3D Human Internal Organs Representation Model

Web3D Korea Standardization Meeting at SIGGRAPH

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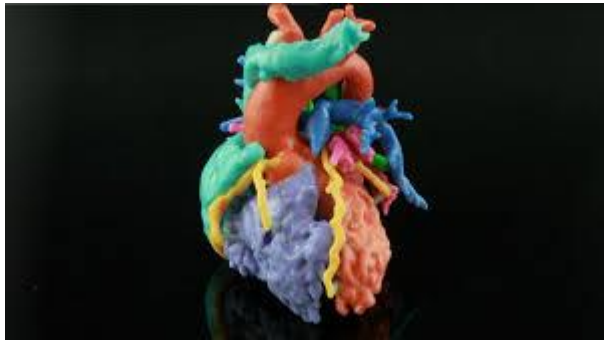
Requirements (1)

- 3D printing and scanning
  - Interface to 3D printers for internal organs
  - Interface to 3D scanners for internal organs



3dprint.com

3dprintingindustry.com

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3dprintingindustry.com

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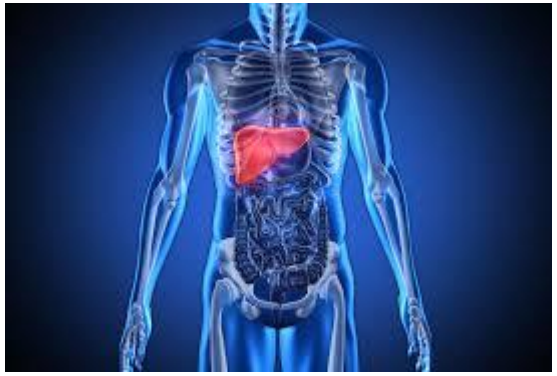
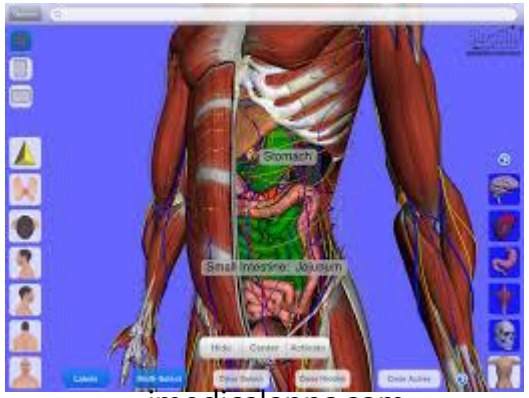
Requirements (2)

- Human health care service applications
  - Internal organs representation
  - Human health device and information service



cargocollective.com



imedicalapps.com

cargocollective.com

123rf.com

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mediafocus.com

3D Digital Human Modeling (1)

- Concepts
  - Provision with digital processing functionalities for an entire human body in 3D using all visual and functional information about internal organs as well as external human surface model and skeleton motion
  - 3D modeling and animation technology for digital information processing that can represent shapes, properties, function, and motion for human bodies, including internal organs
  - Standardized 3D digital information necessary for developing 3D medical and health care applications

3D Digital Human Modeling (2)

- Required technologies
  - Shape modeling of internal and external whole bodies in partial or whole forms using graphics technology
  - Motion modeling of internal and external whole bodies in partial or whole forms using graphics technology
  - For all visual human models, functional properties should be able to be defined and combined for shape and motion modeling of a human model

Humanoid Body Related Standards

- ISO/IEC 19774 Humanoid Animation: 2006 V1.0 (IS)
- ISO/IEC 19774 Humanoid Animation – Part 1: Architecture V2.0 (CD)
- ISO/IEC 19774 Humanoid Animation – Part 2: Motion Capture V2.0 (CD)
- ISO 7250-1: 2008 Basic human body measurements for technological design – Part 1: Body measurement definitions and landmarks
- ISO/TR 7250-2: 2010 Basic human body measurements for technological design – Part 2: Statistical summaries of body measurements from national populations
- ISO 7250-3: 2015 Basic human body measurements for technological design – Part 2: Worldwide and regional design ranges for use in product standards

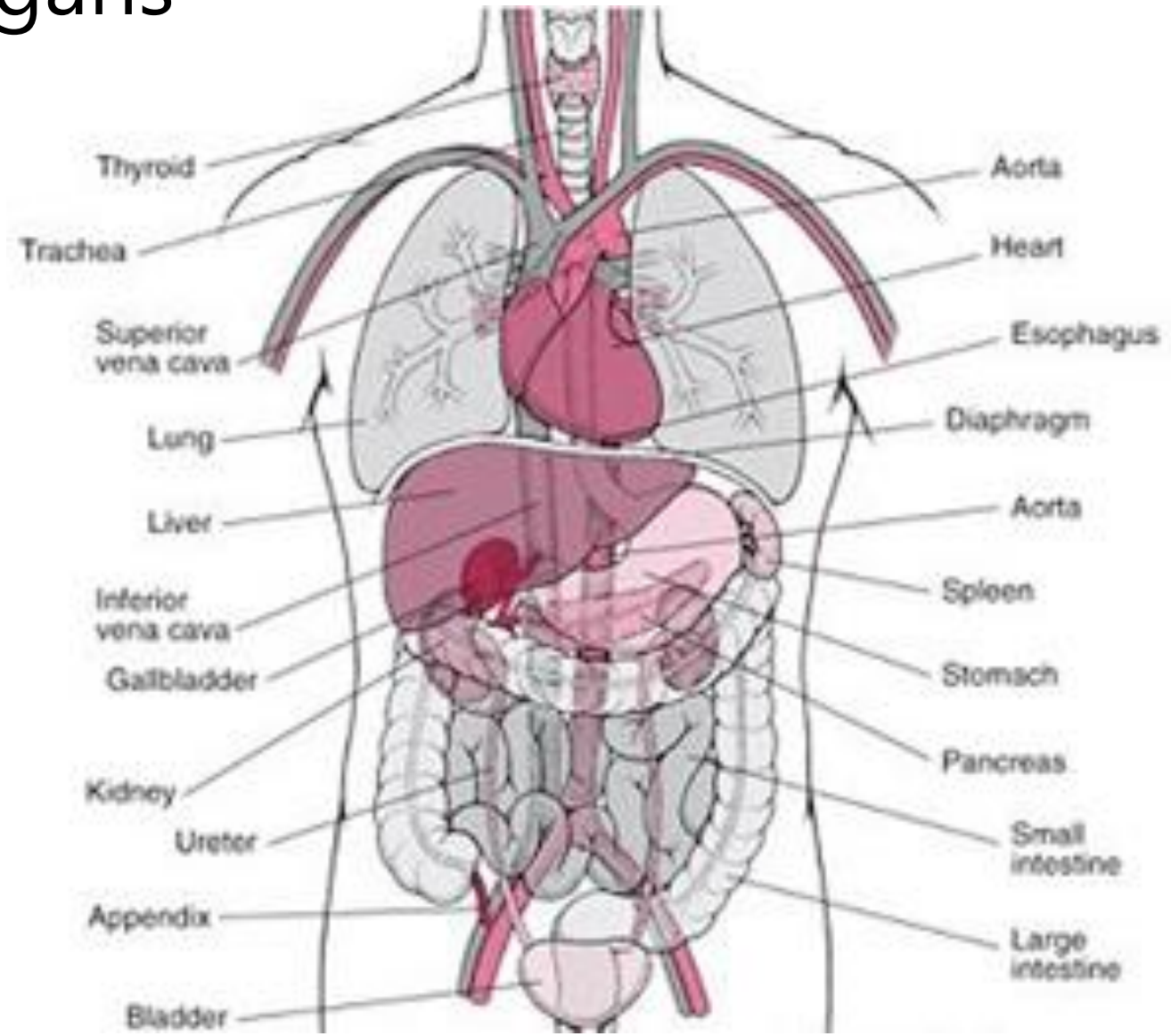
Standardization Topics

- Representation data model for visualizing human internal organs and their functionalities
  - Modeling data exchange format of human internal organs
  - Animation data exchange format of human internal organs
- Interface data model for representing functions of medical and health devices with human internal organ models in 3D scenes

Representation Data Model for Human Internal Organs

- Modeling data model
  - Soft object representation
  - Soft object modeling
  - Landmarks
  - Data model for shape representation
- Animation data model
  - Animation methods
  - Animation parameters
  - Animation definition
  - Data model for animation representation
- Interface data model with medical and health devices

Internal Organs



commons.wikimedia.org

Internal organs

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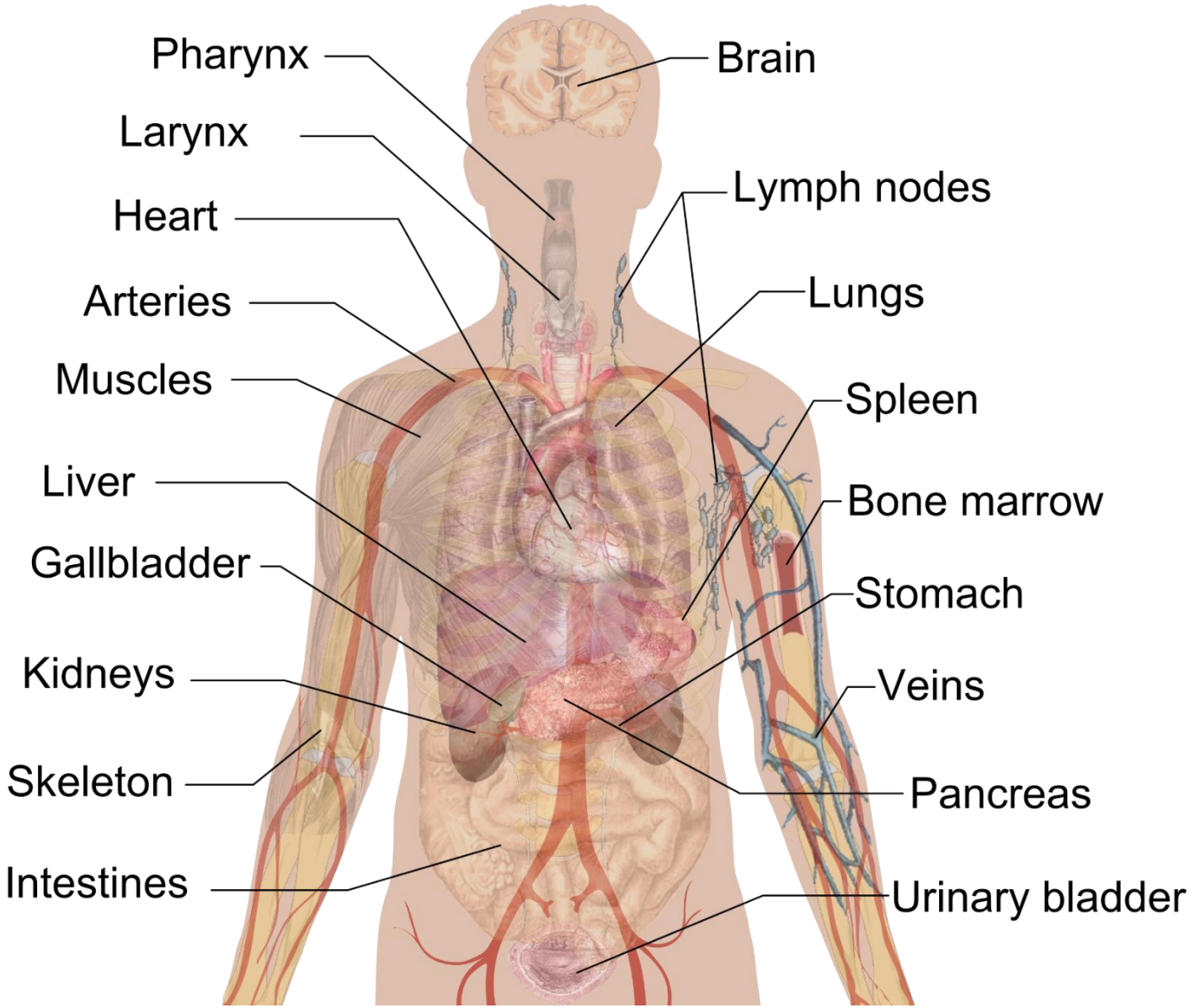

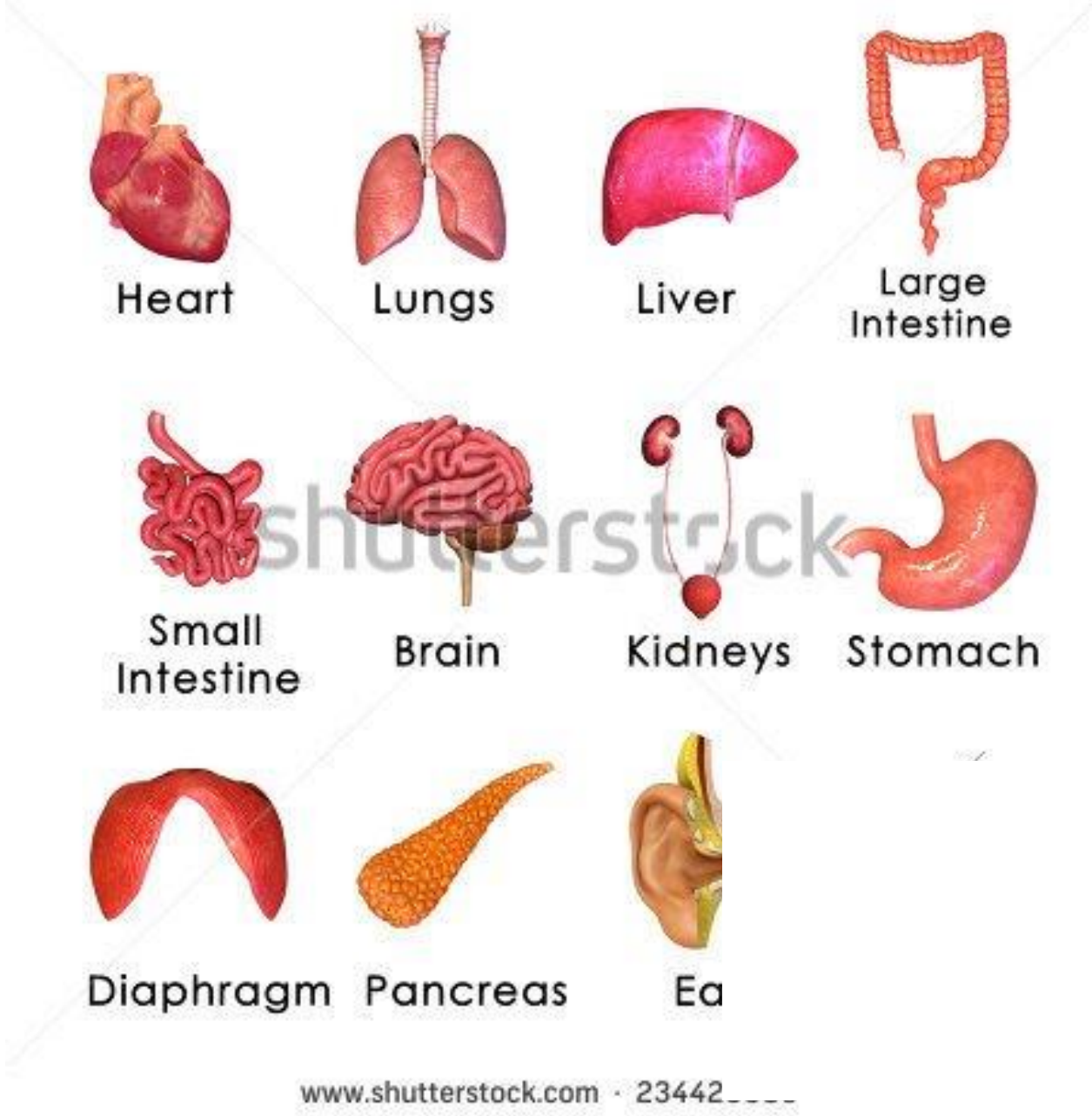

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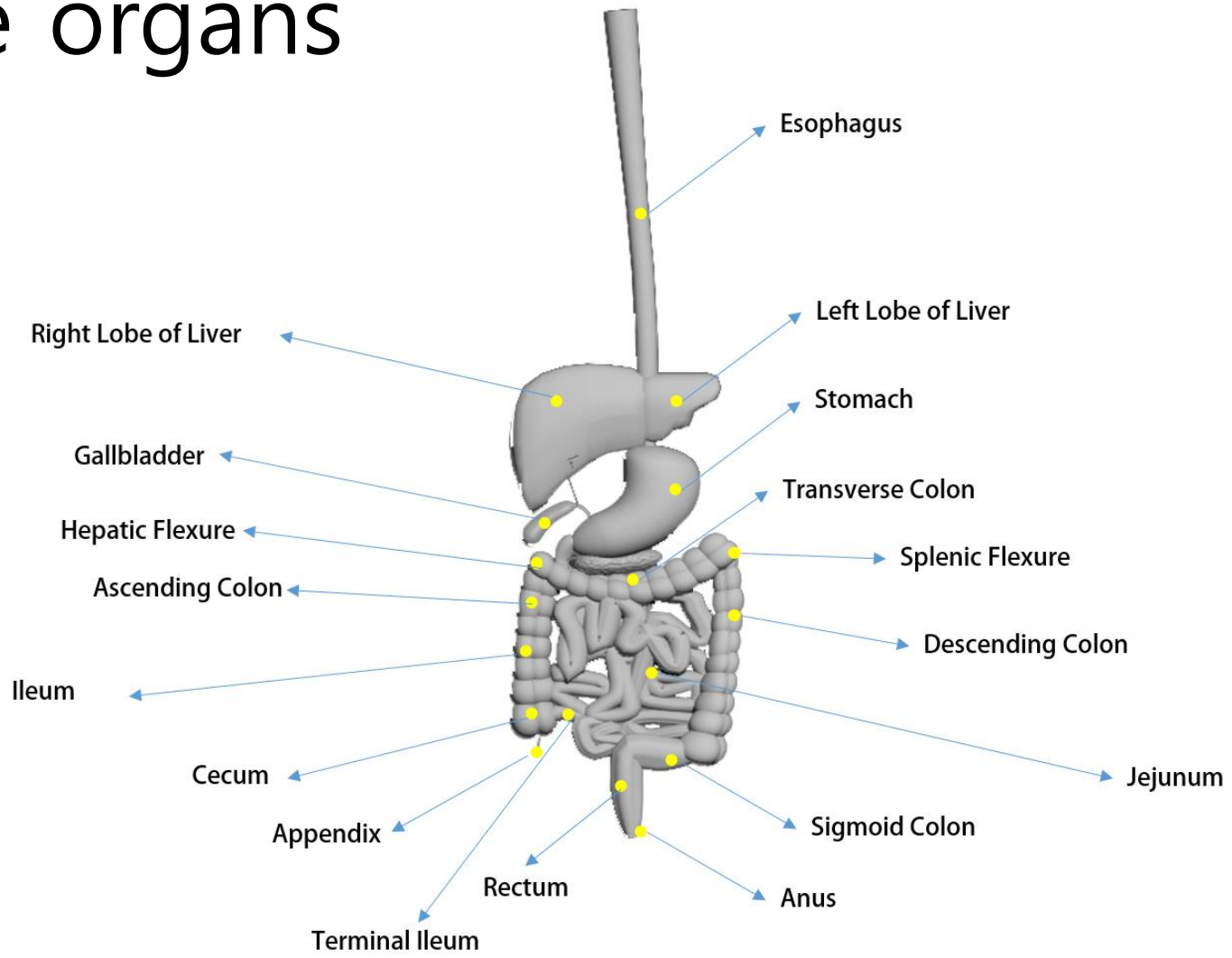
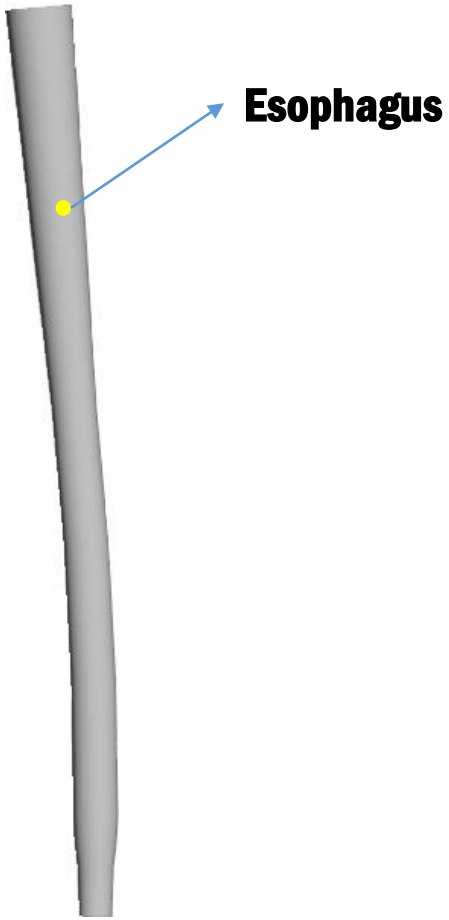
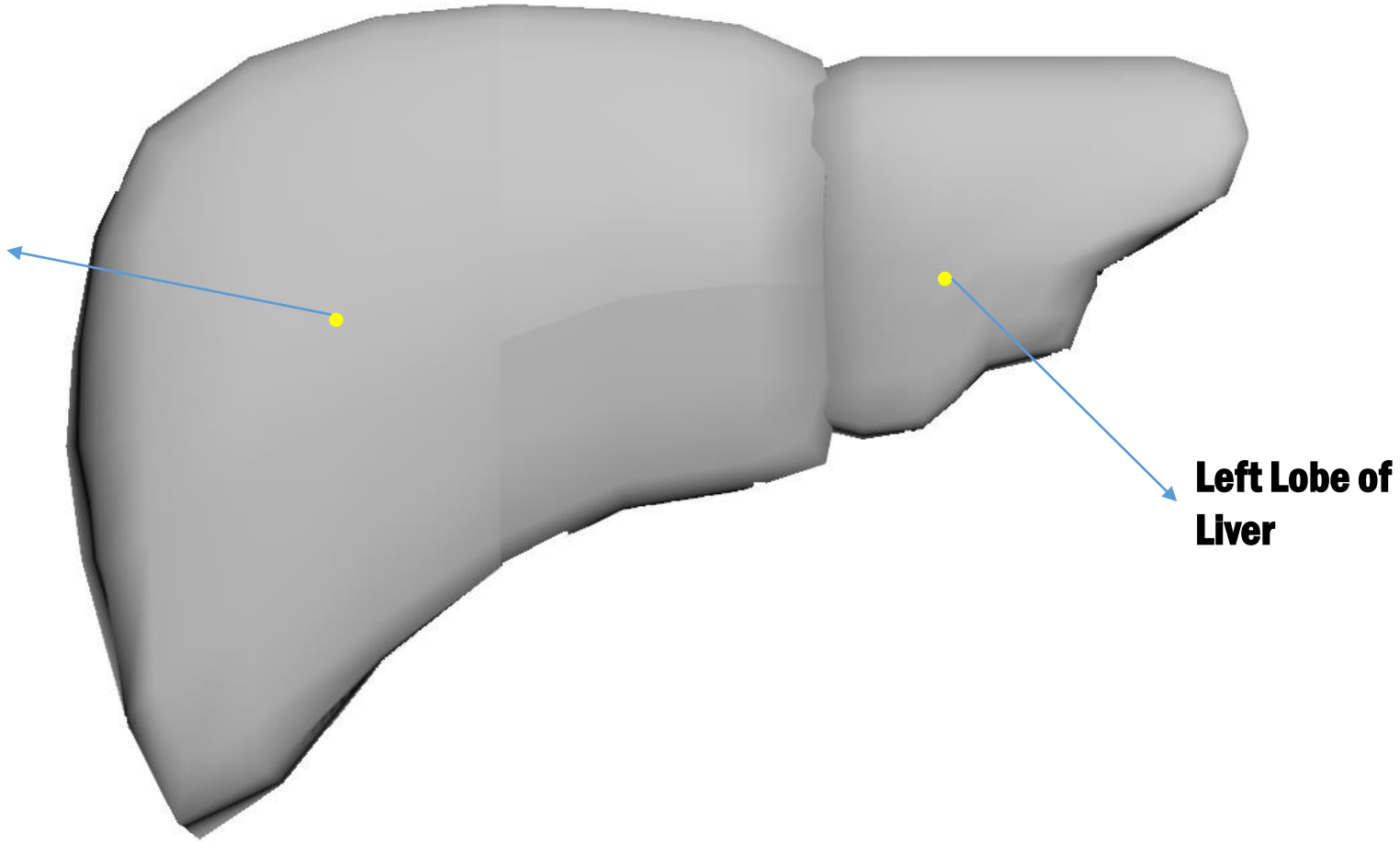
Digestive organs



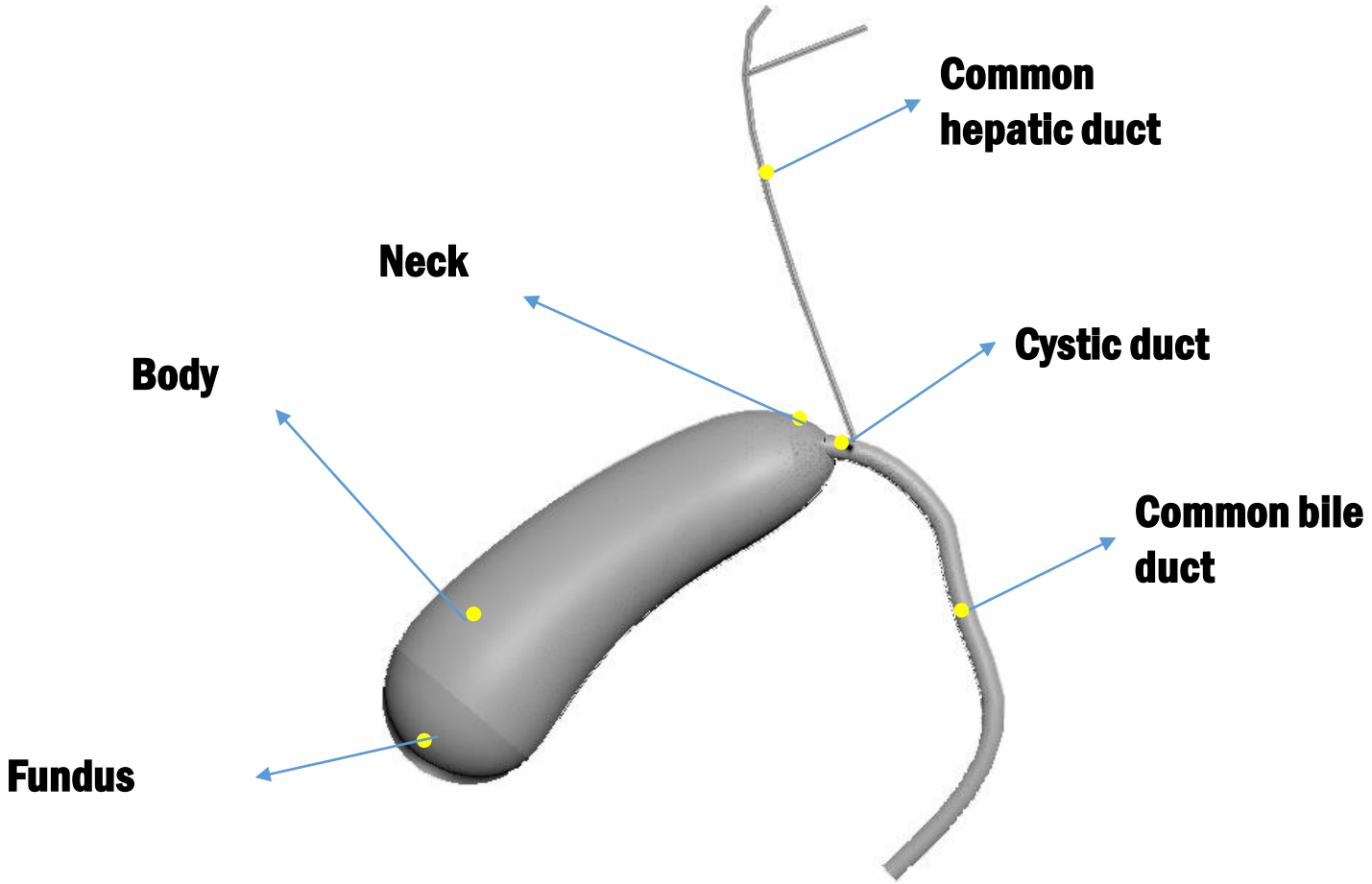
Esophagus



Liver

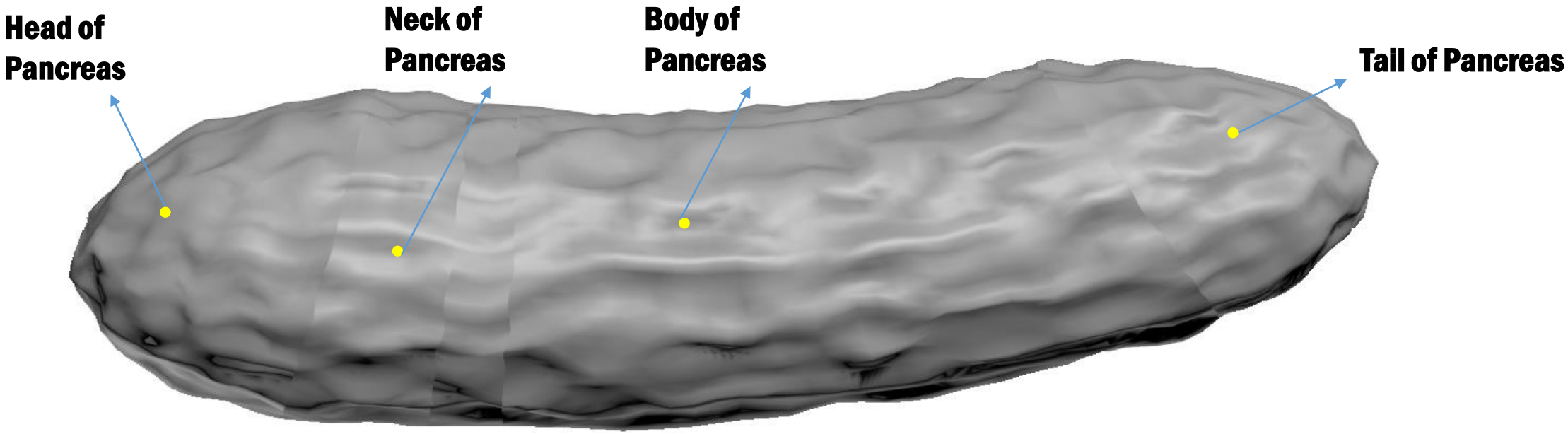


Gallbladder

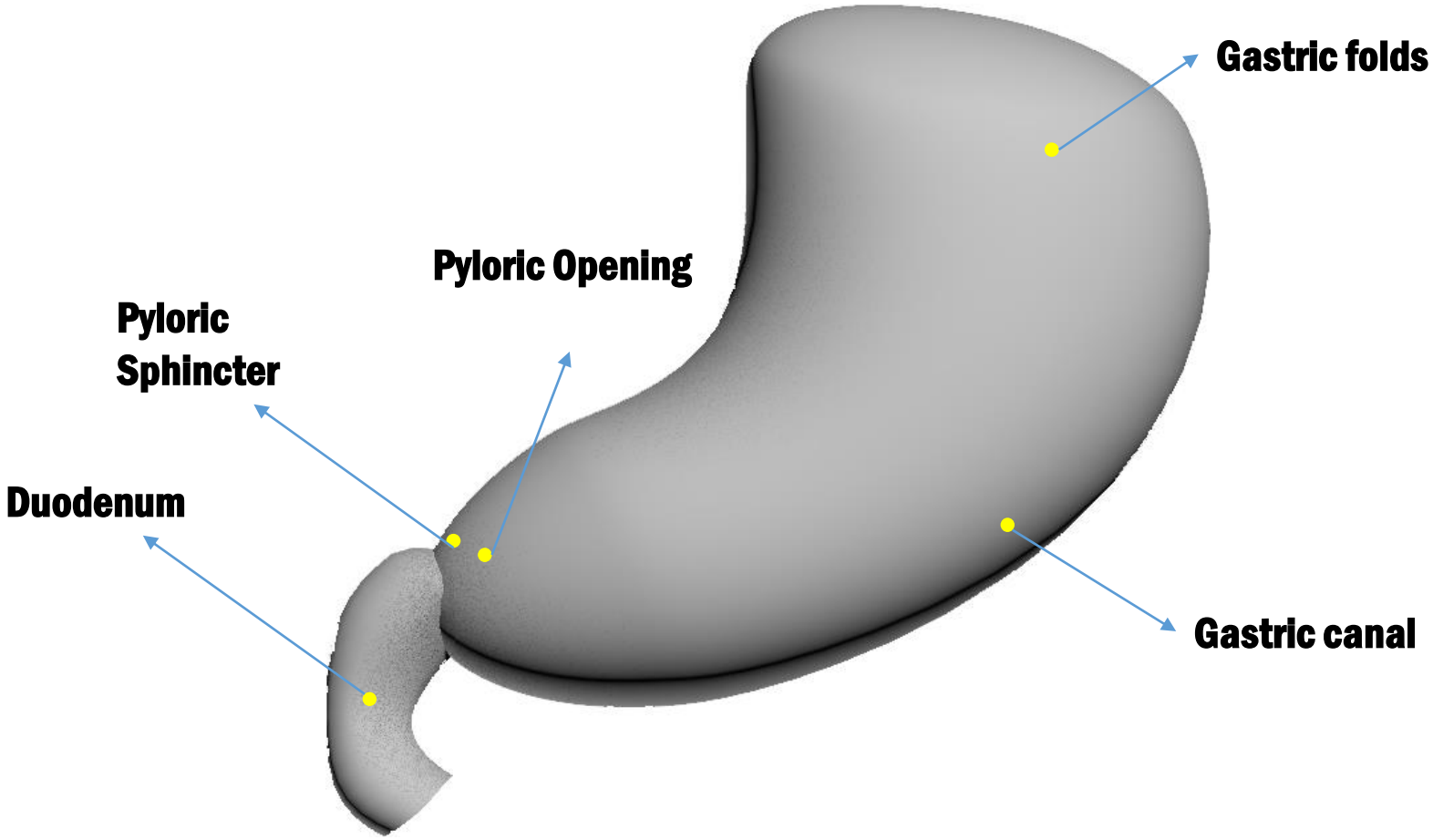


Animation Link: https://www.youtube.com/watch?v=oagtdvOf6ro

Pancreas

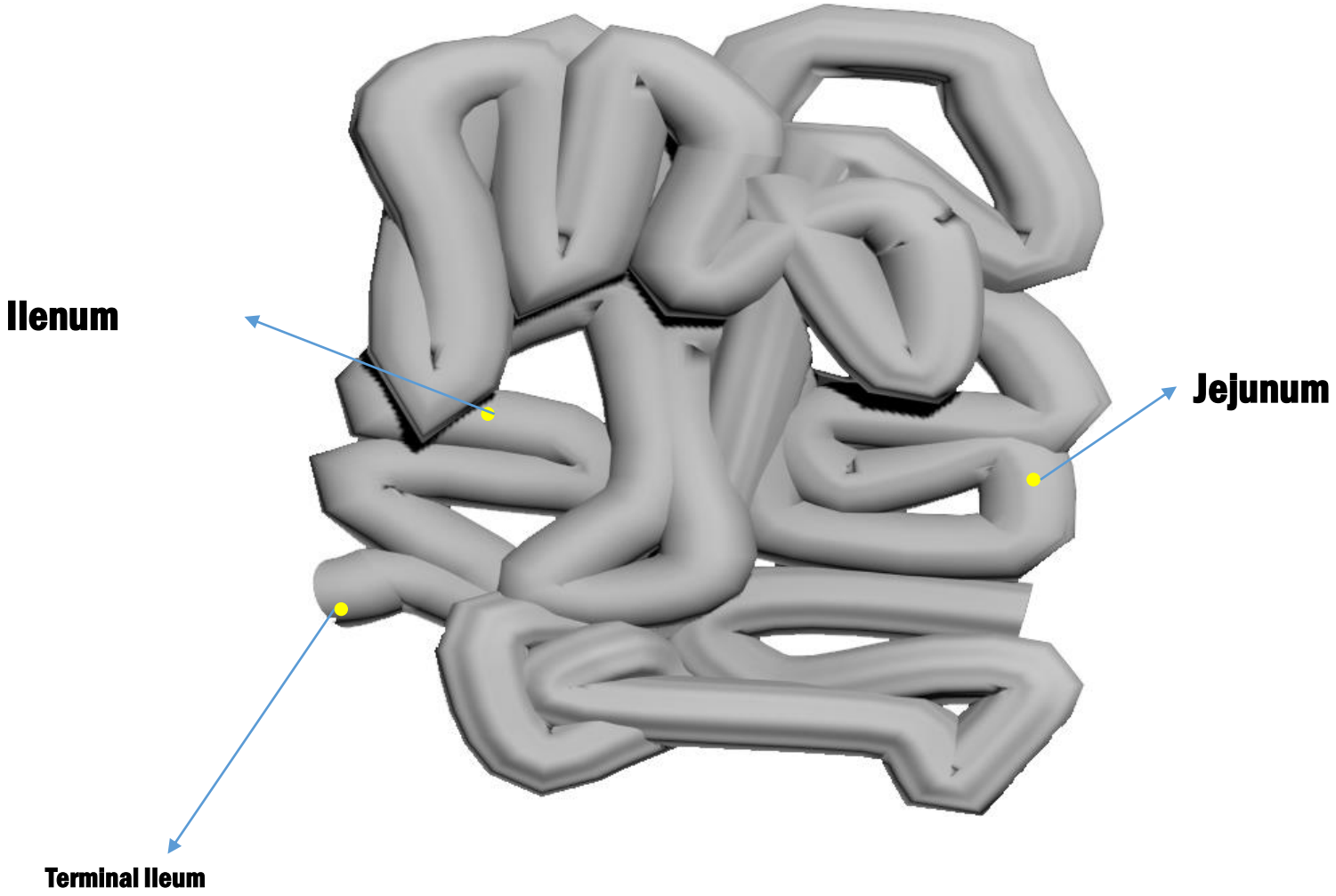

Head of Pancreas
Neck of Pancreas
Body of Pancreas
Tail of Pancreas

Stomach



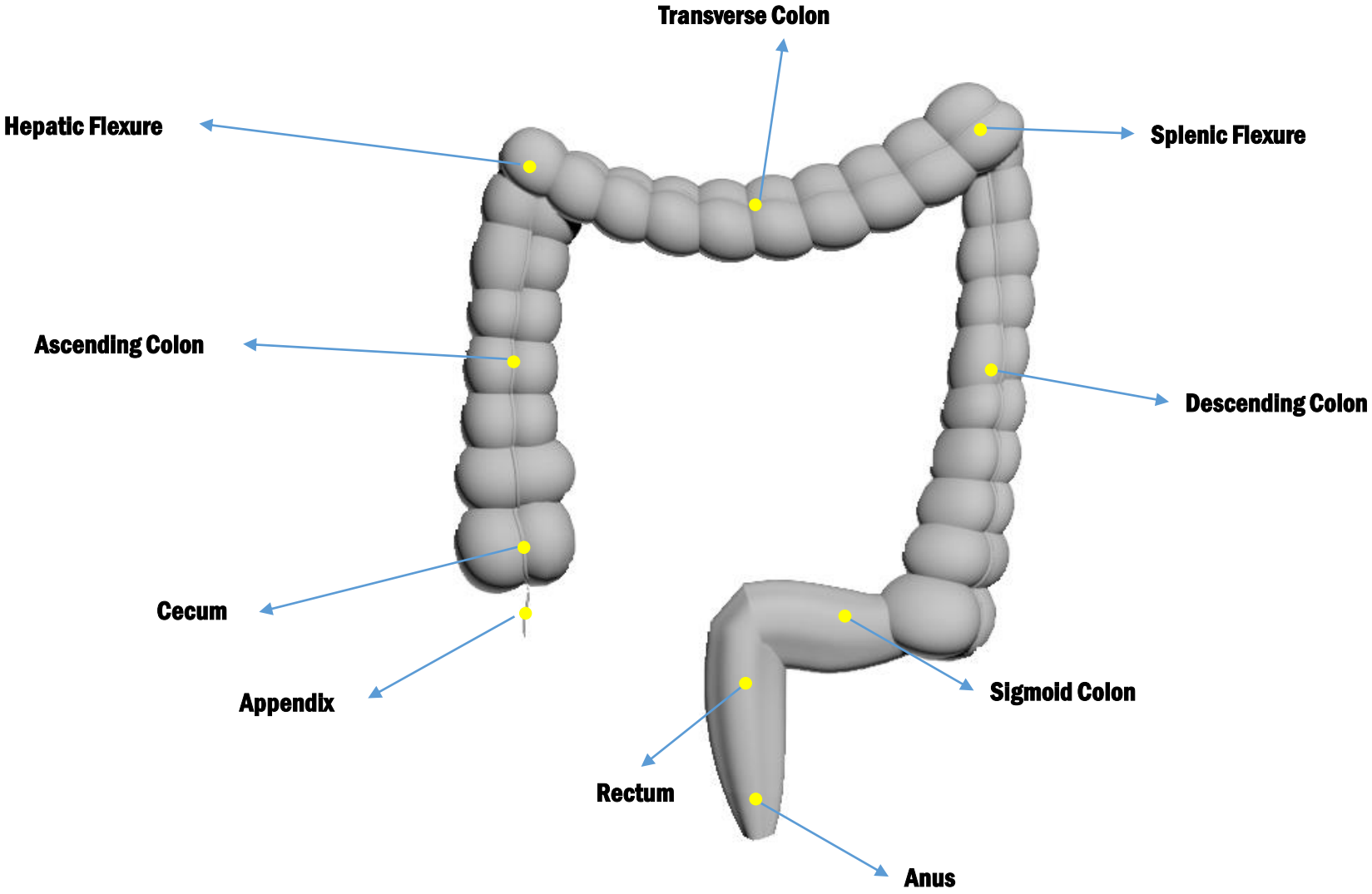
Animation Link: https://www.youtube.com/watch?v=4THOgSqwow0

Small Intestine

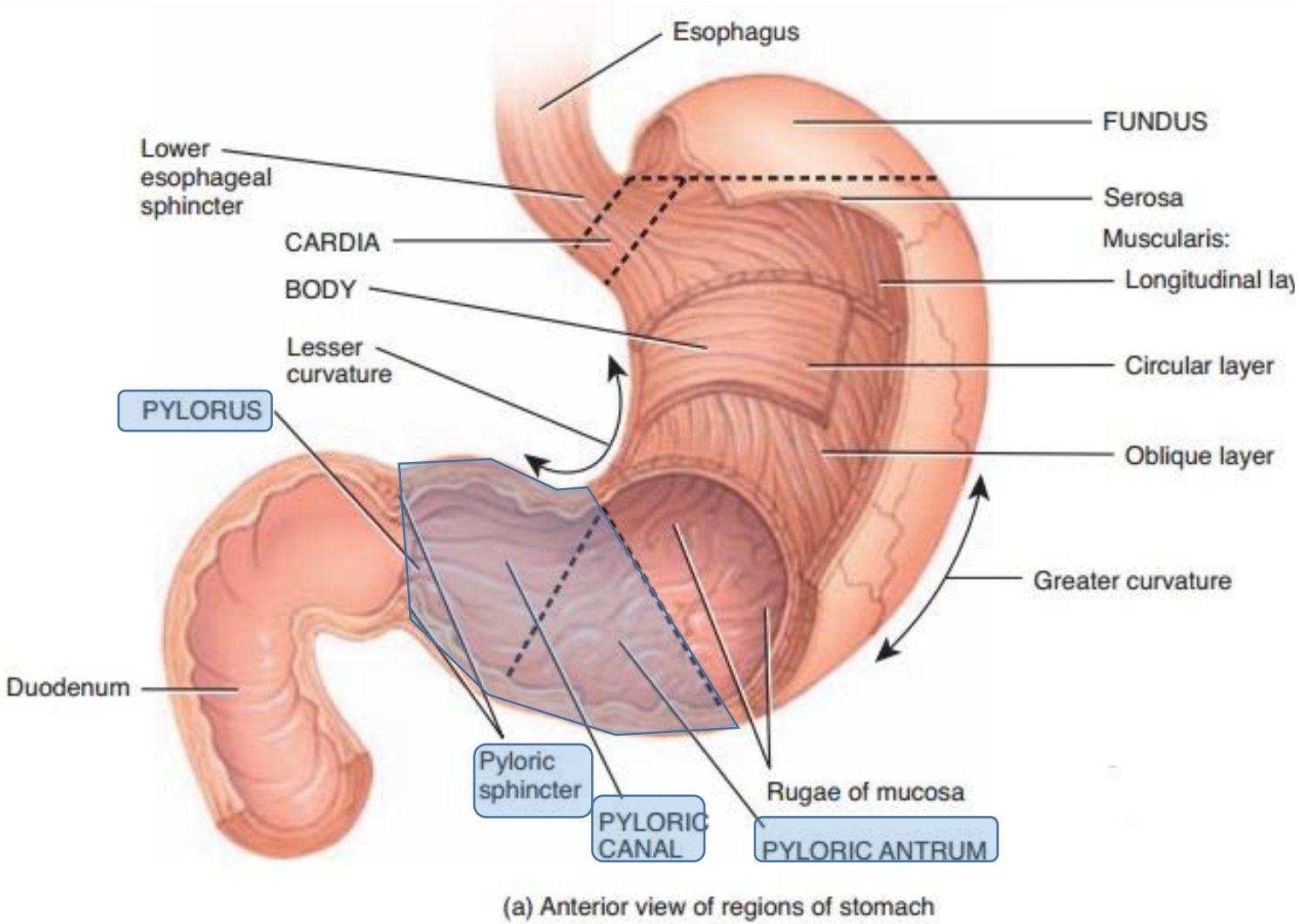


Animation Link: https://www.youtube.com/watch?v=Ujr0UAbyPS4

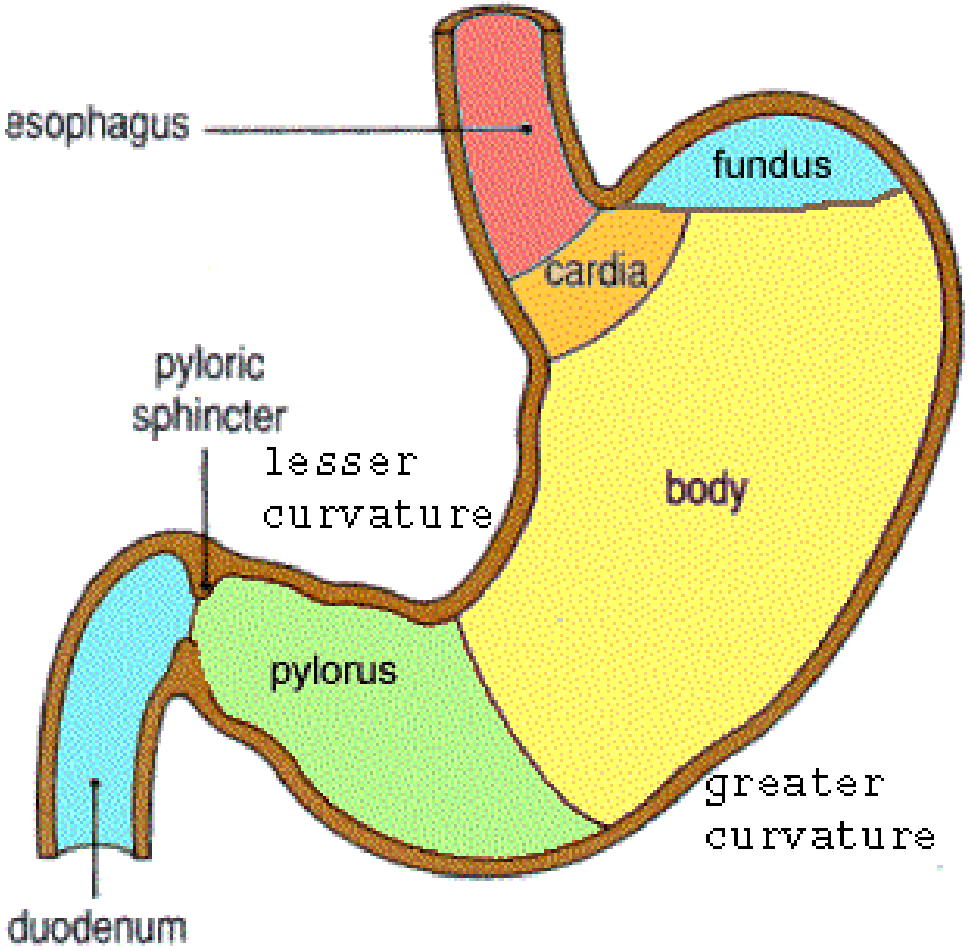
Large Intestine



Animation Link: https://www.youtube.com/watch?v=Ujr0UAbyPS4



(a) Anterior view of regions of stomach



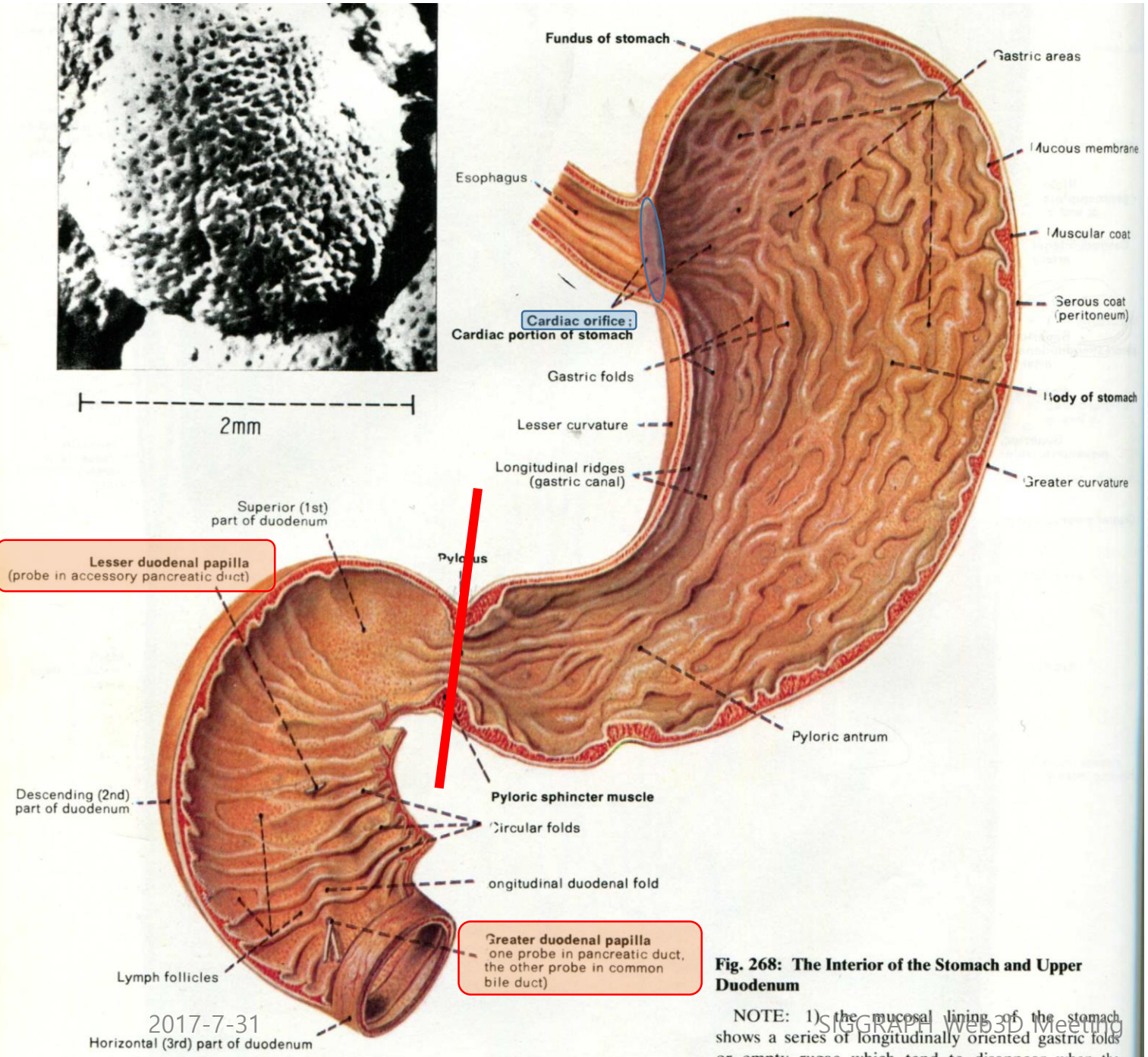
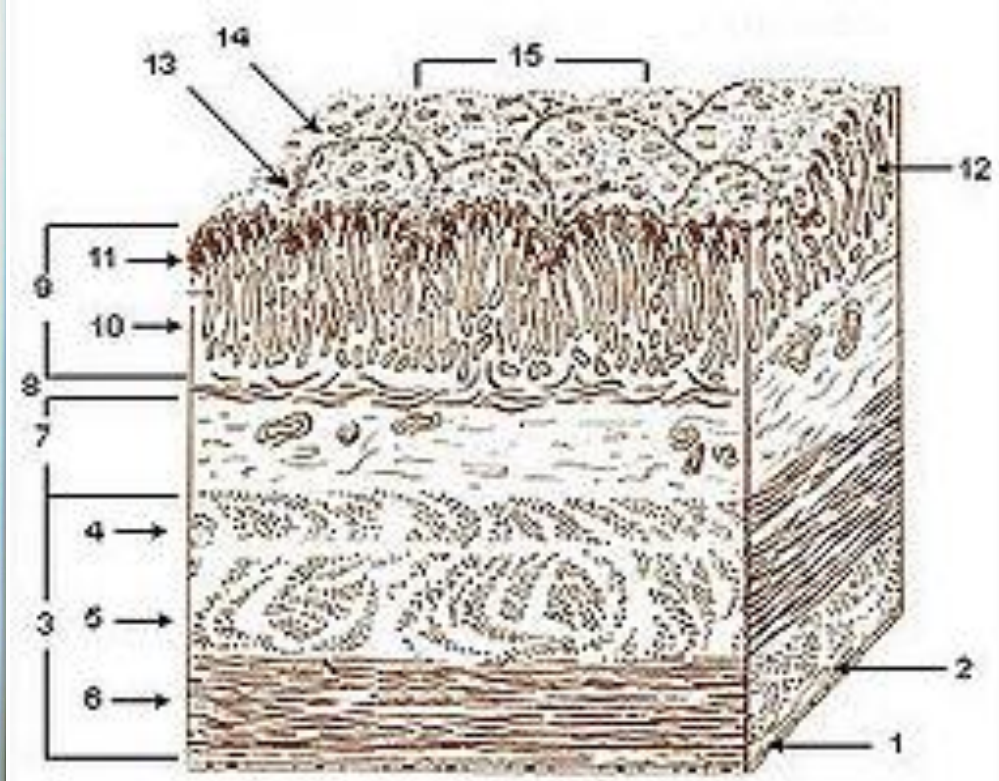


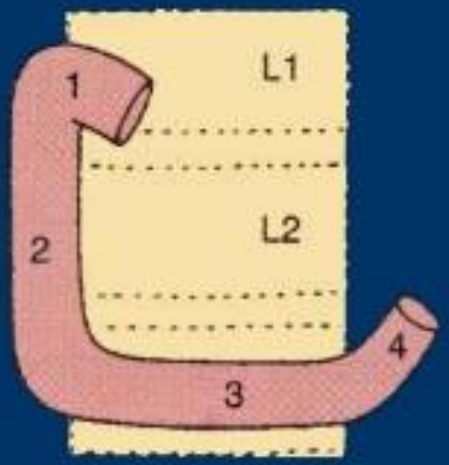
Fig. 268: The Interior of the Stomach and Upper Duodenum

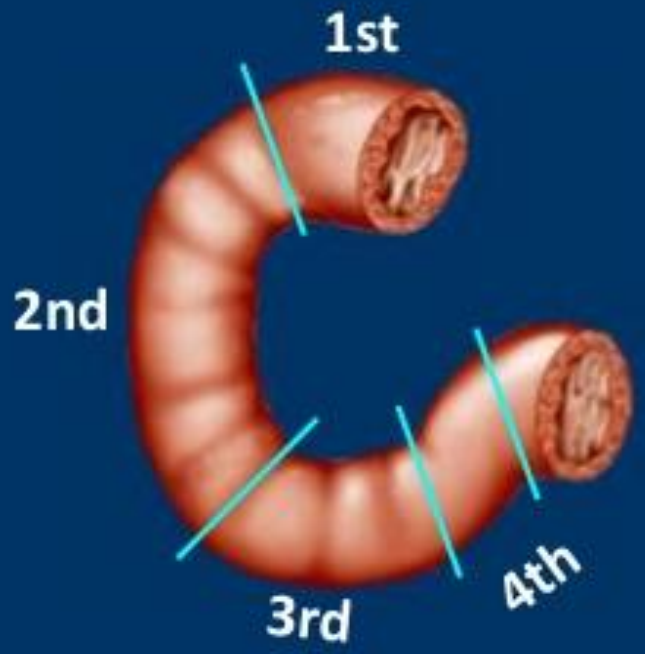
NOTE: 1) the mucosal lining of the stomach shows a series of longitudinally oriented gastric folds or empty rugae which tend to disappear when the



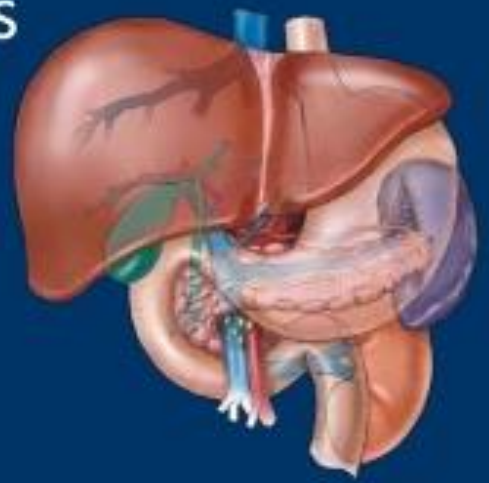
Layers of Stomach Wall:

Duodenum - parts

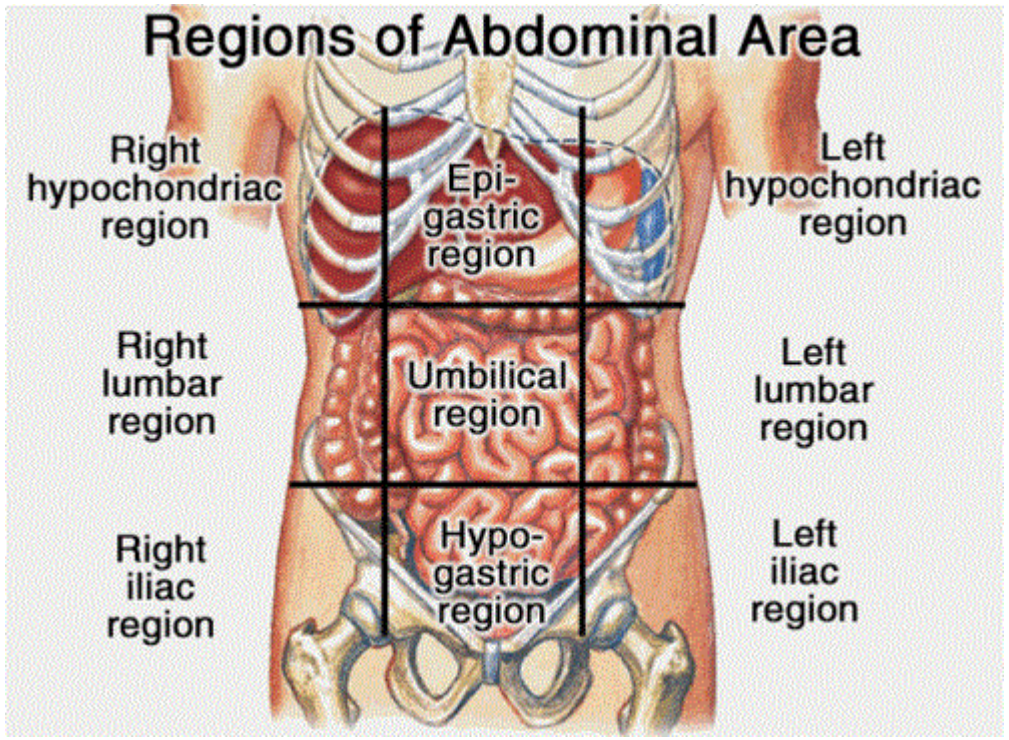


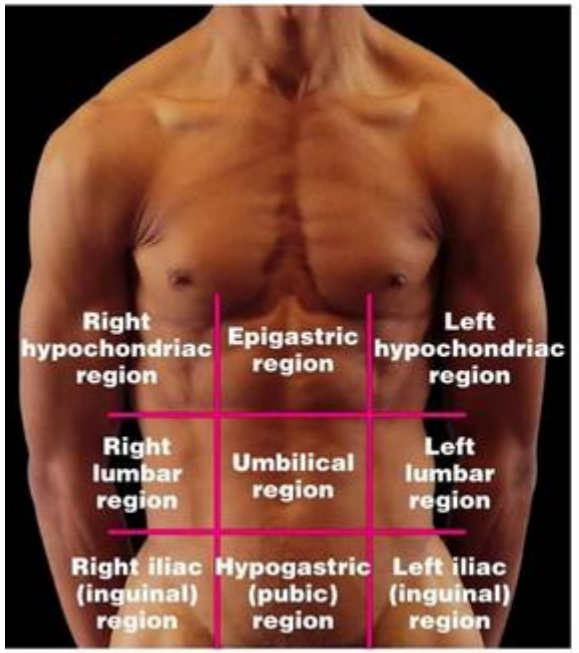


25 cm long & Subdivided into 4 parts

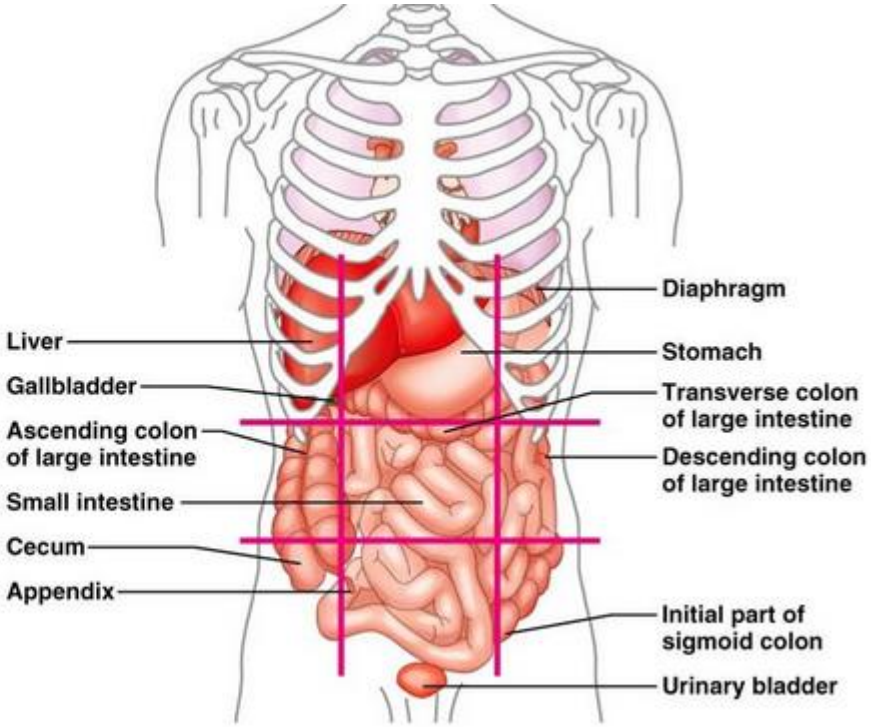


First / upper part – 5 cm
Second / vertical part – 7.5 cm
Third / horizontal part – 10 cm
Fourth / ascending part – 2.5 cm

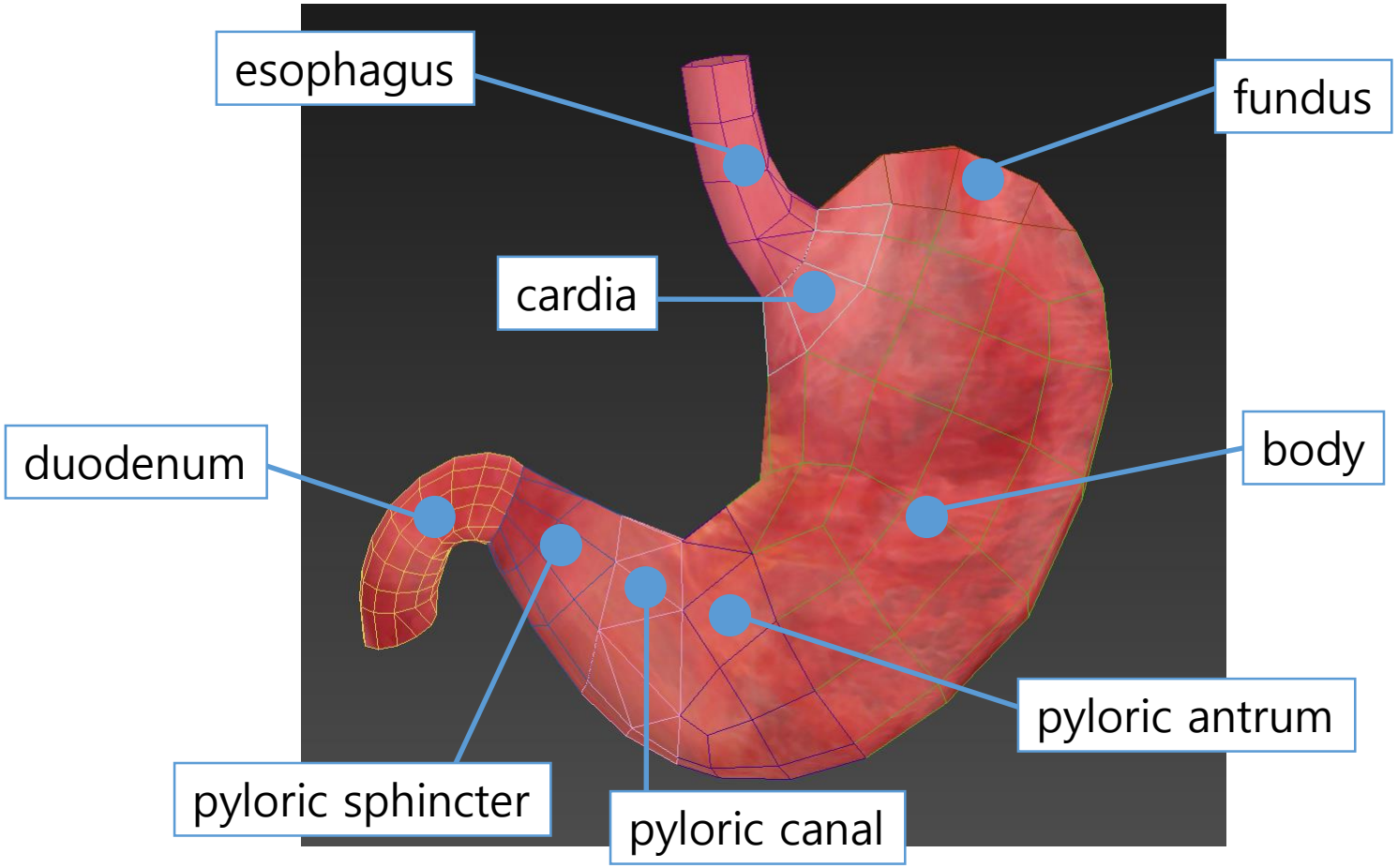

Regions of Abdominal Area
Right hypochondriac region
Epi-gastric region
Left hypochondriac region
Right lumbar region
Umbilical region
Left lumbar region
Right iliac region
Hypo-gastric region
Left iliac region


Right hypochondriac region
Epigastric region
Left hypochondriac region
Right lumbar region
Umbilical region
Left lumbar region
Right iliac (inguinal) region
Hypogastric (pubic) region
Left iliac (inguinal) region

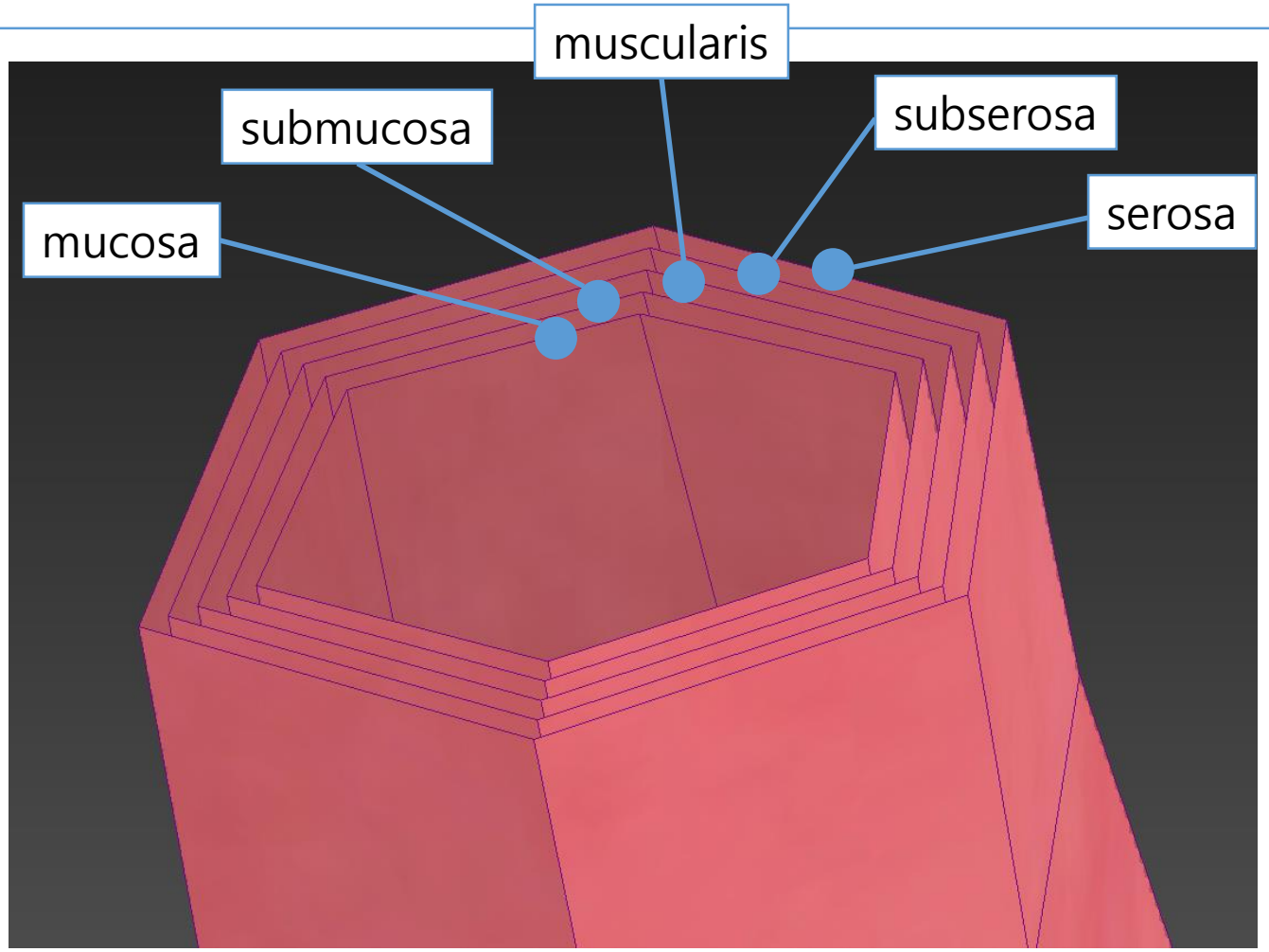
(a)


Liver
Gallbladder
Ascending colon of large intestine
Small intestine
Cecum
Appendix
Diaphragm
Stomach
Transverse colon of large intestine
Descending colon of large intestine
Initial part of sigmoid colon
Urinary bladder

Stomach Modeling

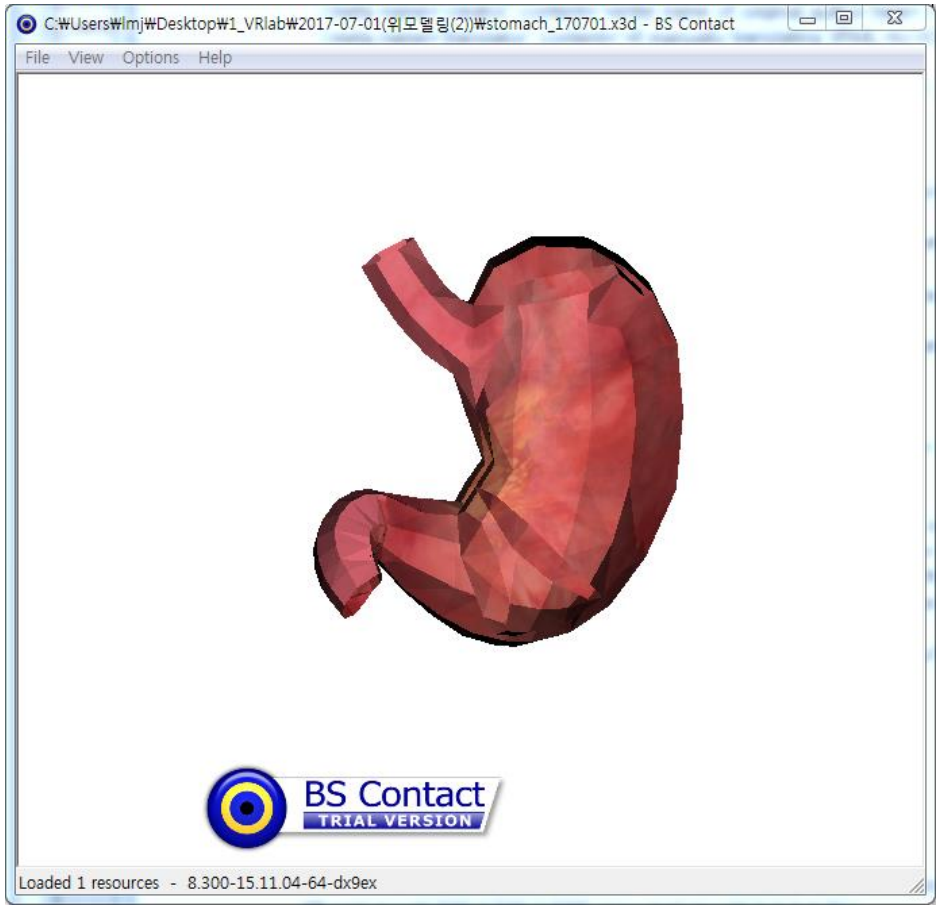


Stomach Layers Modeling



Stomach X3D

Problem in layers modeling:
Some polygons turned outside and intermingled



Internal organs data model

- Modeling
  - Organ
    - Regions
      - Region name
      - Region meta interface
      - Geometry
      - Appearance
    - Layers
      - Layer name
      - Layer meta interface
      - Geometry
      - Appearance
- Animation and simulation

Conclusions

- Representation data model for human internal organs
  - Modeling data model
  - Animation data model
  - Interface data model with medical and health devices
- Modeling: region and layer based modeling
  - Region partitioning and landmarks
  - Layer definition
- Animation and simulation: region and layer based deformation
  - Definition of deformation parameters
- Interface with medical and health devices
  - Definition of information from devices
  - Meta information related to specific parts of an organ