ICRP
International Commission on Radiological Protection

Task Group 103: Mesh-type Reference Computational Phantoms

Mandate

The mandate for Task Group 103 is to convert the current voxel-type reference computational phantoms into a high-fidelity mesh format to address the limitations of the voxel-type phantoms in some dose coefficient calculations.

Specific tasks include:

(1) Development of ICRP mesh-type reference computational phantoms which have all source and target tissues including the details of the eyes and skin and the thin target issues (8–300 micron) of the alimentary and respiratory tract organs;

(2) Use of these mesh-type phantoms to calculate external and internal dose coefficients to estimate the uncertainties of the current reference dose coefficients, especially for the dose coefficients calculated with stylized phantoms (eye lenses, skin, and alimentary and respiratory tract organs) for weakly penetrating radiations; and

(3) Demonstration of phantom posture and body-size change and related dose coefficient calculations.

Membership

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Conversion of adult reference phantoms – completed

The adult male and female reference computational phantoms in *Publication* 110 have been converted to mesh-type reference computational phantoms (MRCPs). The adult MRCPs include all source and target regions required for evaluating effective dose, even the micron-thick target and source regions in the respiratory and alimentary tract organs, skin, and urinary bladder wall (see Figure 1), assimilating the supplemental stylized models. The adult MRCPs can also be directly implemented in Monte Carlo codes without voxelization, fully maintaining the fidelity of the mesh phantoms. In addition, due to the high deformability of mesh format, the adult MRCPs can be easily deformed into different body sizes and postures, allowing various practical approaches to individualize phantoms. Taking the advantage of the high deformability, the Task Group has developed additional adult phantoms that represent different body sizes (10th and 90th body height/weight percentile of Caucasian adults) and postures (i.e., walking, bending, kneeling, squatting, and sitting), investigating the variations in dose values from individual differences.
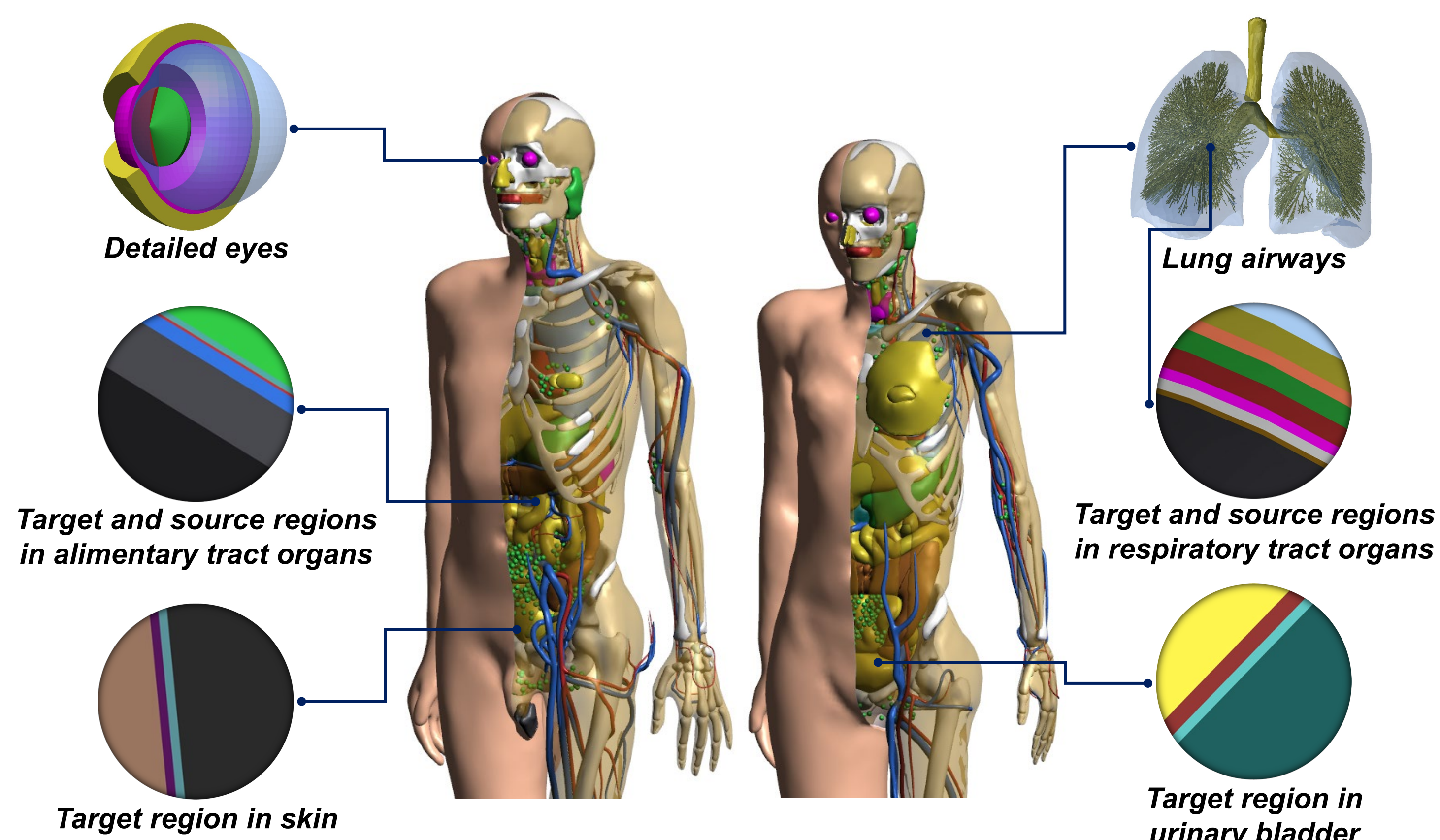

Detailed eyes

Lung airways

Target and source regions in alimentary tract organs

Target and source regions in respiratory tract organs

Target region in skin

Target region in urinary bladder

Figure 1. Adult male (left) and female (right) MRCPs

Conversion of pediatric reference phantoms – in progress

The pediatric MRCPs are under development in three steps: (1) to produce the high-quality mesh replica of pediatric voxel-type reference phantoms; (2) to include the blood content in the organs/tissues; and (3) to construct the complex or micron-scaled organs/tissues. Currently, steps 1 and 2 have been completed, and step 3 is in progress (see Figure 2). The development is planned to be completed by the end of 2019 or early 2020. The pediatric MRCPs are expected to have the same advantages as those of the adult MRCPs, i.e., high fidelity and deformability. In addition, the phantoms will be used to develop non-reference pediatric phantoms with different body sizes and postures, allowing individualized dose calculations. On completion of the pediatric MRCPs, the Task Group will start to convert pregnant-female / fetus phantoms.
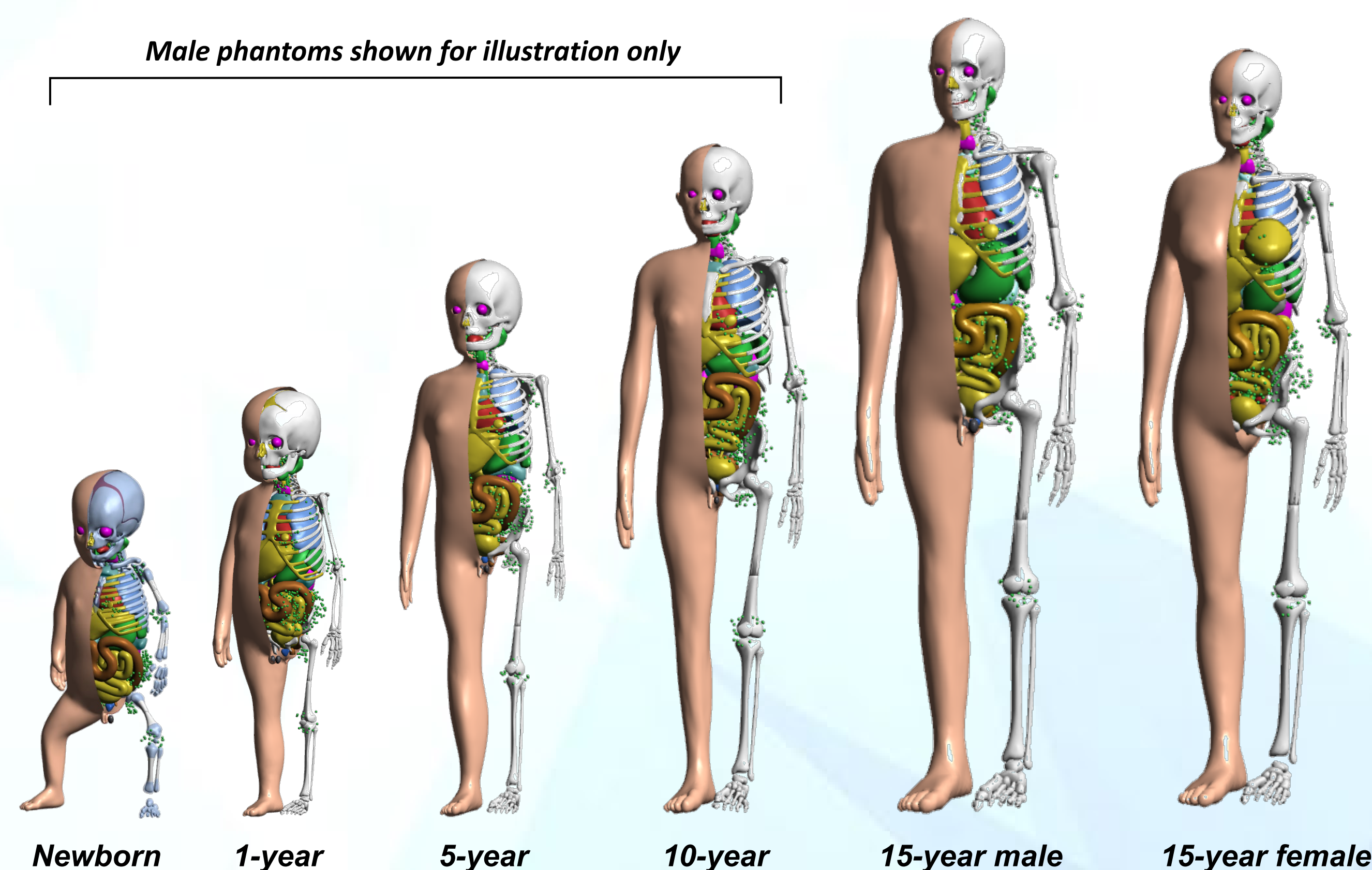

Male phantoms shown for illustration only

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

Figure 2. Pediatric MRCPs under development

Schedule

- **Q4 2017:** Completion of adult MRCPs (done)

- **Q4 2019:** Completion of pediatric MRCPs (expected)

- **Q2 2020:** Publication for adult MRCPs (expected)

- **Q4 2020:** Publication for pediatric MRCPs (expected)