder well Bituitery gland Selivery	11.2	0.4	0.1	00.5										1.015
45	glands Tonsils Spinal cord Ureter	10.6	30.8	2.4	55.4	0.1		0.2	0.2	0.1	0.2				1.021
46	Gall bladder contents	10.6	31.5	24	54 7	0.1		0.2	0.2	0.1	0.2				1.020
47	Stomach wall. Oesophagus	10.6	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.036
48	Small intestine wall, Colon wall	10.5	11.4	2.5	75.0	0.1		0.1	0.1	0.2	0.1				1.036
49	GI contents	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1.030
50	Heart wall	10.5	10.5	2.6	75.5	0.1		0.2	0.1	0.2	0.3				1.043
51	Kidney	10.3	12.7	3.0	72.9	0.2		0.2	0.2	0.2	0.2	0.1			1.052
52	Liver	10.2	13.3	3.1	72.2	0.2		0.2	0.3	0.2	0.3		<u>.</u>		1.060
53	Lung	10.3	10.8	3.2	74.7	0.1		0.1	0.2	0.3	0.2		0.1		0.401
54 55	Lympnatic nodes	10.8	4.4	1.2	82.8	0.3		0.2	0.1	0.4	0.4				1.031
<i>33</i> 56	Gonads	10.2	14.2 9.4	5.4 2.4	76.7	0.1		0.2	0.5	0.1	0.4				1.050
50	Contado	10.5	2.7	4.7	/0./	0.2		0.4	0.2	0.2	0.2				1.001



57 58	Pancreas Uterus	10.5 10.5	15.9 9.4	2.4 2.4	70.3 76.7	0.2 0.2		0.2	0.1 0.2	0.2 0.2	0.2			1.043 1.050
59	RST	11.1	39.5	1.0	47.8	0.1		0.2	0.2	0.1				0.979
60	Skin	10.0	20.0	4.2	64.9	0.2		0.1	0.2	0.3	0.1			1.098
61	Spleen	10.3	11.2	3.2	74.2	0.1		0.3	0.2	0.2	0.3			1.060
62	Permanent, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		3.000
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1		1.030
68	Thymus	10.6	30.8	2.4	55.4	0.1		0.2	0.2	0.1	0.2			1.026
69	Thyroid	10.4	11.8	2.5	74.5	0.2		0.1	0.1	0.2	0.1		0.1	1.051
70	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2		0.2	0.2	0.3	0.3			1.040
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000



Table B.7. List of media, their elemental compositions (percent by mass) and their mass densities for the 10-year-old male phantom.

Medium		н	C	N	0	Na	Μα	D	S	Cl	K	Ca	Fe	т	Density
no.		11	C	1	0	INA	wig	1	5	CI	К	Ca	10	1	(g/cm ³)
1	Adrenal	10.5	23.2	2.8	62.5	0.1		0.2	0.3	0.2	0.2				1.035
2	ET, Trachea, BB, bb	10.1	17.5	2.5	67.6	0.3		1.1	0.6	0.2	0.1				1.065
3	Oral mucosa, Tongue	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
4	Blood	10.2	11.0	3.3	74.5	0.1		0.1	0.2	0.3	0.2		0.1		1.060
5	Cortical hone	43	16.1	43	47.2	0.1	0.2	8.9	0.3	0.0	0.2	18.6	0.1		1 701
6	Humeri upper spongiosa	9.0	34.5	31	45.4	0.1	0.1	2.4	0.2	0.1	0.1	49	0.1		1 203
7	Humeri upper, sponglosa Humeri upper, medullary cavity	10.9	48.8	2.2	37.5	0.1	0.1	0.1	0.2	0.2	0.1	,	0.1		1 010
8	Humeri lower spongiosa	93	42.0	2.2	38.7	0.1		2.3	0.2	0.1	0.1	48			1 182
ğ	Humeri lower medullary cavity	10.9	49.1	2.1	37.2	0.1		0.1	0.2	0.1	0.1	4.0			1.009
10	Radii spongiosa	9.4	43.6	2.1	37.4	0.1		2.2	0.2	0.1	0.1	4.6			1 174
11	Ulnae spongiosa	9.1	41.0	2.5	38.7	0.1	0.1	2.2	0.2	0.1	0.1	5.5			1 210
12	Radii medullary cavity	11.2	56.0	1.5	30.9	0.1	0.1	2.7	0.2	0.1	0.1	5.5			0.996
12	Ulnae medullary cavity	11.2	56.0	1.5	30.9	0.1			0.1	0.1	0.1				0.996
14	Wrists and hand hones spongiosa	10.0	50.7	1.5	31.7	0.1		1.8	0.1	0.1	0.1	38			1 131
15	Clavicles, spongiosa	0.7	30.7	2.8	12.8	0.1		1.0	0.2	0.1	0.1	20	0.1		1 1 2 7
15	Cranium spongiosa	9.7	22.2	2.0	42.0	0.1	0.1	2.1	0.2	0.2	0.1	6.5	0.1		1.127
10	Eamona ymnar anaraiaaa	0.5	24.1	3.2	45.0	0.1	0.1	2.1	0.2	0.1	0.1	0.5	0.1		1.239
19	Femore, upper, sponglosa	0.9	10 0	3.2	43.5	0.1		2.5	0.2	0.1	0.1	5.2	0.1		1.211
10	Femore, lower, medunary cavity	10.9	40.0	2.2	20.1	0.1		0.1	0.2	0.2	0.1	5 1			1.010
19	Femore, lower, sponglosa	9.2	41.2	2.5	39.1	0.1		2.4	0.2	0.1	0.1	5.1			1.194
20	Titica analyce and the terminal termi	10.9	49.1	2.1	37.2	0.1	0.1	0.1	0.2	0.2	0.1	4.4			1.009
21	Tibiae, spongiosa	9.5	44.1	2.2	3/.1	0.1	0.1	2.1	0.2	0.1	0.1	4.4			1.100
22	Pibliae, spongiosa	9.0	40.5	2.1	30.0	0.1		1.7	0.2	0.1	0.1	5.0			1.155
23	Patenae, spongiosa	10.8	55.1	1.0	32.4	0.1		0.5	0.2	0.1	0.1	1.1			1.036
24	Fibrate, medullary cavity	11.2	56.0	1.5	30.9	0.1			0.1	0.1	0.1				0.996
25	Fibulae, medullary cavity	11.2	56.0	1.5	30.9	0.1		2.0	0.1	0.1	0.1	4.0			0.996
20	Ankles and root, sponglosa	9.8	49.4	1.7	32.5	0.1	0.1	2.0	0.2	0.1	0.1	4.2			1.147
27	Mandible, sponglosa	8.8	33.8	3.1	45.2	0.1	0.1	2.8	0.2	0.1	0.1	5.7	0.1		1.230
20	Pervis, spoligiosa	9.8	36.0	5.0	44.1			1.5	0.2	0.2	0.1	2.0	0.1		1.117
29	Kibs, spoligiosa	9.7	30.7	5.1	43.7	0.1		1.4	0.2	0.2	0.2	2.7	0.1		1.123
30	Complete Sponglosa	9.4	26.1	2.9	45.0	0.1		1.9	0.2	0.2	0.1	5.9	0.1		1.105
22	Thornaia amine, spongiosa	9.0	30.1	5.2	45.9			1.5	0.2	0.2	0.1	5.1	0.1		1.156
32	I noracic spine, spongiosa	9.9	37.0	5.1	45.4			1.1	0.2	0.2	0.1	2.5	0.1		1.108
24	Lumbar spine, spongiosa	9.5	33.0	5.2	40.0			1.0	0.2	0.2	0.1	5.5	0.1		1.140
25	Stormum anonoicee	10.2	20.0	2.9	45.4			0.7	0.2	0.2	0.1	1.4	0.1		1.073
35	Contilogo	10.1	30.0	3.0	45.0	0.5		0.8	0.2	0.2	0.2	1.0	0.1		1.062
30	Proin	9.0	9.9	2.2	74.4	0.5		2.2	0.9	0.5	0.3				1.099
29	Braast adipasa tissua	10.7	14.5	2.3	11.5	0.2		0.4	0.2	0.5	0.5				0.064
20	Breast, alandular tissue	11.5	43.0	2.0	527	0.1		0.1	0.1	0.1					1.022
40	Eve long consistive	10.0	10.5	5.0	55.7	0.1		0.1	0.2	0.1					1.022
40	Eye lens, sensitive	9.0	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.050
41	Compo	9.0	19.5	2.7	72.1	0.1		0.1	0.3	0.1					1.063
42	Aguagus	10.2	12.3	5.7	202	0.1		0.1	0.2	0.1					1.075
43	Vitroous	11.2	0.4	0.1	88.5										1.003
44	Call bladder wall Dituitery aland Saliyary	11.2	0.4	0.1	00.5										1.015
45	clands Tonsils Spinel cord Urster	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2				1.031
16	Gall bladdar contents	10.5	25.6	27	60.2	0.1		0.2	0.2	0.2	0.2				1.020
40	Stomach well Occorbague	10.5	25.0	2.7	75.0	0.1		0.2	0.5	0.2	0.2				1.030
47	Small intesting well Colon well	10.0	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.030
40	GL contents	10.5	22.2	2.5	64.4	0.1		0.1	0.1	0.2	0.1	0.1			1.030
49 50	Hoort well	10.0	10.5	2.2	75.5	0.1		0.2	0.5	0.1	0.4	0.1			1.030
51	Kidney	10.3	12.7	2.0	72.9	0.1		0.2	0.1	0.2	0.3	0.1			1.043
52	Liver	10.2	13.3	3.0	72.2	0.2		0.2	0.2	0.2	0.2	0.1			1.052
53	Lung	10.2	10.8	3.1	74.7	0.2		0.2	0.3	0.2	0.3		0.1		0.420
54	Lymphatic nodes	10.5	4.4	1.2	82.8	0.1		0.1	0.2	0.5	0.2		0.1		1.031
55	Muscle	10.2	14.2	3.4	71.1	0.1		0.2	0.1	0.1	0.4				1.050
56	Gonads	10.6	10.0	2.1	76.4	0.2		0.1	0.2	0.2	0.2				1 042
20		10.0	10.0	<i>2</i> .1	, 0.1	0.2		0.1	0.2	0.2	0.2				1.012



57	Pancreas	10.5	15.9	2.4	70.3	0.2		0.2	0.1	0.2	0.2			1.043
58	Prostate	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2			1.031
59	RST	11.1	39.1	1.0	48.2	0.1		0.2	0.2	0.1				0.979
60	Skin	10.0	20.0	4.2	64.9	0.2		0.1	0.2	0.3	0.1			1.098
61	Spleen	10.3	11.2	3.2	74.2	0.1		0.3	0.2	0.2	0.3			1.060
62	Permanent, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		3.000
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1		1.030
68	Thymus	10.5	25.0	2.7	60.8	0.1		0.2	0.3	0.2	0.2			1.026
69	Thyroid	10.4	11.8	2.5	74.5	0.2		0.1	0.1	0.2	0.1		0.1	1.051
70	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2		0.2	0.2	0.3	0.3			1.040
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000



Table B.8. List of media, their elemental compositions (percent by mass) and their mass densities for the 10-year-old female phantom.

Medium		Н	С	Ν	0	Na	Mg	Р	S	C1	Κ	Ca	Fe	Ι	Density
1	A deserved	10.5	20.2	26	57.0	0.1		0.2	0.2	0.1	0.2				(g/cm)
1	Adrenal	10.5	28.2	2.0	57.9	0.1		0.2	0.2	0.1	0.2				1.026
2	Oral mucasa Tongua	10.1	20.5	2.4	04.9	0.5		1.2	0.3	0.2	0.1				1.000
3	Dian Inucosa, Tongue	10.2	14.2	2.4	71.1	0.1		0.2	0.3	0.1	0.4		0.1		1.050
4	Dioou Contiant home	10.2	16.2	5.5	14.5	0.1	0.2	0.1	0.2	0.5	0.2	196	0.1		1.000
5	Humori uppor spongiosa	4.4	10.5	4.5	47.0	0.1	0.2	0.0	0.3	0.1	0.1	18.0	0.1		1.701
0 7	Humeri, upper, spongiosa	9.0	34.7	3.1	43.2	0.1	0.1	2.4	0.2	0.1	0.1	4.9	0.1		1.203
/ 0	Humeri, upper, medunary cavity	10.9	49.0	2.2	37.5	0.1		0.1	0.1	0.2	0.1	1.9			1.010
0	Humeri, lower, spoligiosa	9.5	42.2	2.4	30.3 27.1	0.1		2.5	0.2	0.1	0.1	4.0			1.162
10	Padii apongiosa	10.9	49.3	2.1	27.2	0.1		0.1	0.1	0.2	0.1	16			1.009
10	Kauli, spoligiosa	9.4	45.7	2.5	37.5	0.1	0.1	2.2	0.2	0.1	0.1	4.0			1.1/4
12	Padii madullaru aavitu	9.1	41.2 56.2	2.4	20.9	0.1	0.1	2.7	0.2	0.1	0.1	5.5			0.005
12	Ulnea medullary cavity	11.2	56.2	1.4	20.7	0.1			0.1	0.1	0.1				0.995
13	Wrists and hand honos, spongiosa	10.0	50.2	1.5	30.7	0.1		1.9	0.1	0.1	0.1	2.9			0.995
14	Clavicles, spongiosa	0.0	30.9	2.8	42.6	0.1		1.0	0.1	0.1	0.1	2.0	0.1		1.131
15	Cranium spongiosa	9.0	32.0	2.0	42.0	0.1	0.1	3.1	0.2	0.1	0.1	6.5	0.1		1.120
17	Eamora upper spongiosa	8.5	24.2	2.1	45.0	0.1	0.1	2.5	0.2	0.1	0.1	5.2	0.1		1.239
18	Femora, upper, medullary cavity	10.9	49.0	2.2	37.3	0.1		0.1	0.2	0.1	0.1	5.2	0.1		1.010
10	Femora lower spongiosa	0.2	41.4	2.2	38.0	0.1	0.1	2.4	0.1	0.2	0.1	5 1			1 104
20	Femora lower medullary cavity	10.0	41.4	2.4	37.1	0.1	0.1	0.1	0.2	0.1	0.1	5.1			1.194
20	Tibiae spongiosa	0.5	49.5	2.1	37.0	0.1		2.1	0.1	0.2	0.1	4.4			1.009
21	Fibulae spongiosa	9.5	46.5	2.2	35.8	0.1		17	0.2	0.1	0.1	3.6			1 1 3 4
22	Patellae, spongiosa	10.8	53.3	1.6	32.3	0.1		0.5	0.2	0.1	0.1	1.1			1.036
23	Tibiaa medullary cavity	11.2	56.2	1.0	30.8	0.1		0.5	0.1	0.1	0.1	1.1			0.005
24	Fibulae medullary cavity	11.2	56.2	1.4	30.8	0.1			0.1	0.1	0.1				0.995
26	Ankles and foot spongiosa	9.8	49.6	1.4	32.3	0.1		2.0	0.1	0.1	0.1	4.2			1 147
20	Mandible spongiosa	8.8	34.0	3.1	45.0	0.1	0.1	2.0	0.2	0.1	0.1	57			1.147
28	Pelvis spongiosa	9.8	38.7	2.9	44.0	0.1	0.1	13	0.2	0.1	0.1	2.6	0.1		1 1 1 6
20	Ribs spongiosa	9.7	36.9	3.1	45.5	0.1		1.5	0.2	0.2	0.1	2.0	0.1		1 1 2 5
30	Scanulae spongiosa	94	37.6	2.9	43.7	0.1		1.9	0.2	0.1	0.1	3.9	0.1		1 162
31	Cervical spine spongiosa	9.6	36.3	31	45.7	0.1		1.5	0.2	0.2	0.1	31	0.1		1 1 3 8
32	Thoracic spine, spongiosa	99	37.7	31	45.3	0.1		11	0.2	0.2	0.1	2.3	0.1		1 107
33	Lumbar spine, spongiosa	95	35.9	3.2	45.8	0.1		1.6	0.2	0.2	0.1	3 3	0.1		1 146
34	Sacrum, spongiosa	10.2	41.0	2.8	43.2	0.1		0.8	0.2	0.2	0.1	1.4	0.1		1.073
35	Sternum, spongiosa	10.1	39.0	3.0	44.9			0.8	0.2	0.2	0.2	1.5	0.1		1.081
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3					1.099
37	Brain	10.7	14.3	2.2	71.4	0.2		0.4	0.2	0.3	0.3				1.041
38	Breast, adipose tissue	11.3	43.2	0.7	44.5	0.1			0.1	0.1					0.964
39	Breast, glandular tissue	10.6	32.4	3.0	53.5	0.1		0.1	0.2	0.1					1.021
40	Eye lens, sensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.050
41	Eye lens, insensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.083
42	Cornea	10.2	12.5	3.7	73.1	0.1		0.1	0.2	0.1					1.075
43	Aqueous	11.2	0.4	0.1	88.3										1.005
44	Vitreous	11.2	0.4	0.1	88.3										1.013
15	Gall bladder wall, Pituitary gland, Salivary	10.6	20.7	2.4	55 5	0.1		0.2	0.2	0.1	0.2				1.021
43	glands, Tonsils, Spinal cord, Ureter	10.0	50.7	2.4	55.5	0.1		0.2	0.2	0.1	0.2				1.021
46	Gall bladder contents	10.6	31.5	2.4	54.7	0.1		0.2	0.2	0.1	0.2				1.020
47	Stomach wall, Oesophagus	10.6	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.036
48	Small intestine wall, Colon wall	10.5	11.4	2.5	75.0	0.1		0.1	0.1	0.2	0.1				1.036
49	GI contents	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1.030
50	Heart wall	10.5	10.5	2.6	75.5	0.1		0.2	0.1	0.2	0.3				1.043
51	Kidney	10.3	12.7	3.0	72.9	0.2		0.2	0.2	0.2	0.2	0.1			1.052
52	Liver	10.2	13.3	3.1	72.2	0.2		0.2	0.3	0.2	0.3				1.060
53	Lung	10.3	10.8	3.2	74.7	0.1		0.1	0.2	0.3	0.2		0.1		0.429
54	Lymphatic nodes	10.8	4.4	1.2	82.8	0.3			0.1	0.4					1.032
55	Muscle	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
56	Gonads	10.5	9.4	2.4	76.7	0.2		0.2	0.2	0.2	0.2				1.050



57	Pancreas	10.5	15.9	2.4	70.3	0.2		0.2	0.1	0.2	0.2			1.043
58	Uterus	10.5	9.4	2.4	76.7	0.2		0.2	0.2	0.2	0.2			1.050
59	RST	11.1	39.6	1.0	47.7	0.1		0.2	0.2	0.1				0.979
60	Skin	10.0	20.0	4.2	64.9	0.2		0.1	0.2	0.3	0.1			1.098
61	Spleen	10.3	11.2	3.2	74.2	0.1		0.3	0.2	0.2	0.3			1.060
62	Permanent, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		3.000
63	Deciduous, enamel	0.4	0.7	0.2	43.4		0.3	18.0				37.0		2.840
64	Permanent, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
65	Deciduous, dentin and cementum	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.185
66	Pulp	10.8	4.1	1.1	83.2	0.3			0.1	0.4				1.021
67	Teeth, retention region	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1		1.030
68	Thymus	10.6	30.7	2.4	55.5	0.1		0.2	0.2	0.1	0.2			1.026
69	Thyroid	10.4	11.8	2.5	74.5	0.2		0.1	0.1	0.2	0.1		0.1	1.051
70	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2		0.2	0.2	0.3	0.3			1.040
71	Urine	10.7	0.3	1.0	87.3	0.4		0.1			0.2			1.010
72	Air inside body			80.0	20.0									0.001
73	Water	11.2			88.8									1.000



1652 Table B.9. List of media, their elemental compositions (percent by mass) and their mass densities for the 15-year-old male phantom.

Medium		Н	С	Ν	0	Na	Mg	Р	S	Cl	K	Ca	Fe	Ι	Density
1	Adrenal	10.4	22.8	2.8	63.0	0.1	U	0.2	03	0.2	0.2				(g/cm²)
2	ET. Trachea, BB, bb	10.1	17.4	2.5	67.7	0.3		1.1	0.6	0.2	0.1				1.065
3	Oral mucosa, Tongue	10.2	14.1	3.4	71.2	0.1		0.2	0.3	0.1	0.4				1.051
4	Blood	10.2	11.0	3.3	74.5	0.1		0.1	0.2	0.3	0.2		0.1		1.060
5	Cortical bone	4.3	16.1	4.3	47.0	0.1	0.2	8.9	0.3			18.8			1.752
6	Humeri, upper, spongiosa	9.9	40.9	2.6	42.1	0.1		1.3	0.2	0.2	0.1	2.6			1.118
7	Humeri, upper, medullary cavity	11.1	52.1	1.8	34.5	0.1			0.1	0.2	0.1				1.003
8	Humeri, lower, spongiosa	9.9	49.7	1.7	32.7	0.1		1.8	0.2	0.1		3.8			1.144
9	Humeri, lower, medullary cavity	11.2	56.4	1.4	30.6	0.1			0.1	0.1	0.1				0.995
10	Radii, spongiosa	10.0	50.6	1.6	32.1	0.1		1.7	0.2	0.1		3.6			1.133
11	Ulnae, spongiosa	9.7	48.2	1.8	33.6	0.1		2.0	0.2	0.1		4.3			1.164
12	Radii, medullary cavity	11.5	62.5	0.8	24.9	0.1			0.1	0.1					0.983
13	Ulnae, medullary cavity	11.5	62.5	0.8	24.9	0.1		1.1	0.1	0.1		2.2			0.983
14	Clauislas, ano nano bones, spongiosa	10.6	35.1	1.5	29.4	0.1		1.1	0.1	0.1	0.1	2.2	0.1		1.076
15	Cranium spongiosa	9.8	40.7	2.0	41.9	0.1	0.1	1.4	0.2	0.2	0.1	2.9	0.1		1.150
10	Famora upper spongiosa	9.0	20.0	5.0 2.7	44.7	0.1	0.1	2.3	0.2	0.1	0.1	3.1	0.1		1.220
18	Femora upper, medullary cavity	9.0	52.1	2.7	42.9	0.1		1.7	0.2	0.2	0.1	5.4	0.1		1.003
10	Femora lower spongiosa	9.5	46.3	1.0	34.7	0.1	0.1	23	0.1	0.2	0.1	48			1.005
20	Femora lower medullary cavity	11.2	56.4	1.9	30.6	0.1	0.1	2.5	0.2	0.1	0.1	4.0			0.995
20	Tibiae spongiosa	10.6	55.1	1.4	29.4	0.1		1.1	0.1	0.1	0.1	2.2			1.077
22	Fibulae, spongiosa	10.0	50.2	1.6	32.4	0.1		1.8	0.1	0.1		3.7			1.138
23	Patellae, spongiosa	10.6	55.1	1.3	29.4	0.1		1.1	0.1	0.1		2.2			1.076
24	Tibiae, medullary cavity	11.5	62.5	0.8	24.9	0.1			0.1	0.1					0.983
25	Fibulae, medullary cavity	11.5	62.5	0.8	24.9	0.1			0.1	0.1					0.983
26	Ankles and foot, spongiosa	10.6	55.1	1.3	29.4	0.1		1.1	0.1	0.1		2.2			1.076
27	Mandible, spongiosa	9.2	36.4	2.9	44.1	0.1		2.2	0.2	0.1	0.1	4.6	0.1		1.198
28	Pelvis, spongiosa	10.2	40.7	2.7	43.1	0.1		0.9	0.2	0.2	0.1	1.7	0.1		1.088
29	Ribs, spongiosa	10.0	37.9	3.0	45.5			1.0	0.2	0.2	0.1	2.0	0.1		1.101
30	Scapulae, spongiosa	9.1	35.6	2.9	44.5	0.1	0.1	2.4	0.2	0.1	0.1	4.9			1.213
31	Cervical spine, spongiosa	9.8	36.7	3.0	45.9	0.1		1.3	0.2	0.2	0.1	2.6	0.1		1.126
32	Thoracic spine, spongiosa	9.9	37.7	3.0	45.6			1.1	0.2	0.2	0.1	2.1	0.1		1.106
33	Lumbar spine, spongiosa	10.1	38.3	3.0	45.4			0.9	0.2	0.2	0.1	1.7	0.1		1.092
34	Sacrum, spongiosa	10.4	42.4	2.6	42.5	0.1		0.5	0.2	0.2	0.1	0.9	0.1		1.056
35	Sternum, spongiosa	10.1	38.7	2.9	45.2	0.1		0.8	0.2	0.2	0.2	1.5	0.1		1.084
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3	0.2				1.099
37	Brain	10.7	14.3	2.2	/1.4	0.2		0.4	0.2	0.3	0.3				1.041
38	Breast, adipose tissue	11.2	42.7	0.8	45.0	0.1		0.1	0.1	0.1					0.965
39	Eve long congitive	10.6	32.0	3.0 5.7	55.9	0.1		0.1	0.2	0.1					1.022
40	Eye lens, sensitive	9.0	19.5	57	64.6	0.1		0.1	0.3	0.1					1.050
41	Cornes	10.2	12.5	37	73.1	0.1		0.1	0.3	0.1					1.034
42	Aqueous	11.2	0.5	0.1	88.2	0.1		0.1	0.2	0.1					1.075
43	Vitreous	11.2	0.5	0.1	88.2										1.003
	Gall bladder wall Pituitary gland Saliyary	11.2	0.5	0.1	00.2										1.015
45	glands. Tonsils. Spinal cord. Ureter	10.5	24.8	2.7	61.0	0.1		0.2	0.3	0.2	0.2				1.032
46	Gall bladder contents	10.5	25.6	2.7	60.2	0.1		0.2	0.3	0.2	0.2				1.030
47	Stomach wall, Oesophagus	10.5	11.4	2.5	75.0	0.1		0.1	0.1	0.2	0.1				1.037
48	Small intestine wall, Colon wall	10.5	11.4	2.5	75.0	0.1		0.1	0.1	0.2	0.1				1.037
49	GI contents	10.0	22.2	2.2	64.4	0.1		0.2	0.3	0.1	0.4	0.1			1.030
50	Heart wall	10.5	10.5	2.6	75.5	0.1		0.2	0.1	0.2	0.3				1.043
51	Kidney	10.3	12.6	3.1	72.9	0.2		0.2	0.2	0.2	0.2	0.1			1.053
52	Liver	10.2	13.2	3.1	72.3	0.2		0.2	0.3	0.2	0.3				1.060
53	Lung	10.3	10.8	3.2	74.7	0.1		0.1	0.2	0.3	0.2		0.1		0.344
54	Lymphatic nodes	10.8	4.5	1.2	82.7	0.3			0.1	0.4					1.032
55	Muscle	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
56	Gonads	10.6	9.9	2.1	76.5	0.2		0.1	0.2	0.2	0.2				1.041



57 58 59 60 61 62 63	Pancreas Prostate RST Skin Spleen Permanent, enamel Deciduous, enamel	$10.5 \\ 10.5 \\ 11.1 \\ 10.0 \\ 10.3 \\ 0.4$	15.8 24.8 38.6 19.9 11.2 0.7	2.4 2.7 1.0 4.2 3.2 0.2	70.4 61.0 48.7 65.0 74.3 43.4	$\begin{array}{c} 0.2 \\ 0.1 \\ 0.1 \\ 0.2 \\ 0.1 \end{array}$	0.3	0.2 0.2 0.1 0.2 18.0	0.1 0.3 0.2 0.2 0.2	$\begin{array}{c} 0.2 \\ 0.2 \\ 0.1 \\ 0.3 \\ 0.2 \end{array}$	0.2 0.2 0.1 0.3	37.0		$\begin{array}{c} 1.044 \\ 1.032 \\ 0.981 \\ 1.098 \\ 1.060 \\ 3.000 \end{array}$
64 65	Permanent, dentin and cementum Deciduous, dentin and cementum [*]	1.5	2.8	0.9	47.5		0.8	15.2				31.3		2.140
66 67 68 69 70 71 72 73	Pulp Teeth, retention region Thymus Thyroid Urinary bladder wall Urine Air inside body Water	10.8 10.0 10.5 10.4 10.5 10.7	4.1 22.2 24.8 11.8 9.6 0.3	1.1 2.2 2.7 2.5 2.6 1.0 80.0	83.2 64.4 61.0 74.5 76.1 87.3 20.0 88.8	$\begin{array}{c} 0.3 \\ 0.1 \\ 0.1 \\ 0.2 \\ 0.2 \\ 0.4 \end{array}$		$\begin{array}{c} 0.2 \\ 0.2 \\ 0.1 \\ 0.2 \\ 0.1 \end{array}$	0.1 0.3 0.3 0.1 0.2	0.4 0.1 0.2 0.2 0.3	0.4 0.2 0.1 0.3 0.2	0.1	0.1	1.021 1.030 1.027 1.051 1.040 1.010 0.001 1.000

* The deciduous enamel, dentin and cementum are not included in the 15-year-old phantoms.



Table B.10. List of media, their elemental compositions (percent by mass) and their mass densities for the 15-year-old female phantom.

Medium		н	C	N	0	Na	Mσ	р	S	Cl	к	Ca	Fe	T	Density
no.		п	e	11	0	144	1115	I	b	ei	R	eu	10	1	(g/cm ³)
1	Adrenal	10.6	28.6	2.5	57.5	0.1		0.2	0.2	0.1	0.2				1.025
2	ET, Trachea, BB, bb	10.1	20.4	2.3	64.9	0.3		1.2	0.5	0.2	0.1				1.060
3	Oral mucosa, Tongue	10.2	14.2	3.4	71.1	0.1		0.2	0.3	0.1	0.4				1.050
4	Blood	10.2	11.0	3.3	74.5	0.1		0.1	0.2	0.3	0.2		0.1		1.060
5	Cortical bone	4.3	16.3	4.3	46.7	0.1	0.2	9.0	0.3			18.8			1.755
6	Humeri, upper, spongiosa	9.9	41.9	2.6	41.0	0.1		1.3	0.2	0.2	0.1	2.6	0.1		1.118
7	Humeri upper medullary cavity	111	53.0	1.8	33.7	0.1			0.1	0.1	0.1				1.002
8	Humeri lower spongiosa	9.9	50.4	17	32.0	0.1		1.8	0.2	0.1	0.1	3.8			1 144
ğ	Humeri lower medullary cavity	11.2	57.1	1.7	29.9	0.1		1.0	0.1	0.1	0.1	5.0			0.994
10	Radii spongiosa	10.0	51.2	1.4	31.5	0.1		17	0.1	0.1	0.1	3.6			1 1 3 3
11	Ulnae spongiosa	0.7	18.8	1.0	32.0	0.1		2.1	0.2	0.1		13			1.155
12	Padii medullary cavity	11.5	62.8	0.8	24.6	0.1		2.1	0.2	0.1		4.5			0.082
12	Ulnoo modullory cavity	11.5	62.8	0.8	24.0	0.1			0.1	0.1					0.982
14	Wrists and hand hones, spongiosa	10.6	55.6	1.2	24.0	0.1		1.1	0.1	0.1		2.2			1.075
14	Clavialas, spongiosa	10.0	41.7	1.5	20.9	0.1		1.1	0.1	0.1	0.1	2.2	0.1		1.075
15	Clavicies, spoligiosa	9.8	41.7	2.0	40.8	0.1		1.5	0.2	0.1	0.1	5.0	0.1		1.151
10	Cramum, spongiosa	9.0	50.1	2.9	45.0	0.1		2.0	0.2	0.1	0.1	3.5	0.1		1.224
17	Femora, upper, spongiosa	9.0	40.0	2.7	41.9	0.1		1./	0.2	0.1	0.1	3.5	0.1		1.152
18	Femora, upper, meduliary cavity	11.1	55.0	1.8	33.7	0.1		2.2	0.1	0.1	0.1	1.0			1.002
19	Femora, lower, spongiosa	9.5	47.0	1.9	34.0	0.1		2.3	0.2	0.1	0.1	4.9			1.188
20	Femora, lower, medullary cavity	11.2	57.1	1.4	29.9	0.1			0.1	0.1	0.1				0.994
21	Tibiae, spongiosa	10.6	55.6	1.3	28.9	0.1		1.1	0.1	0.1		2.2			1.076
22	Fibulae, spongiosa	10.0	50.8	1.6	31.7	0.1		1.8	0.2	0.1		3.7			1.138
23	Patellae, spongiosa	10.6	55.6	1.3	28.9	0.1		1.1	0.1	0.1		2.2			1.076
24	Tibiae, medullary cavity	11.5	62.8	0.8	24.6	0.1			0.1	0.1					0.982
25	Fibulae, medullary cavity	11.5	62.8	0.8	24.6	0.1			0.1	0.1					0.982
26	Ankles and foot, spongiosa	10.6	55.6	1.3	28.9	0.1		1.1	0.1	0.1		2.2			1.075
27	Mandible, spongiosa	9.2	37.3	2.9	43.1	0.1		2.3	0.2	0.1	0.1	4.7			1.201
28	Pelvis, spongiosa	10.2	41.8	2.7	42.0			0.9	0.2	0.2	0.1	1.8	0.1		1.088
29	Ribs, spongiosa	10.0	39.0	3.0	44.4			1.0	0.2	0.2	0.1	2.0	0.1		1.102
30	Scapulae, spongiosa	9.0	36.5	2.9	43.4	0.1	0.1	2.5	0.2	0.1	0.1	5.1			1.216
31	Cervical spine, spongiosa	9.8	37.8	3.0	44.8			1.3	0.2	0.2	0.1	2.7	0.1		1.127
32	Thoracic spine, spongiosa	9.9	38.8	3.0	44.4	0.1		1.1	0.2	0.2	0.1	2.1	0.1		1.107
33	Lumbar spine, spongiosa	10.1	39.5	2.9	44.2			0.9	0.2	0.2	0.1	1.8	0.1		1.092
34	Sacrum, spongiosa	10.5	43.5	2.6	41.3			0.5	0.2	0.2	0.1	1.0	0.1		1.055
35	Sternum, spongiosa	10.1	39.9	2.9	44.1			0.8	0.2	0.2	0.1	1.6	0.1		1.084
36	Cartilage	9.6	9.9	2.2	74.4	0.5		2.2	0.9	0.3					1.099
37	Brain	10.7	14.4	2.2	71.3	0.2		0.4	0.2	0.3	0.3				1.041
38	Breast, adipose tissue	11.3	43.3	0.7	44.4	0.1			0.1	0.1					0.963
39	Breast, glandular tissue	10.6	32.4	3.0	53.5	0.1		0.1	0.2	0.1					1.021
40	Eve lens, sensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.050
41	Eve lens, insensitive	9.6	19.5	5.7	64.6	0.1		0.1	0.3	0.1					1.084
42	Cornea	10.2	12.5	3.7	73.1	0.1		0.1	0.2	0.1					1.075
43	Aqueous	11.2	0.5	0.1	88.2										1.005
44	Vitreous	11.2	0.5	0.1	88.2										1.013
	Gall bladder wall Pituitary gland Saliyary		0.0	0.1	00.2										1.015
45	glands Tonsils Spinal cord Ureter	10.6	30.8	2.4	55.4	0.1		0.2	0.2	0.1	0.2				1.021
46	Gall bladder contents	10.6	31.5	24	547	0.1		0.2	0.2	0.1	0.2				1.020
40	Stomach wall Oeconhague	10.0	11.4	2.4	75.0	0.1		0.2	0.2	0.1	0.2				1.020
48	Small intestine wall Colon wall	10.0	11.4	2.4	75.0	0.1		0.1	0.1	0.2	0.1				1.035
40	GI contents	10.0	22.2	2.7	64.4	0.1		0.1	0.1	0.2	0.1	0.1			1.030
50	Heart wall	10.0	10.5	2.2	75.5	0.1		0.2	0.5	0.1	0.4	0.1			1.030
51	Kidney	10.5	10.5	2.0	728	0.1		0.2	0.1	0.2	0.5	0.1			1.042
52	Liver	10.3	12.7	3.0	72.0	0.2		0.2	0.2	0.2	0.2	0.1			1.052
52		10.2	10.0	3.0	74.2	0.2		0.5	0.5	0.2	0.5		0.1		0.201
33 54	Lung Lymphatic nodes	10.5	10.8	5.2 1.2	14.1	0.1		0.1	0.2	0.5	0.2		0.1		1.021
55	Musele	10.0	4.4	1.2	02.0	0.5		0.2	0.1	0.4	0.4				1.051
55	Canada	10.2	14.2	5.4 2.4	/1.1	0.1		0.2	0.5	0.1	0.4				1.050
30	Oonaus	10.5	9.4	2.4	/0./	0.2		0.2	0.2	0.2	0.2				1.051



57 58 59 60 61 62 63	Pancreas Uterus RST Skin Spleen Permanent, enamel Decidious, enamel*	10.5 10.5 11.2 10.0 10.3 0.4	16.0 9.4 41.6 20.0 11.2 0.7	2.4 2.4 0.8 4.2 3.2 0.2	70.2 76.7 46.0 64.9 74.2 43.4	0.2 0.2 0.1 0.2 0.1	0.3	0.2 0.2 0.1 0.1 0.3 18.0	0.1 0.2 0.1 0.2 0.2	0.2 0.2 0.1 0.3 0.2	0.2 0.2 0.1 0.3	37.0	1.043 1.050 0.971 1.098 1.060 3.000
64 65	Permanent, dentin and cementum Deciduous, dentin and cementum [*]	1.5	2.8	0.9	47.5		0.8	15.2				31.3	2.140
66 67 68 69 70 71 72 73	Pulp Teeth, retention region Thymus Thyroid Urinary bladder wall Urine Air inside body Water	10.8 10.0 10.6 10.4 10.5 10.7	4.1 22.2 30.8 11.8 9.6 0.3	1.1 2.2 2.4 2.5 2.6 1.0 80.0	83.2 64.4 55.4 74.5 76.1 87.3 20.0 88.8	0.3 0.1 0.1 0.2 0.2 0.4		0.2 0.2 0.1 0.2 0.1	0.1 0.3 0.2 0.1 0.2	0.4 0.1 0.1 0.2 0.3	0.4 0.2 0.1 0.3 0.2	0.1	1.021 1.030 1.026 0.1 1.051 1.040 1.010 0.001 1.000

* The deciduous enamel, dentin and cementum are not included in the 15-year-old phantoms.



1659 ANNEX C. LIST OF ANATOMICAL SOURCE REGIONS, ACRONYMS 1660 AND IDENTIFICATION NUMBERS

1661 Table C.1. List of source regions, their acronyms and corresponding identification (ID) 1662 numbers in the phantoms.

Oral cavityO-cavity13300Oral mocosaO-mucosa500, 501, 600Tech surface'Tech-S12556Tech volumeTech-V \dagger Tongue500, 1300, 13301Tonsils1003Oesophagis fastOesophagis11003Oesophagis dawOesophagis11003Oesophagis dawOesophagis1003Oesophagis dawOesophagis200, 7201, 7202, 7203Stomach vallSi-wall7200, 7201, 7202, 7203Stomach nucosaSi-mucosa7200, 7201, 7202, 7203Stomach nucosaSi-mucosa7200, 7201, 7202, 7203Stomach nucosaSi-mucosa7200, 7201, 7202, 7203Stomach nucosaSi-mucosa7200, 7201, 7202, 7203Stomath nucosaSi-mucosa7400, 7401, 7402, 7403Small intestine vallSi-vall7500, 7501Small intestine rusalSi-wall7400, 7401, 7402Right colon contentsRC-cont7000, 7801, 7802, 7800, 7801, 7802Right colon nucosaRC-mucosa7600, 7601, 7800, 7801, 7802Left colon mucosaLC-cont\$100, 8002, 8201, 8202Left colon nucosaLC-mucosa8000, 8001, 8200, 8201, 8202Left colon nucosaLC-mucosa800, 8001, 8002, 8201, 8202Left colon nucosaRS-mutocsa8400, 8401, 8402, 8403, 861, 8602Left colon nucosaRS-mutosa8400, 8401, 8402, 8403, 861, 8602Left colon nucosaRS-mutosa8400, 8401, 8402, 8403, 861, 8602Retosignoid colon nucosaRS-mutosa8	Source region	Acronym	ID number(s)
Oral mocosaO-mucosa500, 501, 600Teeth surface"Teeth S12856Ceth volumeTeeth VtTongueTongue500, 1330, 1330, 1330, 1TonguisTongue500, 1330, 1330, 1OrasifsTonsils11003Oesophagus fastOesophagus11003Oesophagus slowOesophagus11003Oesophagus slowOesophagus1000, 1100, 1100, 11002Stomach contentisSt-cont7300Stomach contentisSt-cont7300, 7201, 7202, 7203Stomach mucosaSt-cont7300, 7201, 7202, 7203Stomach mucosaSt-cont7300, 7201, 7202, 7203Stamal intestime valiSt-cont7300, 7401, 7402, 7403Small intestime valiSt-cont7400, 7401, 7402, 7403Small intestime valiSt-cont700, 7601, 7800, 7801, 7802Sight colon contentisRC-cont7600, 7601, 7800, 7801, 7802Sight colon macosaLC-coral800, 8001, 8002, 8208, 820, 8208, 820Left colon mucosaLC-coral800, 8001, 8002, 8208, 820, 8208, 820Left colon mucosaLC-wall800, 801, 8002, 8208, 820, 8208, 82	Oral cavity	O-cavity	13300
Tech.v3Tech.V312856Tech v0tmeTech.V4*TongueTongue500, 1330, 13301TonsilsTonsils1400Oesophagus fistOesophagus11003, 11002Oesophagus fistOesophagus11003, 11002,	Oral mucosa	O-mucosa	500, 501, 600
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Left colon mucosaLC-mucosa8000, 8001, 8201, 8201Rectosigmoid colon contentsRS-cont8500, 8603Rectosigmoid colon wallRS-wall8400, 8401, 8402, 8600, 8601, 8602Rectosigmoid colon mucosaRS-mucosa8400, 8401, 8402, 8600, 8601Et1 surfaceET1-sur300ET2 surfaceET2-sur400ET1 wallET1-wall300, 301, 302, 303ET2 wallET2-wall401, 402, 403, 404, 405ET2 surfaceET2-wall401, 402, 403, 404, 405ET2 sound regionET2-surl404Extrathoracic lymph nodesLN-ET10000Bronchial - fastBronchi-f800Bronchial - slowBronchi-s801Bronchi sequestered regionBronchi-s801Bronchial - slowBronchi-q807Bronchiolar - fastBrchiole-s811Bronchiolar - fastBrchiole-s811Bronchial - slowBrchiole-s811Bronchial - slowBrchiole-s812Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLN-Th10100Right lung lobeLLung9700Left lung lobeLLung9700, 9900Left lung lobeLLung200Right adrenal glandRAdrenal200Rotareal glandAdrenal200Rotareal glandAdrenal200Rotareal glandAdrenal200Rotareal glandAdrenal200 <tr <td="">Rotareal glandAdrenal</tr>	Left colon wall	LC-wall	8000, 8001, 8002, 8200, 8201, 8202
Rectosigmoid colon contentsRS-cont8500, 8603Rectosigmoid colon wallRS-wall8400, 8401, 8402, 8600, 8601, 8602Rectosigmoid colon mucosaRS-mucosa8400, 8401, 8600, 8601ET1 surfaceET1-sur300ET2 surfaceET2-sur400ET1 wallS00, 301, 302, 303S01ET2 wallET2-wall401, 402, 403, 404, 405ET2 bound regionET2-wall401, 402, 403, 404, 405ET2 sequestered regionET2-seq404Extrathoracic lymph nodesLN-ET10000Bronchial - fastBronchi-f800Bronchial - slowBronchi-f801Bronchial - slowBronchi-g807Bronchiolar - fastBrchiole-f810Bronchiolar - slowBrchiole-s811Bronchiolar sequestered regionBrchiole-s811Bronchiolar sequestered regionAl N-Th10100Alveolar-interstitumAl9700, 9900Thoracic lymph nodesLung9900Left lung lobeLung200Lung + LLungLung200Right adrenal glandAdrenal200Right adrenal glandAdrenal200Right adrenal glandAdrenal200Roternal LungAdrenal200	Left colon mucosa	LC-mucosa	8000, 8001, 8200, 8201
Rectosignoid colon wallRS-wall8400, 8401, 8402, 8600, 8601, 8602Rectosignoid colon mucosaRS-mucosa8400, 8401, 8600, 8601ET1-surfaceET1-sur300ET2-surfaceET2-sur400ET1-wall300, 301, 302, 303812ET2-wallET2-wall401, 402, 403, 404, 405ET2-surdareET2-wall401, 402, 403, 404, 405ET2-surdare ergionET2-seq404Extrathoracic lymph nodesLN-ET10000Bronchial – fastBronchi-f800Bronchi bound regionBronchi-s801Bronchi sequestered regionBronchi-a807Bronchi fastBronchi-fast800Bronchi sequestered regionBronchi-a807Bronchi sequestered regionBronchi-a807Bronchi bound regionBronchi-a811Bronchi sequestered regionBrchiole-f811Bronchiolar – fastBrchiole-f812, 813, 814Bronchiolar sequestered regionBrchiole-b815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLN-Th10100Right lung lobeLung9700, 9900Left lung lobeLungs9700, 9900Right adrenal glandKadrenal200Left adrenal glandKadrenal200Right adrenal glandKadrenal200Roternal Statemal Statemal100, 200	Rectosigmoid colon contents	RS-cont	8500, 8603
Rectosignoid colon mucosaRS-mucosa8400, 8401, 8600, 8601ET1 surfaceET1-sur300ET2 surfaceET2-sur400ET1 wallS00, 301, 302, 303S03ET2 wallET2-wall401, 402, 403, 404, 405ET2 bound regionET2-wall401, 402, 403, 404, 405ET2 sequestered regionET2-seq404Extrathoracic lymph nodesLN-ET10000Bronchial – fastBronchi-f800Bronchial – slowBronchi-f802, 803, 804, 805, 806Bronchi sequestered regionBronchi-g807Bronchi sequestered regionBronchi-q807Bronchi sequestered regionBronchi-g810Bronchi sequestered regionBronchi-q811Bronchi sequestered regionBrchiole-f813, 814Bronchiolar – slowBrchiole-g815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLLung9900Left lung lobeLLung9700, 9900Right adrenal glandLungs9700, 9900Left adrenal glandLAdrenal100Right adrenal glandLAdrenal100	Rectosigmoid colon wall	RS-wall	8400, 8401, 8402, 8600, 8601, 8602
FT1 sur300FT1 surfaceFT1-sur400FT2 surfaceFT2-sur400FT1 wallFT1-wall300, 301, 302, 303FT2 wallFT2-wall401, 402, 403, 404, 405FT2 bound regionFT2-bnd401, 402, 403, 404, 405FT2 sequestered regionFT2-seq404Extanhoracic lymph nodesLN-ET10000Bronchial - fastBronchi-f800Bronchial - fastBronchi-b801Bronchi bound regionBronchi-b802, 803, 804, 805, 806Bronchi sequestered regionBronchi-b807Bronchi sequestered regionBronchi-b810Bronchiolar - fastBrchiole-s811Bronchiolar - slowBrchiole-s811Bronchiolar sequestered regionBrchiole-s812, 813, 814Bronchiolar sequestered regionBrchiole-q815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLLung900Left lung lobeLLung9700, 9900Right 1ug lobeLung9700, 9900Right 4renal glandAdrenal200Left adrenal glandAdrenal200Radrenal LAdrenalAdrenal100Radrenal LAdrenalAdrenal100	Rectosigmoid colon mucosa	RS-mucosa	8400, 8401, 8600, 8601
ET2ET2-surfaceET2-surface400ET1wallET1-wall300, 301, 302, 303ET2wallET2-wall401, 402, 403, 404, 405ET2bound regionET2-bnd401, 402, 403ET2sequestered regionET2-seq404Extrathoracic lymph nodesLN-ET10000Bronchial - fastBronchi-F800Bronchial - fastBronchi-B801Bronchi bound regionBronchi-b802, 803, 804, 805, 806Bronchi sequestered regionBronchi-B807Bronchi sequestered regionBronchi-B810Bronchiolar - fastBrchiole-F811Bronchiolar - slowBrchiole-S811Bronchiolar sequestered regionBrchiole-S811Bronchiolar sequestered regionBrchiole-Q815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLLung900Left lung lobeLLung9700, 9900Right affenal glandRAdrenal200Left afrenal glandLAdrenal100RAdrenal + LAdrenalAdrenal100, 200	ET ₁ surface	ET1-sur	300
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ET2 bound regionET2-bnd401, 402, 403ET2 sequestered regionET2-seq404Extrathoracic lymph nodesLN-ET10000Bronchial – fastBronchi-f800Bronchial – slowBronchi-s801Bronchi sequestered regionBronchi-q807Bronchial – fastBronchi-q807Bronchial – fastBronchi-q810Bronchiolar – fastBrchioler-f811Bronchiolar – slowBrchioler-s811Bronchiolar sequestered regionBrchiole-q815Bronchiolar sequestered regionBrchiole-q815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLN-Th10100Right lung lobeLLung9700, 9900Left lung lobeLungs9700, 9900Right adrenal glandRAdrenal200Left adrenal glandLAdrenal100, 200	ET ₂ wall	ET2-wall	401, 402, 403, 404, 405
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Bronchial – slowBronchi-se801Bronchi bound regionBronchi-bound regionBronchi-bound region802, 803, 804, 805, 806Bronchi sequestered regionBronchi-q807Bronchiolar – fastBrchiole-f810Bronchiolar – slowBrchiole-s811Bronchiolar sequestered regionBrchiole-b812, 813, 814Bronchiolar sequestered regionBrchiole-q815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLN-Th10100Right lung lobeLLung9700RLung + LLung9700, 9900Right adrenal glandRAdrenal200Left adrenal glandLAdrenal100, 200	Bronchial – fast	Bronchi-f	800
Bronchi bound regionBronchi-b802, 803, 804, 805, 806Bronchi squestered regionBronchi-q807Bronchiolar – fastBrchiole-f810Bronchiolar – slowBrchiole-s811Bronchiolar bound regionBrchiole-b812, 813, 814Bronchiolar sequestered regionBrchiole-q815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLN-Th10100Right lung lobeLlung9700RLung + LLungJono9700, 9900Right adrenal glandRAdrenal200Left adrenal glandLAdrenal100, 200	Bronchial – slow	Bronchi-s	801
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Bronchiolar – slowBrchiole-s811Bronchiolar bound regionBrchiole-b812, 813, 814Bronchiolar sequestered regionBrchiole-q815Alveolar-interstitiumAI9700, 9900Thoracic lymph nodesLN-Th10100Right lung lobeRLung9900Left lung lobeLlung9700, 9900RLung + LLungS100, 9900900Right adrenal glandRAdrenal200Left adrenal glandLAdrenal100, 200	Bronchiolar – fast	Brchiole-f	810
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Bronchiolar sequestered regionBrchiole-q815Alveolar-interstitiumAI9700,9900Thoracic lymph nodesLN-Th10100Right lung lobeRLung9900Left lung lobeLLung9700,9900RLung + LLungLungs9700,9900Right adrenal glandRAdrenal200Left adrenal slandLAdrenal100,200	Bronchiolar bound region	Brchiole-b	812, 813, 814
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Thoracic lymph nodes LN-Th 10100 Right lung lobe RLung 9900 Left lung lobe LLung 9700 RLung + LLung Lungs 9700,9900 Right adrenal gland RAdrenal 200 Left adrenal gland LAdrenal 100,200	Alveolar-interstitium	AI	9700, 9900
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Right adrenal glandRAdrenal200Left adrenal glandLAdrenal100RAdrenal + LAdrenalAdrenals100, 200	RLung + LLung	Lungs	9700, 9900
Left adrenal glandLAdrenal100RAdrenal + LAdrenalAdrenals100, 200	Right adrenal gland	RAdrenal	200
RAdrenal + LAdrenal Adrenals 100, 200	Left adrenal gland	LAdrenal	100
	RAdrenal + LAdrenal	Adrenals	100, 200



HBlood

TBlood

ABlood LBlood

Ht-cont

Blood

C-bone-S

C-bone-V T-bone-S

T-bone-V

C-marrow

T-marrow

RBreast-a

RBreast-g

LBreast-a

LBreast-g

RBreast

LBreast

Breast-a

Breast-g

Eye-lens

GB-wall

GB-cont Ht-wall

RKidney-C

RKidney-M

RKidney-P

LKidney-C

LKidney-M

LKidney-P

LKidney

Kidneys

Liver LN-Sys

Muscle

ROvary

LOvary

Ovaries

Pancreas

P-gland

Prostate

S-glands

Sp-cord

Spleen

Testes

Thymus Thyroid

Ureters UB-wall

UB-cont

Uterus

Adipose

T-body

Skin

RKidney

Breast

Brain

Blood vessels of head Blood vessels of trunk Blood vessels of arms Blood vessels of legs Blood in heart Total blood Cortical bone surface Cortical bone volume Trabecular bone surface Trabecular bone volume Cortical bone marrow Trabecular bone marrow Brain Right breast adipose Right breast glandular Left breast adipose Left breast glandular RBreast-a + RBreast-g LBreast-a + LBreast-g RBreast-a + LBreast-a RBreast-g + LBreast-g Breast-a + Breast-g Lens of eye Gall bladder Gall bladder contents Heart Right kidney cortex Right kidney medulla Right kidney pelvis Right kidney C+M+P Left kidney cortex Left kidney medulla Left kidney pelvis Left kidney C+M+P RKidney + LKidney Liver Systemic lymph nodes Muscle Right ovary Left ovary ROvary + LOvary Pancreas Pituitary gland Prostate Salivary glands Skin Spinal cord Spleen Testes Thymus Thyroid Ureters Urinary bladder Urinary bladder content Uterus/cervix Adipose/residual tissue Total body tissues (total body minus contents of walled organs)

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1200, 1210
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12700
12900, 13000
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13200
13500, 13600
13700, 13701
13800
13900
11600, 11700, 11800, 11900
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	Soft tissue (T-body – mineral bone)	S-tissue	§ §	
1663	ET, extrathoracic.			
1664	* Teeth surface is not included in the newborn phant	coms.		
1665	[†] Teeth volume of the newborn phantoms is 12849, 1	2851, 12853 and 12855; teeth volu	me of the 1-year-old phanton	ns is 12802, 12803, 12818,
1666	12819, 12833, 12841, 12848, 12849, 12850, 1285	1, 12852, 12853, 12854 and 1285	5; teeth volume of the 5-yea	ar-old phantoms is 12802,
1667	12803, 12810, 12811, 12814, 12815, 12818, 12819,	12826, 12827, 12830, 12831, 1283	33, 12837, 12839, 12841, 128	845, 12847, 12848, 12850,
1668	12852, 12853, 12854 and 12855; teeth volume of t	the 10-year-old phantoms is 12800	0, 12801, 12802, 12803, 128	04, 12805, 12806, 12807,
1669	12808, 12809, 12810, 12811, 12812, 12813, 12814,	12815, 12816, 12817, 12824, 1282	25, 12826, 12827, 12828, 128	829, 12830, 12831, 12832,
1670	12833, 12834, 12835, 12836, 12837, 12838, 12839,	12840, 12844, 12845, 12846, 1284	47, 12848, 12850, 12852, 128	353, 12854 and 12855; and
16/1	teeth volume of the 15-year-old phantoms is 12800,	12801, 12804, 12805, 12806, 1280	07, 12808, 12809, 12812, 128	813, 12816, 12817, 12820,
1672	12821, 12822, 12823, 12824, 12825, 12828, 12829,	12832, 12834, 12835, 12836, 1283	38, 12840, 12842, 12843, 128	844, 12846, 12848, 12850,
16/3	12852 and 12854.			
1674	[‡] Blood: 900, 910, 1000, 1010, 1100, 1110, 1200, 12	210, 8800, plus blood included in t	the organs and tissues.	
1675	[§] Cortical bone mineral: 1300, 1600, 1900, 1910, 220	00, 2400, 2600, 2800, 3100, 3400,	3410, 3420, 3700, 3900, 4100	0, 4300, 4500, 4700, 4900,
16/6	5100, 5300, 5500.			
16//	[¶] Trabecular bone mineral: mineral bone fraction of	f 1400, 1700, 2000, 2010, 2300, 2	500, 2700, 2900, 3200, 3500	, 3510, 3520, 3800, 4000,
16/8	4200, 4400, 4600, 4800, 5000, 5200, 5400, 5600.			
16/9	** Cortical bone marrow: 1500, 1800, 2100, 2110, 3	000, 3300, 3600, 3610.		
1680	¹¹ Trabecular bone marrow: marrow fraction of 140	0, 1500, 1700, 1800, 2000, 2010, 2	2100, 2110, 2300, 2500, 2700), 2900, 3000, 3200, 3300,
1681	3500, 3510, 3520, 3600, 3610, 3800, 4000, 4200, 44	400, 4600, 4800, 5000, 5200, 5400	, 5600 (red and yellow marro	ow).
1682	^{‡‡} Total body tissues: 100–7000, 7200–7203, 7400-	-7403, 7600-7602, 7800-7802, 80	000-8002, 8200-8202, 8400-	-8402, 8600-8602, 8700-
1083	11002, 11100–13701, 13900.			
1684	^{\$§} Soft tissue: 100–1210, 1500, 1800, 2100, 2110,	3000, 3300, 3600, 3610, 5700-70	000, 7200–7203, 7400–7403	, 7600–7602, 7800–7802,
1085	8000-8002, 8200-8202, 8400-8402, 8600-8602, 8	700–11002, 11100–12700, 12900-	-13701, 13900, plus soft tiss	ue fraction of 1400, 1700,
1080	2000, 2010, 2300, 2500, 2700, 2900, 3200, 3500, 35	510, 3520, 3800, 4000, 4200, 4400), 4600, 4800, 5000, 5200, 54	00, 5600.
108/				



1688 ANNEX D. LIST OF ANATOMICAL TARGET REGIONS, ACRONYMS 1689 AND IDENTIFICATION NUMBERS

1690 Table D.1. List of target regions, their acronyms and corresponding identification (ID) numbers1691 in the phantoms.

Target region	Acronym	ID number(s)
Red (active) marrow	R-marrow	*
Colon wall	Colon	7600, 7601, 7602, 7800, 7801, 7802, 8000, 8001, 8002, 8200, 8201, 8202, 8400, 8401, 8402, 8600, 8601, 8602
Stem cells of colon	Colon-stem	7601, 7801, 8001, 8201, 8401, 8601
RLung + LLung	Lungs	9700, 9900
Stomach wall	St-wall	7200, 7201, 7202, 7203
Stem cells of stomach	St-stem	7201
Breast-a + Breast-g	Breast	6200, 6300, 6400, 6500
ROvary + LOvary	Ovaries	11100, 11200
Testes	Testes	12900, 13000
Urinary bladder wall	UB-wall	13700, 13701
Urinary bladder basal cells	UB-basal	13701
Oesophagus wall	Oesophagus	11000, 11001, 11002
Oesophagus basal cells	Oesophagus-bas	11001
Liver	Liver	9500
Thyroid	Thyroid	13200
50-µm endosteal region	Endost-BS	Ť
Brain	Brain	6100
Salivary glands	S-glands	12000, 12100
Skin	Skin	12200, 12201, 12300, 12301, 12400, 12401, 12500, 12501
Basal cells of skin	Skin-bas	12201, 12301, 12401, 12501
RAdrenal + LAdrenal	Adrenals	100, 200
ET region	ET	300, 301, 302, 303, 401, 402, 403, 404, 405
Gall bladder wall	GB-wall	7000
Heart wall	Ht-wall	8700
RKidney + LKidney	Kidneys	8900, 9000, 9100, 9200, 9300, 9400
Systemic lymph nodes	LN-Sys	10200, 10300, 10400, 10500
Muscle	Muscle	10600, 10700, 10800, 10900
Oral mucosa	O-mucosa	500, 501, 600
Pancreas	Pancreas	11300
Prostate	Prostate	11500
Small intestine wall	SI-wall	7400, 7401, 7402, 7403
Stem cells of small intestine	SI-stem	7401
Spleen	Spleen	12700
Thymus	Thymus	13100
Uterus/cervix	Uterus	13900
Tongue	Tongue	500, 13300, 13301
Tonsils	Tonsils	13400
Right colon wall (ascending + right transverse)	RC-wall	7600, 7601, 7602, 7800, 7801, 7802
Left colon wall (left transverse + descending)	LC-wall	8000, 8001, 8002, 8200, 8201, 8202
Rectosigmoid colon wall (sigmoid + rectum)	RS-wall	8400, 8401, 8402, 8600, 8601, 8602
Stem cells of right colon (ascending + right transverse)	RC-stem	7601, 7801
Stem cells of left colon (left transverse + descending)	LC-stem	8001, 8201
Stem cells of rectosigmoid colon (sigmoid + rectum)	RSig-stem	8401, 8601
Basal cells of anterior nasal passages	ET1-bas	302
Basal cells of posterior nasal passages + pharynx	ET2-bas	402
Extrathoracic lymph nodes	LN-ET	10000
Bronchi basal cells	Bronch-bas	804, 805



Bronchi secretory cells	Bronch-sec	803, 804
Bronchiolar secretory cells	Brchiol-sec	813
Alveolar-interstitial	AI	9700, 9900
Thoracic lymph nodes	LN-Th	10100
Right lung lobe	RLung	9900
Left lung lobe	LLung	9700
Right adrenal gland	RAdrenal	200
Left adrenal gland	LAdrenal	100
Right breast adipose	RBreast-a	6400
Right breast glandular	RBreast-g	6500
Left breast adipose	LBreast-a	6200
Left breast glandular	LBreast-g	6300
RBreast-a + RBreast-g	RBreast	6400, 6500
LBreast-a + LBreast-g	LBreast	6200, 6300
RBreast-a + LBreast-a	Breast-a	6200, 6400
RBreast-g + LBreast-g	Breast-g	6300, 6500
Entire lenses of eye	Lens-ent	6600, 6601, 6800, 6801
Sensitive lenses of eye	Lens-sen	6600, 6800
Right kidney cortex	RKidney-C	9200
Right kidney medulla	RKidney-M	9300
Right kidney pelvis	RKidney-P	9400
Right kidney C+M+P	RKidney	9200, 9300, 9400
Left kidney cortex	LKidney-C	8900
Left kidney medulla	LKidney-M	9000
Left kidney pelvis	LKidney-P	9100
Left kidney C+M+P	LKidney	8900, 9000, 9100
Right ovary	ROvary	11200
Left ovary	LOvary	11100
Pituitary gland	P-gland	11400
Spinal cord	Sp-cord	12600
Ureters	Ureters	13500, 13600
Adipose/residual tissue	Adipose	11600, 11700, 11800, 11900

^{*} Red bone marrow fraction in organ IDs: 1400, 1500, 1700, 1800, 2000, 2010, 2100, 2110, 2300, 2500, 2700, 2900, 3000, 3200, 3300, 3500, 3510, 3520, 3600, 3610, 3800, 4000, 4200, 4400, 4600, 4800, 5000, 5200, 5400, 5600.

[†] Endosteum fraction in organ IDs: 1400, 1500, 1700, 1800, 2000, 2010, 2100, 2100, 2100, 2500, 2700, 2900, 3000, 3200, 3300, 3500, 3510, 3520, 3600, 3610, 3800, 4000, 4200, 4400, 4600, 4800, 5000, 5200, 5400, 5600.



1697 1698

ANNEX E. ORGAN DEPTH DISTRIBUTIONS OF SELECTED ORGANS/TISSUES

1699 (E1) In Figs E.1–E.65, organ depth distributions (ODDs) of the paediatric mesh-type reference computational phantoms (MRCPs) and the P143 phantoms are shown for selected 1700 organs [i.e. red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, 1701 oesophagus, liver, thyroid, brain, salivary glands and skin]. For their ODD calculation, ten 1702 million points were randomly sampled in the considered organ and the distances from the 1703 sampled points to the outer surface (e.g. front, back, left, etc.) of the phantoms were calculated. 1704 1705 The ODDs represent a depth of an organ/tissue below the outer surface of the phantoms, 1706 significantly influencing dose calculation for external exposures.





1709 Fig. E.1. Distribution of depths of 10 million randomly sampled points in the red bone marrow

- (RBM) below the body surface of the newborn male/female phantoms at: front, back, left, right,top and bottom.
- 1712





Fig. E.2. Distribution of depths of 10 million randomly sampled points in the colon below the
body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.3. Distribution of depths of 10 million randomly sampled points in the lungs below the
body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom.





1721

Fig. E.4. Distribution of depths of 10 million randomly sampled points in the stomach below
the body surface of the newborn male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.5. Distribution of depths of 10 million randomly sampled points in the breast below the body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom. 1728 1729





Fig. E.6. Distribution of depths of 10 million randomly sampled points in the gonads below the 1732 body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom. 1733





1734 1735 Fig. E.7. Distribution of depths of 10 million randomly sampled points in the urinary bladder 1736 below the body surface of the newborn male/female phantoms at: front, back, left, right, top 1737 and bottom.





1739

Fig. E.8. Distribution of depths of 10 million randomly sampled points in the oesophagus below
the body surface of the newborn male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.9. Distribution of depths of 10 million randomly sampled points in the liver below the
body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom.





1748

Fig. E.10. Distribution of depths of 10 million randomly sampled points in the thyroid below
the body surface of the newborn male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.11. Distribution of depths of 10 million randomly sampled points in the brain below the
body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom.





1757

Fig. E.12. Distribution of depths of 10 million randomly sampled points in the salivary glands
below the body surface of the newborn male/female phantoms at: front, back, left, right, top
and bottom.




Fig. E.13. Distribution of depths of 10 million randomly sampled points in the skin below the
body surface of the newborn male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.14. Distribution of depths of 10 million randomly sampled points in the red bone marrow (RBM) below the body surface of the 1-year male/female phantoms at: front, back, left, right,

- 1769 top and bottom.
- 1770





1771

Fig. E.15. Distribution of depths of 10 million randomly sampled points in the colon below the
body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.16. Distribution of depths of 10 million randomly sampled points in the lungs below the body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.17. Distribution of depths of 10 million randomly sampled points in the stomach below
the body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.





1783 1784

Fig. E.18. Distribution of depths of 10 million randomly sampled points in the breast below the 1785 body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.19. Distribution of depths of 10 million randomly sampled points in the gonads below 1789 the body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom. 1790





Fig. E.20. Distribution of depths of 10 million randomly sampled points in the urinary bladder
below the body surface of the 1-year male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.21. Distribution of depths of 10 million randomly sampled points in the oesophagus
below the body surface of the 1-year male/female phantoms at: front, back, left, right, top and
bottom.





1801

1802 Fig. E.22. Distribution of depths of 10 million randomly sampled points in the liver below the

body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.23. Distribution of depths of 10 million randomly sampled points in the thyroid below
the body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.





1810 Fig. E.24. Distribution of depths of 10 million randomly sampled points in the brain below the

- 1811 body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.
- 1812





1814 Fig. E.25. Distribution of depths of 10 million randomly sampled points in the salivary glands

- below the body surface of the 1-year male/female phantoms at: front, back, left, right, top andbottom.
- 1817





1819 Fig. E.26. Distribution of depths of 10 million randomly sampled points in the skin below the

- 1820 body surface of the 1-year male/female phantoms at: front, back, left, right, top and bottom.
- 1821





Fig. E.27. Distribution of depths of 10 million randomly sampled points in the red bone marrow

- (RBM) below the body surface of the 5-year male/female phantoms at: front, back, left, right, 1824 1825 top and bottom.
- 1826





1827 1828

Fig. E.28. Distribution of depths of 10 million randomly sampled points in the colon below the

1829 body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





1831 1832

Fig. E.29. Distribution of depths of 10 million randomly sampled points in the lungs below the

1833 body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.30. Distribution of depths of 10 million randomly sampled points in the stomach below
the body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.31. Distribution of depths of 10 million randomly sampled points in the breast below the

- 1841 body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.
- 1842





Fig. E.32. Distribution of depths of 10 million randomly sampled points in the gonads below
the body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.33. Distribution of depths of 10 million randomly sampled points in the urinary bladder
below the body surface of the 5-year male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.34. Distribution of depths of 10 million randomly sampled points in the oesophagus
below the body surface of the 5-year male/female phantoms at: front, back, left, right, top and
bottom.





1857

Fig. E.35. Distribution of depths of 10 million randomly sampled points in the liver below thebody surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.36. Distribution of depths of 10 million randomly sampled points in the thyroid below
the body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





1865

Fig. E.37. Distribution of depths of 10 million randomly sampled points in the brain below the body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.38. Distribution of depths of 10 million randomly sampled points in the salivary glands
below the body surface of the 5-year male/female phantoms at: front, back, left, right, top and
bottom.





1874

1875 Fig. E.39. Distribution of depths of 10 million randomly sampled points in the skin below the

1876 body surface of the 5-year male/female phantoms at: front, back, left, right, top and bottom.1877





1879 Fig. E.40. Distribution of depths of 10 million randomly sampled points in the red bone marrow

- (RBM) below the body surface of the 10-year male/female phantoms at: front, back, left, right,
 top and bottom.
- 1882





1883

Fig. E.41. Distribution of depths of 10 million randomly sampled points in the colon below the
body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.42. Distribution of depths of 10 million randomly sampled points in the lungs below the body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.43. Distribution of depths of 10 million randomly sampled points in the stomach below
the body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.





1895

1896 Fig. E.44. Distribution of depths of 10 million randomly sampled points in the breast below the

1897 body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.1898





Fig. E.45. Distribution of depths of 10 million randomly sampled points in the gonads below
the body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.46. Distribution of depths of 10 million randomly sampled points in the urinary bladder
below the body surface of the 10-year male/female phantoms at: front, back, left, right, top and
bottom.





1909 Fig. E.47. Distribution of depths of 10 million randomly sampled points in the oesophagus 1910 below the body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.

- 1911
- 1912





1913

1914 Fig. E.48. Distribution of depths of 10 million randomly sampled points in the liver below the

body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.




Fig. E.49. Distribution of depths of 10 million randomly sampled points in the thyroid below
the body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.





1921 1922

Fig. E.50. Distribution of depths of 10 million randomly sampled points in the brain below the

1923 body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom. 1924





Fig. E.51. Distribution of depths of 10 million randomly sampled points in the salivary glands
below the body surface of the 10-year male/female phantoms at: front, back, left, right, top and
bottom.





1930

1931 Fig. E.52. Distribution of depths of 10 million randomly sampled points in the skin below the

body surface of the 10-year male/female phantoms at: front, back, left, right, top and bottom.





1935 Fig. E.53. Distribution of depths of 10 million randomly sampled points in the red bone marrow

- (RBM) below the body surface of the 15-year male/female phantoms at: front, back, left, right,top and bottom.
- 1938





1939

1940 Fig. E.54. Distribution of depths of 10 million randomly sampled points in the colon below the

body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





1943

Fig. E.55. Distribution of depths of 10 million randomly sampled points in the lungs below the body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.56. Distribution of depths of 10 million randomly sampled points in the stomach below
the body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





1951

1952 Fig. E.57. Distribution of depths of 10 million randomly sampled points in the breast below the

body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.58. Distribution of depths of 10 million randomly sampled points in the gonads below
the body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.59. Distribution of depths of 10 million randomly sampled points in the urinary bladder
below the body surface of the 15-year male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.60. Distribution of depths of 10 million randomly sampled points in the oesophagus
below the body surface of the 15-year male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.61. Distribution of depths of 10 million randomly sampled points in the liver below the
body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.62. Distribution of depths of 10 million randomly sampled points in the thyroid below
the body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.63. Distribution of depths of 10 million randomly sampled points in the brain below the
body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.





Fig. E.64. Distribution of depths of 10 million randomly sampled points in the salivary glands
below the body surface of the 15-year male/female phantoms at: front, back, left, right, top and
bottom.





Fig. E.65. Distribution of depths of 10 million randomly sampled points in the skin below the
body surface of the 15-year male/female phantoms at: front, back, left, right, top and bottom.



1990 A 1991 S

ANNEX F. CHORD-LENGTH DISTRIBUTIONS BETWEEN SELECTED ORGAN PAIRS (SOURCE/TARGET TISSUES)

1992 (F1) In Figs F.1–F.25, chord-length distributions (CLDs) of the paediatric mesh-type reference computational phantoms (MRCPs) and the P143 phantoms are shown for the selected 1993 organ pairs (i.e. source/target regions): source regions (cortical bone, liver, lungs, thyroid and 1994 urinary bladder contents); target regions [red bone marrow (RBM), colon, lungs, stomach, 1995 breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands]. For the 1996 CLD calculation, ten million-point pairs were randomly sampled in the target and source 1997 1998 regions considered, and distances of the point pairs were calculated. The CLDs represent a 1999 distance between the target and source regions, significantly influencing dose calculation for 2000 internal exposures.





2002

Fig. F.1. Distribution of distances between 10 million randomly sampled point pairs in the cortical bone (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the newborn male/female phantoms.





Fig. F.2. Distribution of distances between 10 million randomly sampled point pairs in the liver (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the newborn male/female phantoms.





Fig. F.3. Distribution of distances between 10 million randomly sampled point pairs in the lungs (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the newborn male/female phantoms.





Fig. F.4. Distribution of distances between 10 million randomly sampled point pairs in the thyroid (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the newborn male/female phantoms.





Fig. F.5. Distribution of distances between 10 million randomly sampled point pairs in the urinary bladder contents (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the newborn male/female phantoms.





2032 2033 Fig. F.6. Distribution of distances between 10 million randomly sampled point pairs in the 2034 cortical bone (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, 2035 gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) 2036 in the 1-year male/female phantoms.





Fig. F.7. Distribution of distances between 10 million randomly sampled point pairs in the liver (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 1-year male/female phantoms.





Fig. F.8. Distribution of distances between 10 million randomly sampled point pairs in the lungs (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 1year male/female phantoms.





2050

Fig. F.9. Distribution of distances between 10 million randomly sampled point pairs in the thyroid (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 1year male/female phantoms.





2056

Fig. F.10. Distribution of distances between 10 million randomly sampled point pairs in the
urinary bladder (source region) and red bone marrow (RBM), colon, lungs, stomach, breast,
gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions)
in the 1-year male/female phantoms.





Fig. F.11. Distribution of distances between 10 million randomly sampled point pairs in the cortical bone (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 5-year male/female phantoms.





Fig. F.12. Distribution of distances between 10 million randomly sampled point pairs in the liver (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 5year male/female phantoms.





Fig. F.13. Distribution of distances between 10 million randomly sampled point pairs in the lungs (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 5year male/female phantoms.





Fig. F.14. Distribution of distances between 10 million randomly sampled point pairs in the thyroid (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 5year male/female phantoms.





Fig. F.15. Distribution of distances between 10 million randomly sampled point pairs in the
urinary bladder (source region) and red bone marrow (RBM), colon, lungs, stomach, breast,
gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions)
in the 5-year male/female phantoms.





Fig. F.16. Distribution of distances between 10 million randomly sampled point pairs in the cortical bone (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 10-year male/female phantoms.





Fig. F.17. Distribution of distances between 10 million randomly sampled point pairs in the liver (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 10year male/female phantoms.





 $\begin{array}{c} 2104 \\ 2105 \end{array}$ Fig. F.18. Distribution of distances between 10 million randomly sampled point pairs in the 2106 lungs (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 10-2107 2108 year male/female phantoms.




 $\begin{array}{c} 2110\\ 2111 \end{array}$ Fig. F.19. Distribution of distances between 10 million randomly sampled point pairs in the 2112 thyroid (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 10-2113

- 2114 year male/female phantoms.
- 2115





Fig. F.20. Distribution of distances between 10 million randomly sampled point pairs in the urinary bladder (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 10-year male/female phantoms.





Fig. F.21. Distribution of distances between 10 million randomly sampled point pairs in the cortical bone (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 15-year male/female phantoms.





Fig. F.22. Distribution of distances between 10 million randomly sampled point pairs in the liver (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 15year male/female phantoms.





Fig. F.23. Distribution of distances between 10 million randomly sampled point pairs in the lungs (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 15year male/female phantoms.





Fig. F.24. Distribution of distances between 10 million randomly sampled point pairs in the thyroid (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 15year male/female phantoms.





Fig. F.25. Distribution of distances between 10 million randomly sampled point pairs in the urinary bladder (source region) and red bone marrow (RBM), colon, lungs, stomach, breast, gonads, urinary bladder, oesophagus, liver, thyroid, brain and salivary glands (target regions) in the 15-year male/female phantoms.



Ascending Colon Urinary bladder

2152 ANNEX G. CROSS-SECTIONAL IMAGES

G.1. Images of the newborn male mesh-type reference computational
phantom



2155





2156



2157

Fig. G.1.1. Transverse (axial) images of the newborn male mesh-type reference computational phantom (*continued on next page*).



Sternum Thymus Trachea Oesophagus Lymphatic nodes

Ribs

Thoracic spine Scapulae Spinal cord

Skin, head



2161



2162





2163

2164 Fig. G.1.1. (*continued*)





2166

Fig. G.1.2. Coronal and sagittal images of the newborn male mesh-type reference computational phantom.



G.2. Images of the newborn female mesh-type reference computational phantom



Fig. G.2.1. Transverse (axial) images of the newborn female mesh-type reference computational phantom (*continued on next page*).











2181 Fig. G.2.1. (continued)





2183

Fig. G.2.2. Coronal and sagittal images of the newborn female mesh-type reference computational phantom.



G.3. Images of the 1-year-old male mesh-type reference computational phantom



Fig. G.3.1. Transverse (axial) images of the 1-year-old male mesh-type reference computational phantom (continued on next page).









Fig. G.3.1. (continued)







2200

Fig. G.3.2. Coronal and sagittal images of the 1-year-old male mesh-type reference computational phantom.



G.4. Images of the 1-year-old female mesh-type reference computational phantom



Fig. G.4.1. Transverse (axial) images of the 1-year-old female mesh-type reference computational phantom (continued on next page).













Fig. G.4.1. (continued)





2217

Fig. G.4.2. Coronal and sagittal images of the 1-year-old female mesh-type reference computational phantom.



G.5. Images of the 5-year-old male mesh-type reference computational phantom



Fig. G.5.1. Transverse (axial) images of the 5-year-old male mesh-type reference computational phantom (*continued on next page*).





2232 Fig. G.5.1. (continued)





2234

Fig. G.5.2. Coronal and sagittal images of the 5-year-old male mesh-type reference computational phantom.



G.6. Images of the 5-year-old female mesh-type reference computational phantom



Fig. G.6.1. Transverse (axial) images of the 5-year-old female mesh-type reference computational phantom (*continued on next page*).





2249 Fig. G.6.1. (continued)





2251

Fig. G.6.2. Coronal and sagittal images of the 5-year-old female mesh-type reference computational phantom.



G.7. Images of the 10-year-old male mesh-type reference computational phantom



Fig. G.7.1. Transverse (axial) images of the 10-year-old male mesh-type reference computational phantom (*continued on next page*).





2266 Fig. G.7.1. (continued)





2268

Fig. G.7.2. Coronal and sagittal images of the 10-year-old male mesh-type reference computational phantom.



G.8. Images of the 10-year-old female mesh-type reference computational phantom



Fig. G.8.1. Transverse (axial) images of the 10-year-old female mesh-type reference computational phantom (*continued on next page*).





2283 Fig. G.8.1. (continued)





2285

Fig. G.8.2. Coronal and sagittal images of the 10-year-old female mesh-type reference computational phantom.



G.9. Images of the 15-year-old male mesh-type reference computational phantom



Fig. G.9.1. Transverse (axial) images of the 15-year-old male mesh-type reference computational phantom (*continued on next page*).





2300 Fig. G.9.1. (continued)





2302

Fig. G.9.2. Coronal and sagittal images of the 15-year-old male mesh-type reference computational phantom.



G.10. Images of the 15-year-old female mesh-type reference computational phantom



Fig. G.10.1. Transverse (axial) images of the 15-year-old female mesh-type reference computational phantom (*continued on next page*).





2317 Fig. G.10.1. (continued)




Fig. G.10.2. Coronal and sagittal images of the 15-year-old female mesh-type reference computational phantom.



ANNEX H. COMPARISON OF DOSE COEFFICIENTS FOR EXTERNAL EXPOSURE

2325 (H 1) This annex compares the dose coefficients (DCs) for organ dose of six organs (i.e. 2326 red bone marrow (RBM), colon, lungs, stomach, breast and skin) and effective dose for external 2327 exposures to photons, neutrons, electrons and helium ions calculated using the paediatric mesh-2328 type reference computational phantoms (MRCPs) with those calculated with the Publication 143 (P143) phantoms (ICRP, 2020). Note that the organs selected for the comparison of organ 2329 2330 DCs, except skin, have the highest tissue-weighting factor (= 0.12) and the skin despite its 2331 small tissue-weighting factor (= 0.01) could significantly affect the effective dose calculation for external exposures to weakly penetrating radiations. To calculate the DCs, the MRCPs and 2332 2333 P143 phantoms were implemented into the Geant4 code (version 10.06.p02) (Allisons et al., 2334 2016) using the G4Tet and G4VNestedParameterisation classes, respectively. The phantoms were assumed to be in vacuum and irradiated by mono-energetic broad beams in six idealised 2335 2336 irradiation geometries, i.e. antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), 2337 right-lateral (RLAT), rotational (ROT) and isotropic (ISO), for photons and neutrons and three irradiation geometries, i.e. AP, PA and ISO, for electrons and helium ions. The energy ranges 2338 considered are 10^{-2} - 10^{4} MeV for photons and electrons, 10^{-9} - 10^{4} MeV for neutrons and 1- 10^{5} 2339 MeV/u for helium ions. The number of primary particles varied from 10^7 to 10^{10} depending on 2340 the particle type and energy, keeping the statistical relative errors for the organ DCs below 5% 2341 and for the effective DCs below 0.5%. The particles were generated by using the 2342 2343 G4VUserPrimaryGeneratorAction class. The physics libraries of FTFP BERT HP and 2344 G4EmLivermorePhysics were used to transport the neutrons and all other particles, respectively 2345 (Geant4 Physics Reference Manual). The thermal neutron scattering treatment $S(\alpha, \beta)$ for 2346 hydrogen in light water at 300 K was also activated to consider the thermal vibration of molecules. The kerma approximation was not applied. A range of 1 µm for the secondary 2347 2348 production cut was applied to all particles. Note that for photons, the RBM and endosteum DCs 2349 were estimated using the fluence-to-absorbed dose response functions (DRFs). For spot-check 2350 purpose, the MCNP6 (version 2.0) (Martz et al., 2017) and PHITS (version 3.10) (Furuta et al., 2017) codes were additionally used to calculate the organ and effective DCs for some selected 2351 2352 energy points, under the same simulation conditions (remaining spot-check DCs will be 2353 included prior to publication). For the MCNP6 code, the default physics library was used to transport all the particles (Martz et al., 2017) except for neutrons for which the ENDF70 physic 2354 library was used (Trellue et al., 2009). For the PHITS code, the EGS5 physics library was used 2355 for photons and electrons (Hirayama et al., 2005), the JENDL-4.0 physics library and event 2356 2357 generator mode version 2.0 were used for neutrons (Shibata et al., 2011) and the default physics 2358 library was used for helium ions (Furuta et al., 2017). The energy cut values, which are 2359 equivalent to the range cut value used in the Geant4 code, were applied to the MCNP6 and PHITS codes. Figs H.1-H.6 show the organ DCs for photons in the AP irradiation geometry, 2360 2361 as examples, and Figs H.7-H.11 show the effective DCs for photons. Figs H.12-H.17 show 2362 the organ DCs for neutrons in the AP irradiation geometry, as examples, and Figs H.18–H.22 2363 show the effective DCs for neutrons. Figs H.23-H.28 show the organ DCs for electrons in the ISO irradiation geometry, as examples, and Figs H.29-H.33 show the effective DCs for 2364 2365 electrons. Figs H.34–H.39 show the organ DCs for helium ions in the ISO irradiation geometry, as examples, and Figs H.40-H.44 show the effective DCs for helium ions. Figs H.45-H.50 2366 show the lens DCs for photons. For discussion of the comparisons, please see Section 7.1 of 2367 2368 the main text.







Fig. H.1. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for photon exposures 2372

2373 calculated with the newborn mesh-type reference computational phantoms (MRCPs), along 2374 with the values calculated with the P143 newborn phantoms. The values shown were averaged 2375 for the male and female phantoms.



2377 Fig. H.2. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for photon exposures 2378 2379 calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along 2380 with the values calculated with the P143 1-year-old phantoms. The values shown were 2381 averaged for the male and female phantoms.







Fig. H.3. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for photon exposures 2385 calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along 2386 2387 with the values calculated with the P143 5-year-old phantoms. The values shown were 2388 averaged for the male and female phantoms.



Fig. H.4. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, 2390 stomach, breast and skin in the antero-posterior (AP) irradiation geometry for photon exposures 2391 2392 calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along 2393 with the values calculated with the P143 10-year-old phantoms. The values shown were 2394 averaged for the male and female phantoms.







Fig. H.5. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for photon exposures calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old male phantom.



Fig. H.6. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs,
stomach, breast and skin in the antero-posterior (AP) irradiation geometry for photon exposures
calculated with the 15-year-old female mesh-type reference computational phantom (MRCP),
along with the values calculated with the P143 15-year-old female phantom.





 $\begin{array}{c} 2407\\ 2408 \end{array}$

Fig. H.7. Effective dose per fluence (pSv cm²) for photon exposures calculated with the 2409 newborn mesh-type reference computational phantoms (MRCPs), along with the values 2410 calculated with the P143 newborn phantoms.





2412 2413

Fig. H.8. Effective dose per fluence (pSv cm²) for photon exposures calculated with the 1-year-2414 old mesh-type reference computational phantoms (MRCPs), along with the values calculated 2415 with the P143 1-year-old phantoms.





 $\begin{array}{c} 2417\\ 2418\end{array}$

Fig. H.9. Effective dose per fluence (pSv cm²) for photon exposures calculated with the 5-year-2419 old mesh-type reference computational phantoms (MRCPs), along with the values calculated 2420 with the P143 5-year-old phantoms.





2422 2423

Fig. H.10. Effective dose per fluence (pSv cm²) for photon exposures calculated with the 10-2424 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2425 calculated with the P143 10-year-old phantoms.





2427 2428

Fig. H.11. Effective dose per fluence (pSv cm²) for photon exposures calculated with the 15-2429 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2430 calculated with the P143 15-year-old phantoms.







Fig. H.12. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, 2434 stomach, breast and skin in the antero-posterior (AP) irradiation geometry for neutron 2435 exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs), 2436 along with the values calculated with the P143 newborn phantoms. The values shown were 2437 averaged for the male and female phantoms.



2438 2439

Fig. H.13. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, 2440 stomach, breast and skin in the antero-posterior (AP) irradiation geometry for neutron 2441 exposures calculated with the 1-year-old mesh-type reference computational phantoms 2442 (MRCPs), along with the values calculated with the P143 1-year-old phantoms. The values 2443 shown were averaged for the male and female phantoms.







2446 Fig. H.14. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for neutron 2447 exposures calculated with the 5-year-old mesh-type reference computational phantoms 2448 2449 (MRCPs), along with the values calculated with the P143 5-year-old phantoms. The values 2450 shown were averaged for the male and female phantoms.



2451 2452

Fig. H.15. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, 2453 stomach, breast and skin in the antero-posterior (AP) irradiation geometry for neutron 2454 exposures calculated with the 10-year-old mesh-type reference computational phantoms 2455 (MRCPs), along with the values calculated with the P143 10-year-old phantoms. The values 2456 shown were averaged for the male and female phantoms.







Fig. H.16. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for neutron 2460 exposures calculated with the 15-year-old male mesh-type reference computational phantom 2461 2462 (MRCP), along with the values calculated with the P143 15-year-old male phantom.



2464 Fig. H.17. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the antero-posterior (AP) irradiation geometry for neutron 2465 exposures calculated with the 15-year-old female mesh-type reference computational phantom 2466 2467 (MRCP), along with the values calculated with the P143 15-year-old female phantom. 2468





Fig. H.18. Effective dose per fluence (pSv cm²) for neutron exposures calculated with the 2471 newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms. 2472





2474 2475

Fig. H.19. Effective dose per fluence (pSv cm²) for neutron exposures calculated with the 1-2476 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2477 calculated with the P143 1-year-old phantoms.





2479 2480

Fig. H.20. Effective dose per fluence (pSv cm²) for neutron exposures calculated with the 5-2481 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2482 calculated with the P143 5-year-old phantoms.





Fig. H.21. Effective dose per fluence (pSv cm²) for neutron exposures calculated with the 10-2486 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2487 calculated with the P143 10-year-old phantoms. 2488





Fig. H.22. Effective dose per fluence (pSv cm²) for neutron exposures calculated with the 15-2491 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2492 calculated with the P143 15-year-old phantoms.





2494

Fig. H.23. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for electron exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms. The values shown were averaged

2499 for the male and female phantoms.



2500

Fig. H.24. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for electron exposures calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms. The values shown were averaged for the male and female phantoms.





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Fig. H.25. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for electron exposures calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms. The values shown were averaged for the male and female phantoms.



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Fig. H.26. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for electron exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms. The values shown were averaged for the male and female phantoms.





2520 2521

Fig. H.27. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for electron exposures 2522 2523 calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), 2524 along with the values calculated with the P143 15-year-old male phantom.



2526 Fig. H.28. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, 2527 stomach, breast and skin in the isotropic (ISO) irradiation geometry for electron exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), 2528 2529 along with the values calculated with the P143 15-year-old female phantom. 2530





Fig. H.29. Effective dose per fluence (pSv cm²) for electron exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms.





Fig. H.30. Effective dose per fluence (pSv cm²) for electron exposures calculated with the 1-2538 year-old mesh-type reference computational phantoms (MRCPs), along with the values 2539 calculated with the P143 1-year-old phantoms.





Fig. H.31. Effective dose per fluence (pSv cm²) for electron exposures calculated with the 5year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms.





Fig. H.32. Effective dose per fluence (pSv cm²) for electron exposures calculated with the 10year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms.





Fig. H.33. Effective dose per fluence (pSv cm²) for electron exposures calculated with the 15-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 15-year-old phantoms.





2556 2557

Fig. H.34. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for helium ion exposures 2558 calculated with the newborn mesh-type reference computational phantoms (MRCPs), along 2559 2560 with the values calculated with the P143 newborn phantoms. The values shown were averaged

2561 for the male and female phantoms.



2562

2563 Fig. H.35. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for helium ion exposures 2564 calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along 2565 2566 with the values calculated with the P143 1-year-old phantoms. The values shown were 2567 averaged for the male and female phantoms.





2569 2570

Fig. H.36. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for helium ion exposures 2571 calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along 2572 2573 with the values calculated with the P143 5-year-old phantoms. The values shown were 2574 averaged for the male and female phantoms.



2575

2576 Fig. H.37. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for helium ion exposures 2577 2578 calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along 2579 with the values calculated with the P143 10-year-old phantoms. The values shown were 2580 averaged for the male and female phantoms.





2582 2583

Fig. H.38. Absorbed dose per fluence (pGy cm²) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for helium ion exposures 2584 2585 calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), 2586 along with the values calculated with the P143 15-year-old male phantom.



2588 Fig. H.39. Absorbed dose per fluence (pGy cm2) to the red bone marrow (RBM), colon, lungs, stomach, breast and skin in the isotropic (ISO) irradiation geometry for helium ion exposures 2589 calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), 2590 2591 along with the values calculated with the P143 15-year-old female phantom. 2592





Fig. H.40. Effective dose per fluence (pSv cm²) for helium ion exposures calculated with the 2595 newborn mesh-type reference computational phantoms (MRCPs), along with the values 2596 calculated with the P143 newborn phantoms.





Fig. H.41. Effective dose per fluence (pSv cm²) for helium ion exposures calculated with the 2600 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values 2601 calculated with the P143 1-year-old phantoms.





Fig. H.42. Effective dose per fluence (pSv cm²) for helium ion exposures calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms.





Fig. H.43. Effective dose per fluence (pSv cm²) for helium ion exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms.





Fig. H.44. Effective dose per fluence (pSv cm²) for helium ion exposures calculated with the 15-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 15-year-old phantoms.







Fig. H.45. Absorbed dose per fluence (pGy cm²) to the lens in the antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), right-lateral (RLAT), rotational (ROT) and isotropic (ISO) irradiation geometries for photon exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms. The values shown were averaged for the male and female phantoms.



Fig. H.46. Absorbed dose per fluence (pGy cm²) to the lens in the antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), right-lateral (RLAT), rotational (ROT) and isotropic (ISO) irradiation geometries for photon exposures calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms. The values shown were averaged for the male and female phantoms.







Fig. H.47. Absorbed dose per fluence (pGy cm²) to the lens in the antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), right-lateral (RLAT), rotational (ROT) and isotropic (ISO) irradiation geometries for photon exposures calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms. The values shown were averaged for the male and female phantoms.



Fig. H.48. Absorbed dose per fluence (pGy cm²) to the lens in the antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), right-lateral (RLAT), rotational (ROT) and isotropic (ISO) irradiation geometries for photon exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms. The values shown were averaged for the male and female phantoms.






Fig. H.49. Absorbed dose per fluence (pGy cm²) to the lens in the antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), right-lateral (RLAT), rotational (ROT) and isotropic (ISO) irradiation geometries for photon exposures calculated with the 15-year-old male meshtype reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old male phantom.



Fig. H.50. Absorbed dose per fluence (pGy cm²) to the lens in the antero-posterior (AP), postero-anterior (PA), left-lateral (LLAT), right-lateral (RLAT), rotational (ROT) and isotropic (ISO) irradiation geometries for photon exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom.



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2673 ANNEX I. COMPARISON OF SPECIFIC ABSORBED FRACTIONS

2674 This annex compares the specific absorbed fractions (SAFs) for photons and (I1) 2675 electrons calculated using the paediatric mesh-type reference computational phantoms (MRCPs) with the values calculated with the Publication 143 (P143) phantoms (ICRP, 2020) 2676 2677 and the values in Publication 1XX (ICRP, 2022). To calculate the values, the MRCPs and P143 2678 phantoms were implemented into the Geant4 code (version 10.06.p02) (Allisons et al., 2016) 2679 using the G4Tet and G4VNestedParameterisation classes, respectively. The considered source organs are the liver, lungs, cortical bone and thyroid, in which mono-energetic photons and 2680 2681 electrons, ranging from 10 keV to 10 MeV, were uniformly generated using the 2682 G4VUserPrimaryGeneratorAction class. The number of source particles varied from 10^7 to 10^{10} , depending on the particle type and energy, keeping the statistical relative errors of the 2683 2684 calculated SAFs below 5%. The kerma approximation was not applied. The physics library of 2685 G4EmLivermorePhysics was used to transport the particles with the secondary range cut value 2686 of 1 µm (Geant4 Physics Reference Manual). Note that for photons, the SAFs for the red bone 2687 marrow (RBM) and endosteum were estimated using the fluence-to-absorbed dose response functions (DRFs). For spot-check purpose, the MCNP6 (Martz et al., 2017) and PHITS (version 2688 2689 3.10) (Furuta et al., 2017) codes were additionally used to calculate the SAFs for some selected 2690 energy points, under the same simulation conditions (remaining spot-check SAFs will be included prior to publication). The default physics library for the MCNP6 (Martz et al., 2017) 2691 and the EGS5 physics library for the PHITS code (Hirayama et al., 2005) were used to transport 2692 2693 photons and electrons. The energy cut values, which are equivalent to the range cut value used 2694 in the Geant4 code, were applied to the MCNP6 and PHITS codes. Figs I.1-I.24 and I.25-I.48 2695 show the SAFs for the selected source and target organs for photons and electrons, respectively. Note that for each source organ, four target organs were selected considering the contribution 2696 2697 to effective dose. For discussion of the comparisons, please see Section 7.2 of the main text. 2698





2699 2700

Fig. I.1. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-

2701 interstitium (AI) and red bone marrow (RBM) as a target for photon exposures calculated with

2702 the newborn mesh-type reference computational phantoms (MRCPs), along with the values

calculated with the P143 newborn phantoms and the Publication 1XX values (ICRP, 2022). 2703

2704 The values shown were averaged for the male and female phantoms.





2705 2706 Fig. I.2. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-2707 interstitium (AI) and red bone marrow (RBM) as a target for photon exposures calculated with 2708 the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the Publication 1XX values (ICRP, 2022). 2709 The values shown were averaged for the male and female phantoms. 2710







2712 2713

Photon energy (MeV)

Fig. I.3. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolarinterstitium (AI) and red bone marrow (RBM) as a target for photon exposures calculated with

2715 the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values

calculated with the P143 5-year-old phantoms and the *Publication 1XX* values (ICRP, 2022).

2717 The values shown were averaged for the male and female phantoms.





Fig. I.4. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolarinterstitium (AI) and red bone marrow (RBM) as a target for photon exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms and the *Publication 1XX* values (ICRP, 2022).





2724 2725

Photon energy (MeV)

Fig. I.5. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-2726 interstitium (AI) and red bone marrow (RBM) as a target for photon exposures calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), along with the

2727 values calculated with the P143 15-year-old male phantom and the Publication 1XX values 2728

2729 (ICRP, 2022).





2730 2731 Fig. I.6. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-2732 interstitium (AI) and red bone marrow (RBM) as a target for photon exposures calculated with 2733 the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the Publication 1XX values 2734 2735 (ICRP, 2022).





2737 2738

Photon energy (MeV)

Fig. I.7. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium (AI), 2739 red bone marrow (RBM), stomach and liver as a target for photon exposures calculated with

the newborn mesh-type reference computational phantoms (MRCPs), along with the values 2740

2741 calculated with the P143 newborn phantoms and the Publication 1XX values (ICRP, 2022).

2742 The values shown were averaged for the male and female phantoms.





2744 Fig. I.8. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium (AI), 2745 red bone marrow (RBM), stomach and liver as a target for photon exposures calculated with 2746 the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the Publication 1XX values (ICRP, 2022). 2747 2748 The values shown were averaged for the male and female phantoms.





2750 2751

Photon energy (MeV)

Fig. I.9. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium (AI),

red bone marrow (RBM), stomach and liver as a target for photon exposures calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values

calculated with the P143 5-year-old phantoms and the *Publication 1XX* values (ICRP, 2022).

2755 The values shown were averaged for the male and female phantoms.



Fig. I.10. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium (AI), red bone marrow (RBM), stomach and liver as a target for photon exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.







2763 2764

Photon energy (MeV)

Fig. I.11. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium (AI), red bone marrow (RBM), stomach and liver as a target for photon exposures calculated 2765 with the 15-year-old male mesh-type reference computational phantom (MRCP), along with 2766 the values calculated with the P143 15-year-old male phantom and the Publication 1XX values 2767

2768 (ICRP, 2022).





2769 2770 Fig. I.12. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium 2771 (AI), red bone marrow (RBM), stomach and liver as a target for photon exposures calculated 2772 with the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the Publication 1XX 2773 2774 values (ICRP, 2022).





2776 2777

Photon energy (MeV)

Fig. I.13. Specific absorbed fractions (SAFs) for cortical bone as a source and red bone marrow 2778 (RBM), alveolar-interstitium (AI), endosteum and muscle as a target for photon exposures 2779 calculated with the newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms and the Publication 1XX values 2780 2781 (ICRP, 2022). The values shown were averaged for the male and female phantoms.



2783 Fig. I.14. Specific absorbed fractions (SAFs) for cortical bone as a source and red bone marrow 2784 (RBM), alveolar-interstitium (AI), endosteum and muscle as a target for photon exposures 2785 calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the Publication 1XX values 2786 (ICRP, 2022). The values shown were averaged for the male and female phantoms. 2787





2789 2790

Photon energy (MeV)

Fig. I.15. Specific absorbed fractions (SAFs) for cortical bone as a source and red bone marrow 2791 (RBM), alveolar-interstitium (AI), endosteum and muscle as a target for photon exposures 2792 calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms and the Publication IXX values 2793 2794 (ICRP, 2022). The values shown were averaged for the male and female phantoms.





2795 2796 Fig. I.16. Specific absorbed fractions (SAFs) for cortical bone as a source and red bone marrow 2797 (RBM), alveolar-interstitium (AI), endosteum and muscle as a target for photon exposures 2798 calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along 2799 with the values calculated with the P143 10-year-old phantoms and the Publication 1XX values 2800 (ICRP, 2022). The values shown were averaged for the male and female phantoms.







2802 2803

Photon energy (MeV)

Fig. I.17. Specific absorbed fractions (SAFs) for cortical bone as a source and red bone marrow (RBM), alveolar-interstitium (AI), endosteum and muscle as a target for photon exposures calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old male phantom and the *Publication IXX* values (ICRP, 2022).





Fig. I.18. Specific absorbed fractions (SAFs) for cortical bone as a source and red bone marrow (RBM), alveolar-interstitium (AI), endosteum and muscle as a target for photon exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the *Publication*

- 2813 *1XX* values (ICRP, 2022).
- 2814





2815

Photon energy (MeV)

2816 Fig. I.19. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, red bone

marrow (RBM), extrathoracic (ET) region and alveolar-interstitium (AI) as a target for photon
 exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs),

along with the values calculated with the P143 newborn phantoms and the *Publication 1XX*

values (ICRP, 2022). The values shown were averaged for the male and female phantoms.



2821

Fig. I.20. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, red bone marrow (RBM), extrathoracic (ET) region and alveolar-interstitium (AI) as a target for photon exposures calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.





2829

Photon energy (MeV)

Fig. I.21. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, red bone marrow (RBM), extrathoracic (ET) region and alveolar-interstitium (AI) as a target for photon exposures calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.



2836

Fig. I.22. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, red bone marrow (RBM), extrathoracic (ET) region and alveolar-interstitium (AI) as a target for photon exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.





2844 2845

Photon energy (MeV)

Fig. I.23. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, red bone marrow (RBM), extrathoracic (ET) region and alveolar-interstitium (AI) as a target for photon exposures calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old male phantom and the *Publication 1XX* values (ICRP, 2022).



2850

Fig. I.24. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, red bone marrow (RBM), extrathoracic (ET) region and alveolar-interstitium (AI) as a target for photon exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the *Publication 1XX* values (ICRP, 2022).





2857

Fig. I.25. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-

interstitium (AI) and stomach as a target for electron exposures calculated with the newborn

2860 mesh-type reference computational phantoms (MRCPs), along with the values calculated with 2861 the P143 newborn phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown

2862 were averaged for the male and female phantoms.





Fig. I.26. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolarinterstitium (AI) and stomach as a target for electron exposures calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.







2870

Fig. I.27. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-

interstitium (AI) and stomach as a target for electron exposures calculated with the 5-year-old

2873 mesh-type reference computational phantoms (MRCPs), along with the values calculated with 2874 the P143 5-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown

2875 were averaged for the male and female phantoms.



2876

Fig. I.28. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolarinterstitium (AI) and stomach as a target for electron exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.





2883 2884

Fig. I.29. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolar-

- interstitium (AI) and stomach as a target for electron exposures calculated with the 15-year-old
 male mesh-type reference computational phantom (MRCP), along with the values calculated
- with the P143 15-year-old male phantom and the *Publication 1XX* values (ICRP, 2022).



2888

Fig. I.30. Specific absorbed fractions (SAFs) for liver as a source and liver, colon, alveolarinterstitium (AI) and stomach as a target for electron exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the *Publication 1XX* values (ICRP, 2022).





2894 2895

Fig. I.31. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium

(AI), stomach, heart and liver as a target for electron exposures calculated with the newborn 2896 mesh-type reference computational phantoms (MRCPs), along with the values calculated with 2897

2898 the P143 newborn phantoms and the Publication 1XX values (ICRP, 2022). The values shown

were averaged for the male and female phantoms. 2899



2900 2901 Fig. I.32. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium 2902 (AI), stomach, heart and liver as a target for electron exposures calculated with the 1-year-old 2903 mesh-type reference computational phantoms (MRCPs), along with the values calculated with 2904 the P143 1-year-old phantoms and the Publication 1XX values (ICRP, 2022). The values shown 2905 were averaged for the male and female phantoms.





2907 2908

Fig. I.33. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium

(AI), stomach, heart and liver as a target for electron exposures calculated with the 5-year-old 2909 2910

mesh-type reference computational phantoms (MRCPs), along with the values calculated with 2911 the P143 5-year-old phantoms and the Publication 1XX values (ICRP, 2022). The values shown

were averaged for the male and female phantoms. 2912





2913 2914 Fig. I.34. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium 2915 (AI), stomach, heart and liver as a target for electron exposures calculated with the 10-year-old 2916 mesh-type reference computational phantoms (MRCPs), along with the values calculated with 2917 the P143 10-year-old phantoms and the Publication 1XX values (ICRP, 2022). The values shown were averaged for the male and female phantoms. 2918





2920 2921

Fig. I.35. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium

- (AI), stomach, heart and liver as a target for electron exposures calculated with the 15-year-old
 male mesh-type reference computational phantom (MRCP), along with the values calculated
- with the P143 15-year-old male phantom and the *Publication 1XX* values (ICRP, 2022).





2925

Fig. I.36. Specific absorbed fractions (SAFs) for lungs as a source and alveolar-interstitium (AI), stomach, heart and liver as a target for electron exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the *Publication 1XX* values (ICRP, 2022).





2931

Electron energy (MeV)

Fig. I.37. Specific absorbed fractions (SAFs) for cortical bone as a source and colon, alveolarinterstitium (AI), brain and muscle as a target for electron exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.



2937

Fig. I.38. Specific absorbed fractions (SAFs) for cortical bone as a source and colon, alveolarinterstitium (AI), brain and muscle as a target for electron exposures calculated with the 1-yearold mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.





2944

Fig. I.39. Specific absorbed fractions (SAFs) for cortical bone as a source and colon, alveolar-

interstitium (AI), brain and muscle as a target for electron exposures calculated with the 5-year-

old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values

shown were averaged for the male and female phantoms.





Fig. I.40. Specific absorbed fractions (SAFs) for cortical bone as a source and colon, alveolarinterstitium (AI), brain and muscle as a target for electron exposures calculated with the 10year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.







2957

2958 Fig. I.41. Specific absorbed fractions (SAFs) for cortical bone as a source and colon, alveolar-2959 interstitium (AI), brain and muscle as a target for electron exposures calculated with the 15year-old male mesh-type reference computational phantom (MRCP), along with the values 2960 calculated with the P143 15-year-old male phantom and the Publication 1XX values (ICRP, 2961

2962 2022).



2963 2964 Fig. I.42. Specific absorbed fractions (SAFs) for cortical bone as a source and colon, alveolar-2965 interstitium (AI), brain and muscle as a target for electron exposures calculated with the 15-2966 year-old female mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old female phantom and the Publication 1XX values (ICRP, 2967 2968 2022).





2970

Electron energy (MeV)

Fig. I.43. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, oesophagus, extrathoracic (ET) region and alveolar-interstitium (AI) as a target for electron exposures calculated with the newborn mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 newborn phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.





Fig. I.44. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, oesophagus, extrathoracic (ET) region and alveolar-interstitium (AI) as a target for electron exposures calculated with the 1-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 1-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.







2983

Electron energy (MeV)

Fig. I.45. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, oesophagus, extrathoracic (ET) region and alveolar-interstitium (AI) as a target for electron exposures calculated with the 5-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 5-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.



Fig. I.46. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, oesophagus, extrathoracic (ET) region and alveolar-interstitium (AI) as a target for electron exposures calculated with the 10-year-old mesh-type reference computational phantoms (MRCPs), along with the values calculated with the P143 10-year-old phantoms and the *Publication 1XX* values (ICRP, 2022). The values shown were averaged for the male and female phantoms.







2996 2997 Fig. I.47. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, oesophagus, extrathoracic (ET) region and alveolar-interstitium (AI) as a target for electron exposures 2998 2999 calculated with the 15-year-old male mesh-type reference computational phantom (MRCP), along with the values calculated with the P143 15-year-old male phantom and the Publication 3000

1XX values (ICRP, 2022). 3001



3002

3003 Fig. I.48. Specific absorbed fractions (SAFs) for thyroid as a source and thyroid, oesophagus, 3004 extrathoracic (ET) region and alveolar-interstitium (AI) as a target for electron exposures calculated with the 15-year-old female mesh-type reference computational phantom (MRCP), 3005 3006 along with the values calculated with the P143 15-year-old female phantom and the Publication 3007 1XX values (ICRP, 2022).



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- 3021



3022 **ANNEX J. DESCRIPTION OF ELECTRONIC FILES**

3023 (J 1) The package of electronic files containing the detailed data of the paediatric mesh3024 type reference computational phantoms (MRCPs) can be found in a downloadable data file.
3025 The package is organised in two folders: *Phantom_data and MC_examples*.

3026 J.1. Data files in Phantom_data

3027 (J 2) This folder is subdivided into ten folders, one for each of the ten reference phantoms
3028 (MRCP_00M: newborn male, MRCP_00F: newborn female, MRCP_01M: 1-year-old male,
3029 MRCP_01F: 1-year-old female, MRCP_05M: 5-year-old male, MRCP_05F: 5-year-old female,
3030 MRCP_10M: 10-year-old male, MRCP_10F: 10-year-old female, MRCP_15M: 15-year-old
3031 male, MRCP_15F: 15-year-old female). Each folder contains the following files:

• Data files for the tetrahedral mesh (TM) version MRCPs; the file names are:

NODE-format file	ELE-format file
MRCP_00M.node	MRCP_00M.ele
MRCP_00F.node	MRCP_00F.ele
MRCP_01M.node	MRCP_01M.ele
MRCP_01F.node	MRCP_01F.ele
MRCP_05M.node	MRCP_05M.ele
MRCP_05F.node	MRCP_05F.ele
MRCP_10M.node	MRCP_10M.ele
MRCP_10F.node	MRCP_10F.ele
MRCP_15M.node	MRCP_15M.ele
MRCP_15F.node	MRCP_15F.ele

3033The data files consist of NODE- and ELE-format files. The NODE-format files contain a3034list of node coordinates composing the TM-version phantoms. The NODE-format files3035are represented by:

3036-First line:3037<# of nodes> <dimension (= 3)> <n/a (= 0)> <n/a (= 0)>3038-Remaining lines list # of points:3039<node ID> <x> <y> <z>

3040The ELE-format files contain a list of tetrahedrons composing the TM-version phantoms.3041Each tetrahedron is represented as four node IDs listed in the corresponding NODE-3042format files and an organ ID number with respect to the tetrahedron. The ELE-format files3043are represented by:

3044 – First line:

3045

<# of tetrahedrons> <dimension (= 3)> <# of attributes (= 1, for organ ID)>



- 3046 Remaining lines list # of tetrahedrons:
- 3047 <tetrahedron ID> <node 1> <node 2> <node 3> <node 4> <organ ID>
- Data files for the polygon mesh (PM) version MRCPs; the file names are:

OBJ-format file	MTL-format file
MRCP_00M.obj	MRCP_00M.mtl
MRCP_00F.obj	MRCP_00F.mtl
MRCP_01M.obj	MRCP_01M.mtl
MRCP_01F.obj	MRCP_01F.mtl
MRCP_05M.obj	MRCP_05M.mtl
MRCP_05F.obj	MRCP_05F.mtl
MRCP_10M.obj	MRCP_10M.mtl
MRCP_10F.obj	MRCP_10F.mtl
MRCP_15M.obj	MRCP_15M.mtl
MRCP_15F.obj	MRCP_15F.mtl

These files consist of OBJ- and MTL-format files, which contain data on PM and colours,
 respectively. They can be imported in various 3D commercial programs such as 3ds
 MaxTM (Autodesk, USA), MAYATM (Autodesk, USA), RapidformTM (INUS Technology
 INC., Korea) and Rhinoceros 5.0 (Robert McNeel, USA).

• Lists of the media, elemental compositions and densities; the file names are:

MRCP_00M_media.dat
MRCP_00F_media.dat
MRCP_01M_media.dat
MRCP_01F_media.dat
MRCP_05M_media.dat
MRCP_05F_media.dat
MRCP_10M_media.dat
MRCP_10F_media.dat
MRCP_15M_media.dat
MRCP_15F_media.dat

• The mass ratios of bone constituents in the bone sites; the file names are:

MRCP_00M_bone.dat
MRCP_00F_bone.dat
MRCP_01M_bone.dat
MRCP_01F_bone.dat



MRCP_05M_bone.dat
MRCP_05F_bone.dat
MRCP_10M_bone.dat
MRCP_10F_bone.dat
MRCP_15M_bone.dat
MRCP_15F_bone.dat

The mass ratios of blood in various body tissues; the file names are:

MRCP_00M_blood.dat
MRCP_00F_blood.dat
MRCP_01M_blood.dat
MRCP_01F_blood.dat
MRCP_05M_blood.dat
MRCP_05F_blood.dat
MRCP_10M_blood.dat
MRCP_10F_blood.dat
MRCP_15M_blood.dat
MRCP_15F_blood.dat

PDF files for phantom visualisation; the file names are

MRCP_00M.pdf
MRCP_00F.pdf
MRCP_01M.pdf
MRCP_01F.pdf
MRCP_05M.pdf
MRCP_05F.pdf
MRCP_10M.pdf
MRCP_10F.pdf
MRCP_15M.pdf
MRCP_15F.pdf

3057	The PDF files visualise the MRCPs in a 3D view, as shown in Fig. J.1. The PDF files can
3058	be opened in Acrobat program (Adobe Systems, San Jose, CA, USA) where one can
3059	navigate the phantoms in detail, e.g. by rotating or enlarging each of the organs/tissues.
3060	Detailed instruction on these 3D PDF files can be found in elsewhere
3061	(https://helpx.adobe.com/acrobat/using/displaying-3d-models-pdfs.html)
3062	





3063

Fig. J.1. 3D view of the 5-year-old mesh-type reference computational phantom (MRCP) visualised in the Adobe Acrobat program importing the MRCP_05M.pdf file.

J.2. Data files in *MC_examples*

3067 ((J 3)	This folder	contains th	e following	three com	pressed files:
0001		11110 101001	contains in	• 10110 // IIIS	un ee eom	

MRCP_GEANT4.zip
MRCP_MCNP6.zip
MRCP_PHITS.zip

3068 The data files contain input examples for implementation of the TM-version phantoms in the 3069 three Monte Carlo codes, i.e. Geant4 (Allison et al., 2016), MCNP6 (Martz et al., 2017) and 3070 PHITS (Furuta et al., 2017). Each of the compressed files includes examples for internal and 3071 external exposures. The internal exposure source is defined as a homogeneous liver source 3072 isotropically emitting 1-MeV photons. The external exposure source is defined as a point 3073 source isotropically emitting 1-MeV photons located at 1 m in front of the phantom. Detailed 3074 information on the implementation is described in the 'README.txt' file included in each 3075 compressed file.

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Martz, R.L., 2017. The MCNP6 book on unstructured mesh geometry: a user's guide for MCNP6.2. Report LA-UR-17-22442. Los Alamos National Laboratory, Los Alamos, NM. 3081 3082 3083



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3085 The Acknowledgements heading is a standard heading, but unnumbered. As such, it will appear 3086 in the Contents. This section begins with a brief description, generally one paragraph, about 3087 the establishment of the Task Group. The date the Task Group was established, its number, and its name, must be included. It then goes on as shown in the following way, with many parts 3088 3089 serving both to acknowledge contributions and to preserve the record of membership for historical purposes, including: 3090

- 3091 • a sentence of thanks:
- 3092 a list of Task Group members and the years during which they were involved; •
- 3093 • where appropriate, the members of the working party (working party is not capitalised) 3094 that paved the way to establishment of the Task Group;
- 3095 • the names of critical reviewers from the responsible Committee(s) and the Main 3096 Commission:
- 3097 the editorial members (Editor-in-Chief and Associate Editors);
- 3098 the members of the responsible Committee(s) during the preparation of the publication, 3099 including emeritus members;
- Main Commission members at the time of approval of the publication, including 3100 emeritus members; and 3101
- 3102 • a final sentence thanking individuals and organisations who participated in the public 3103 consultation process.
- 3104

3084

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