Anatomical boundaries and immaterial objects

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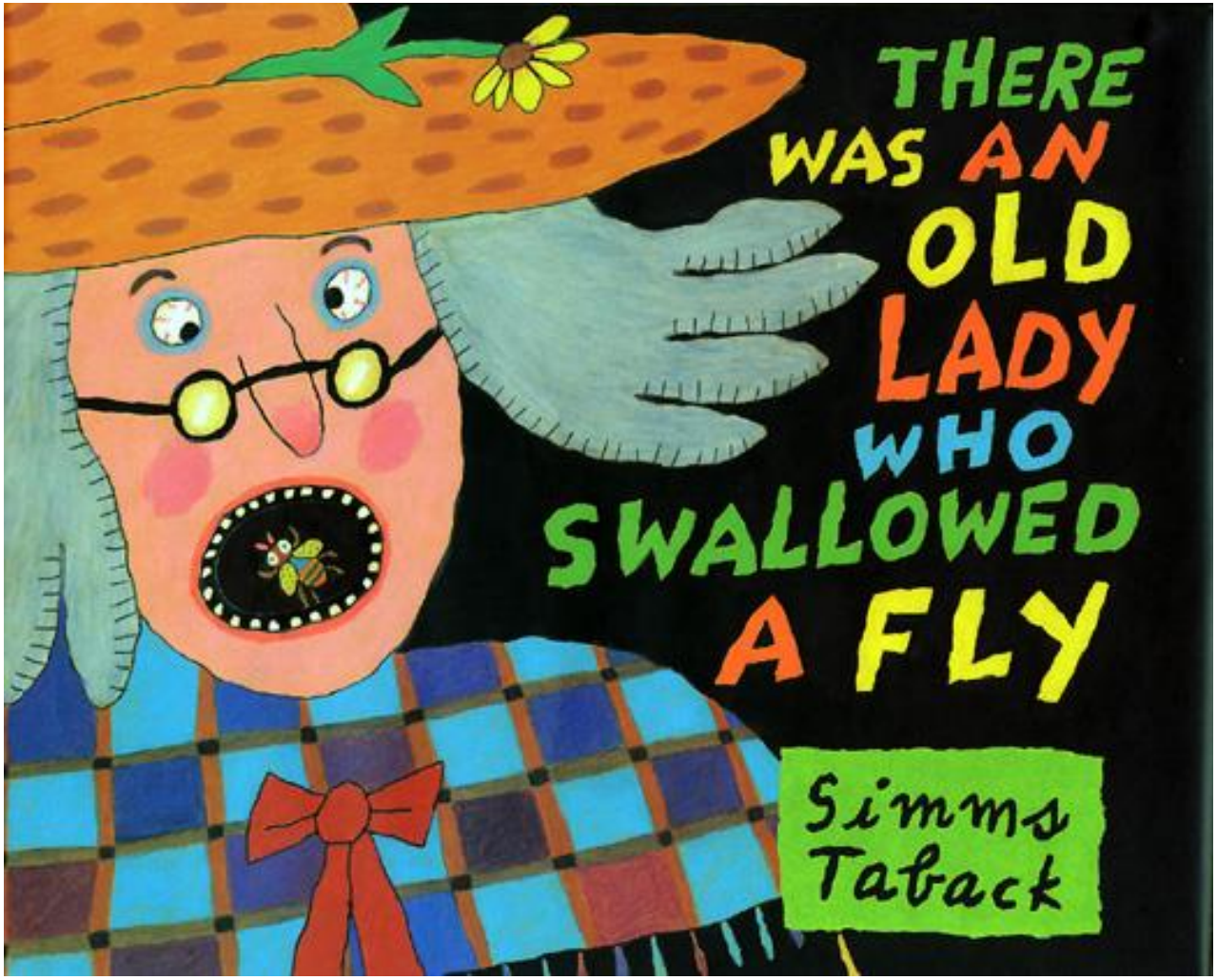
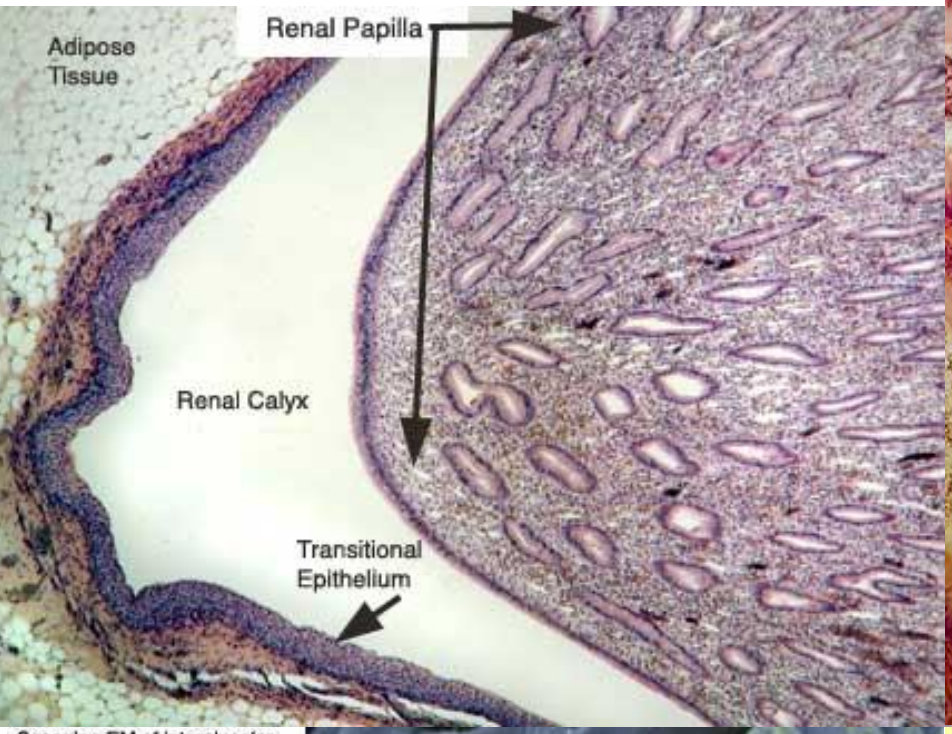


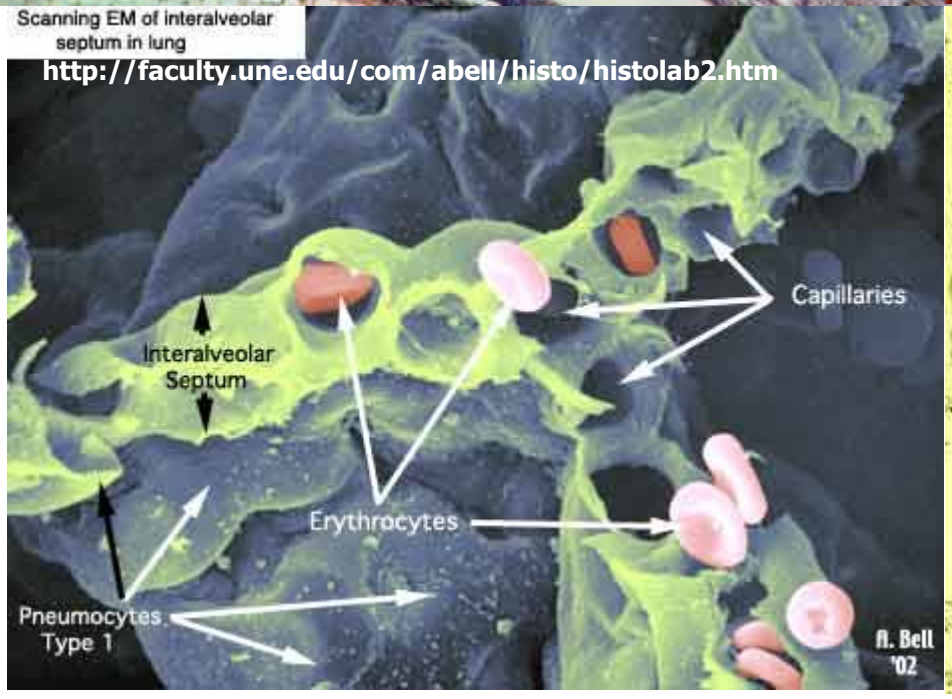
Is the fly inside or outside her body ?

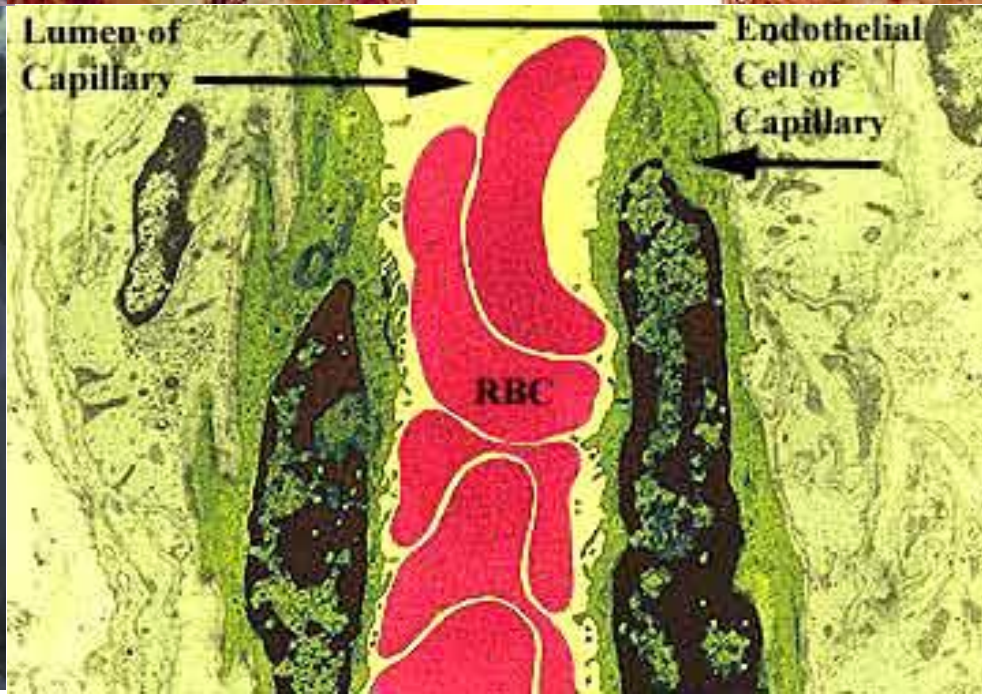
Problem (I)

- Biological objects need clearly defined boundaries to enable assertions parthood and location
- Most Biological objects are sponge-like (full of vessels, capillaries, cavities, holes and other hollow spaces)


Adipose Tissue
Renal Papilla
Renal Calyx
Transitional Epithelium

Stereocila in head of Epididymis

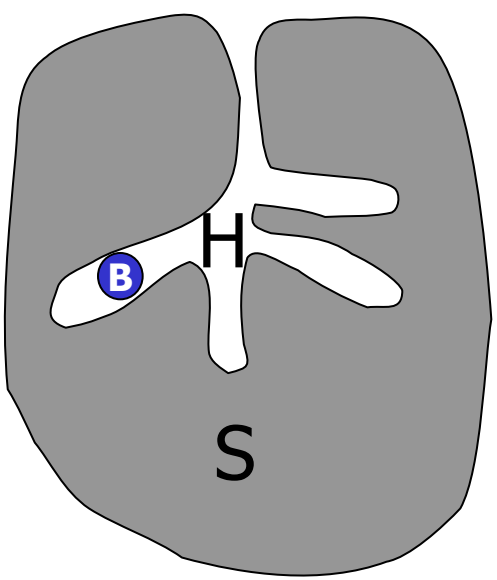

Scanning EM of interalveolar septum in lung
http://faculty.une.edu/com/abell/histo/histolab2.htm
Capillaries
Interalveolar Septum
Erythrocytes
Pneumocytes Type 1
A. Bell '02


Lumen of Capillary
Endothelial Cell of Capillary
RBC

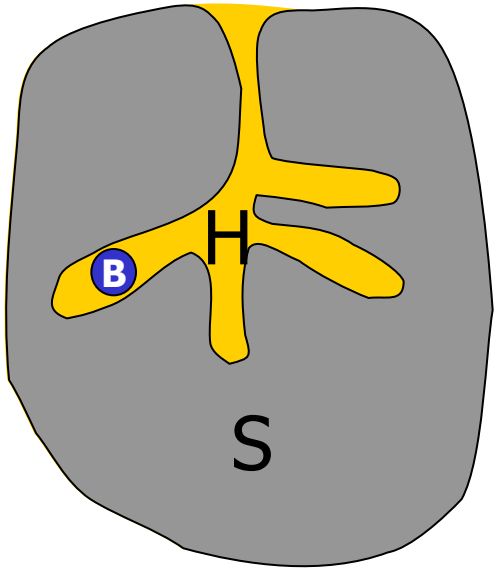
Problem (II)

- Many cavities communicate with the exterior space (e.g. respiratory system)
- Common conceptualization (cf. biomedical terminologies): biological objects have immaterial parts, eg. Lumen of esophagus, alveolar lumen, many cavities and holes in bones, …

How to deal with hollow spaces ?



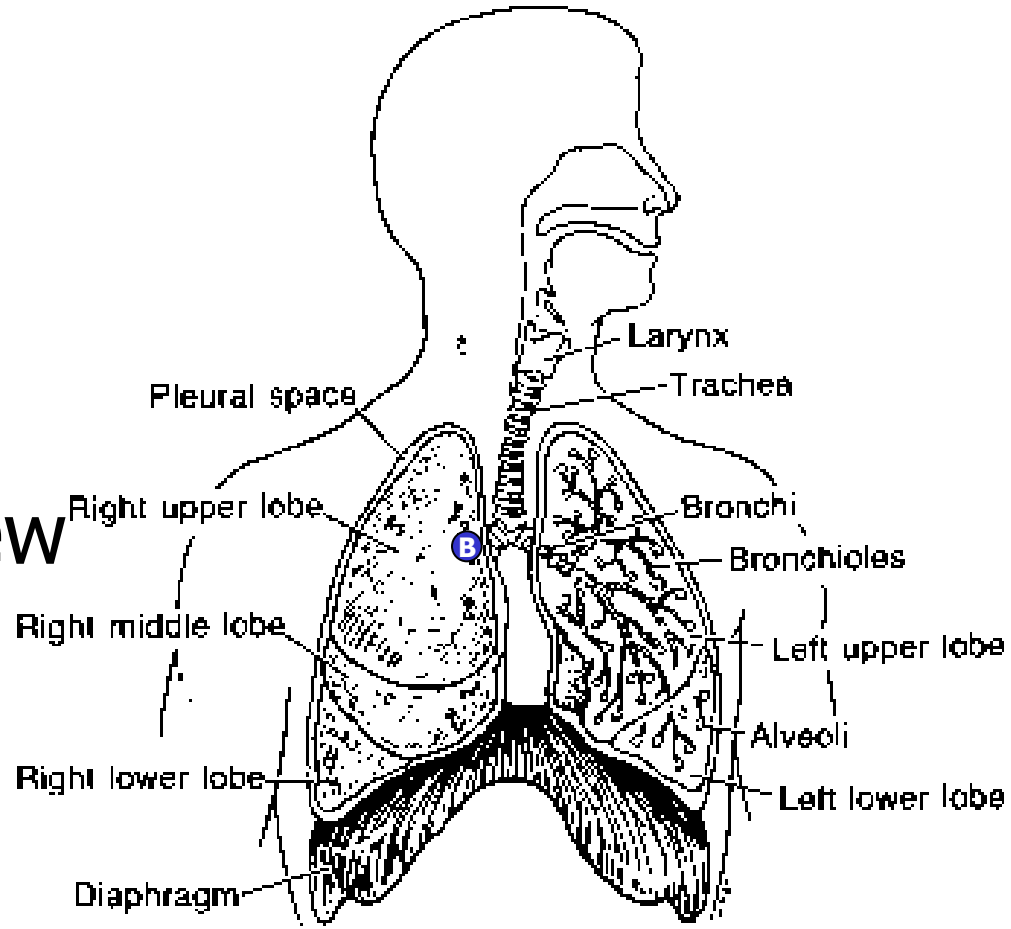
H is part of E, hence B is located outside of S



H is part of S, hence B is located inside of S

Problem

- Inside or outside ?
- Example: Bronchi
  A foreign body
  in a bronchus
  is in the lung
- Strict topological view
  conflicts with
  shared
  conceptualization



Where to delimit ?

1. All hollow spaces are part of the exterior…

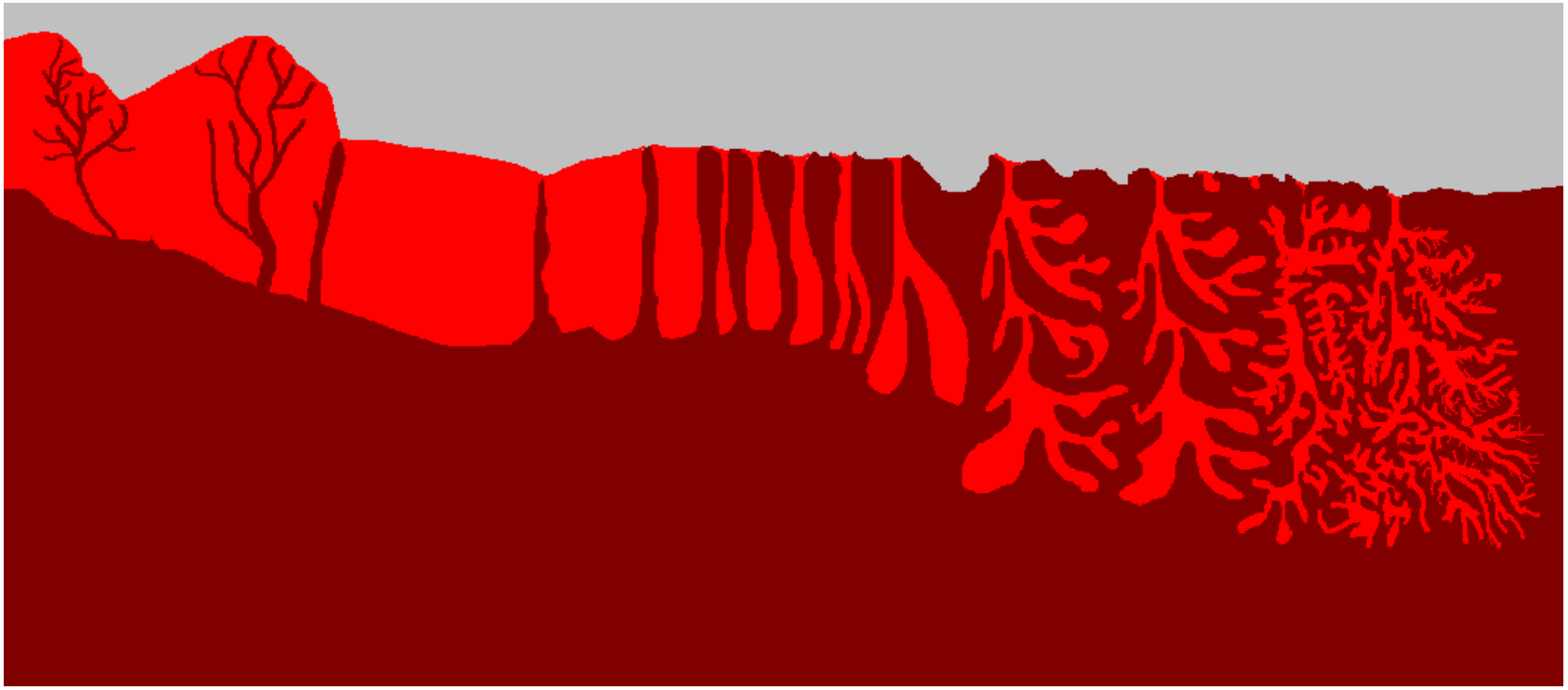
… but nothing can be located inside…

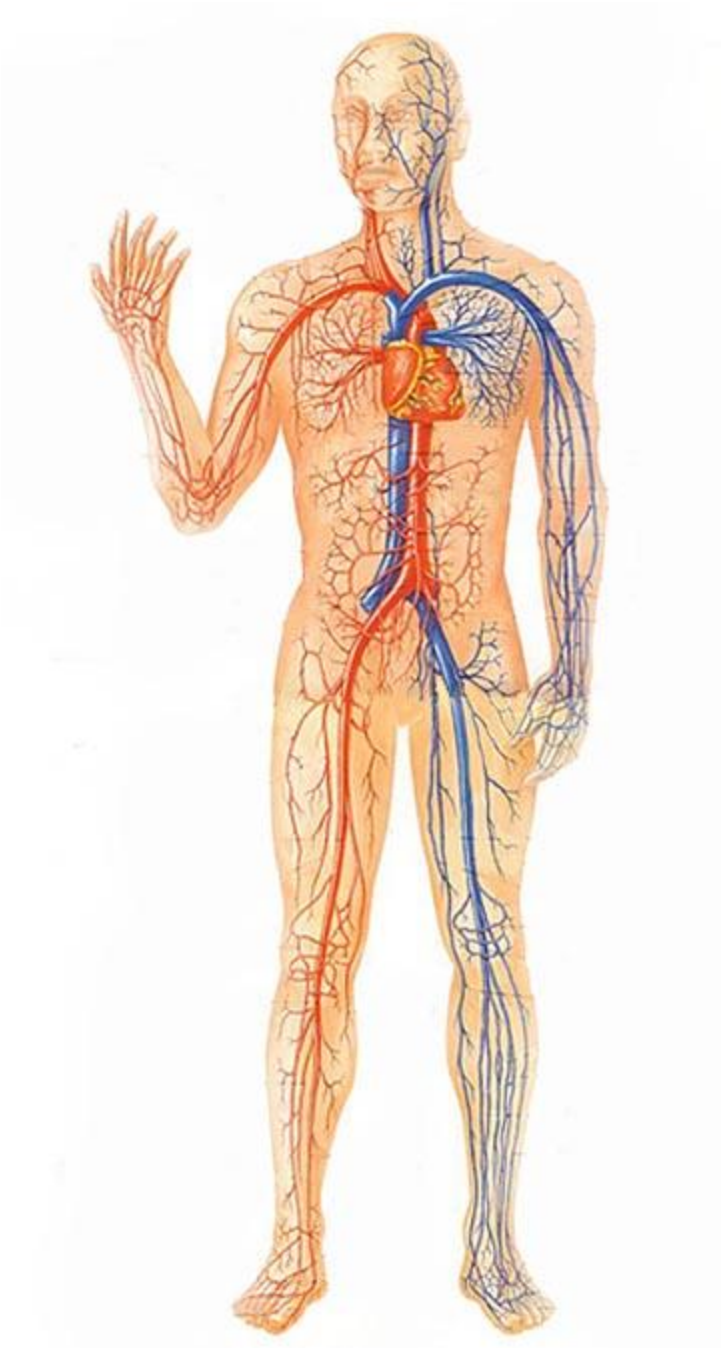
2. Those hollow spaces which communicate with the exterior are part of the exterior space…

… what if some spaces only temporarily communicate ?

4. The complete convex hull is part of the object…

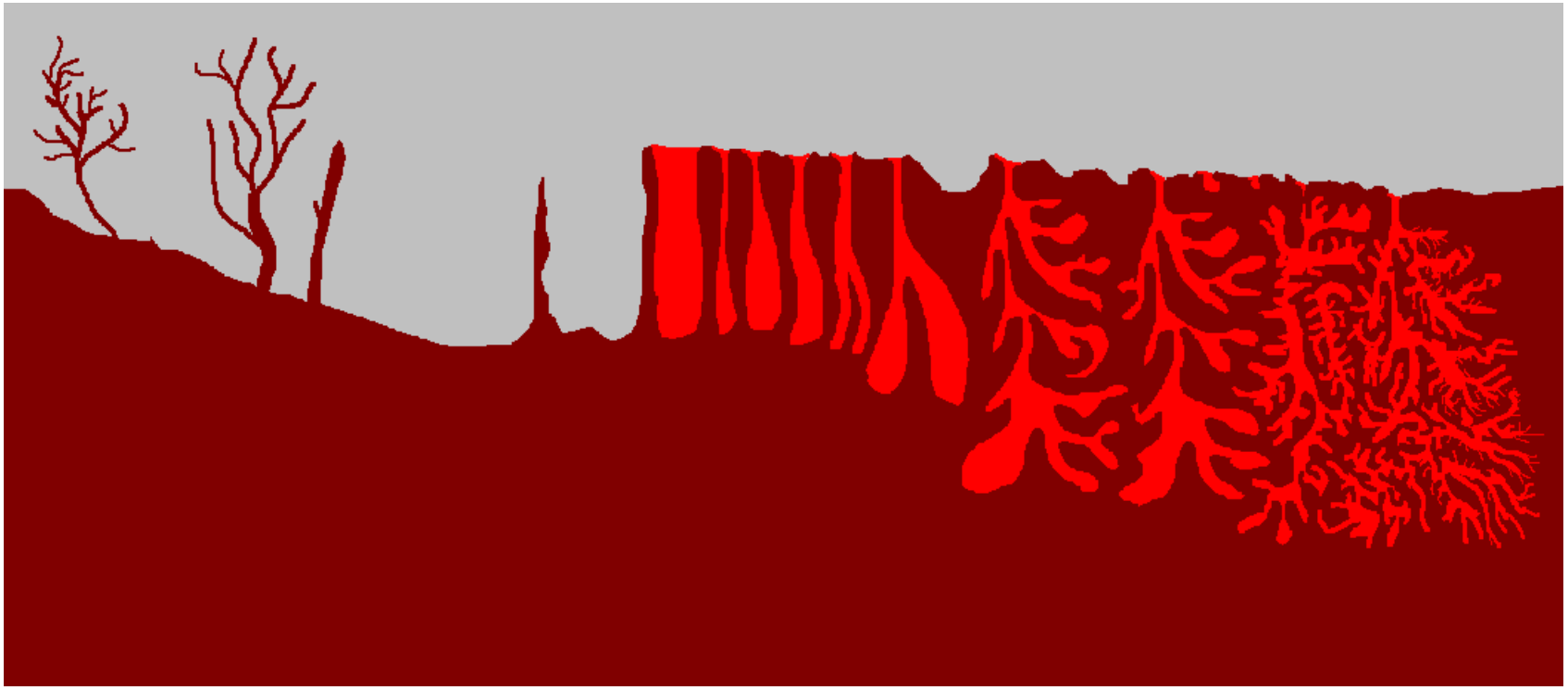
… then the body would practically spatially coincide with the vascular system !





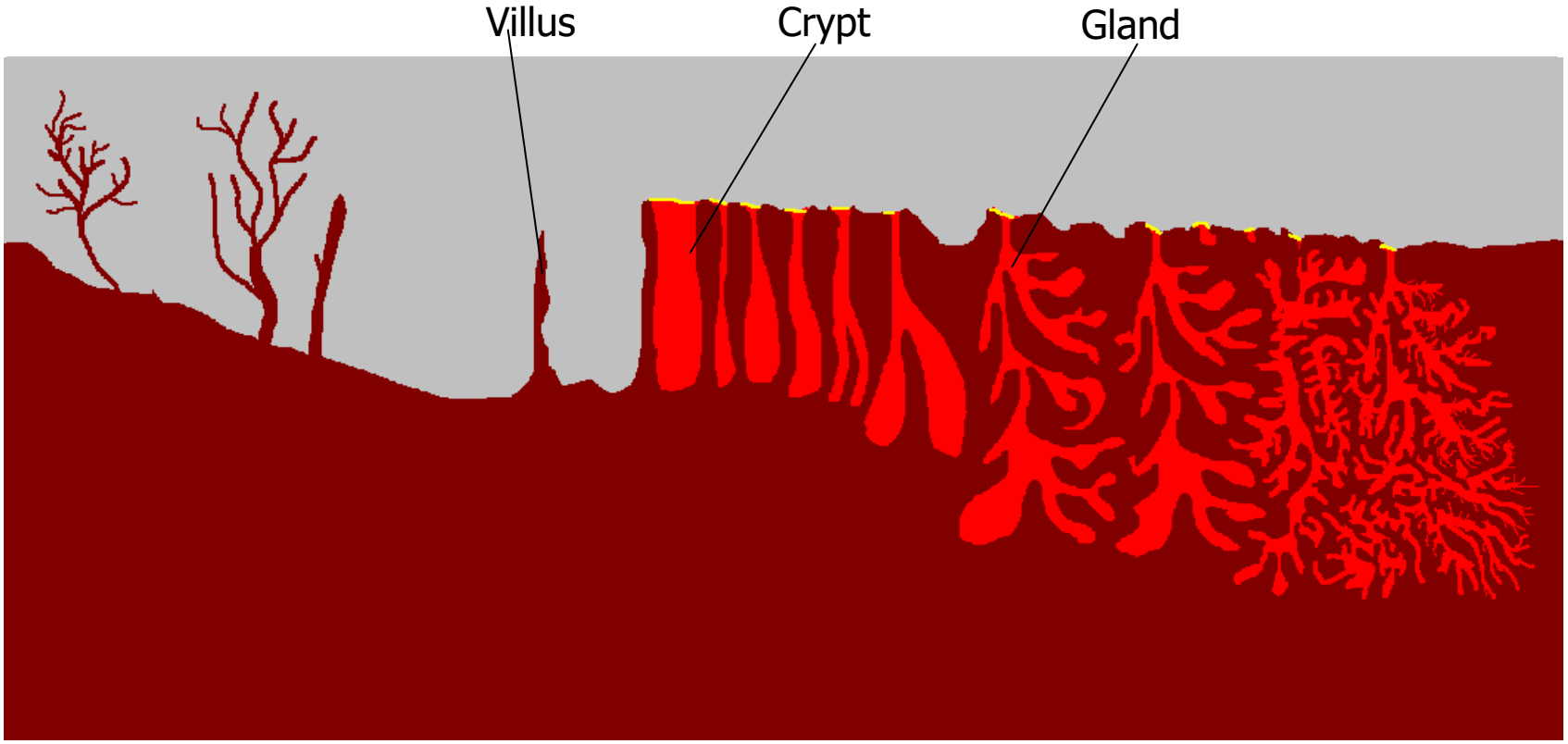
3. Only those hollow spaces which are containers something are part of the exterior space…

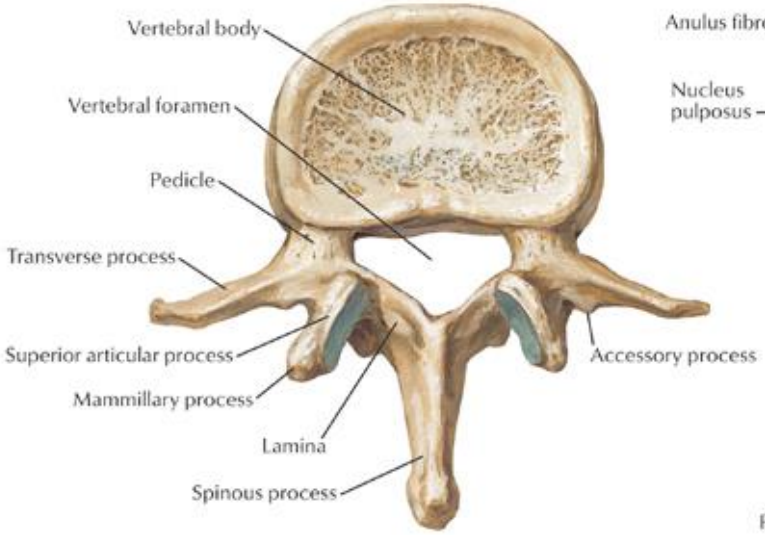
… how to ascertain whether they are containers ?



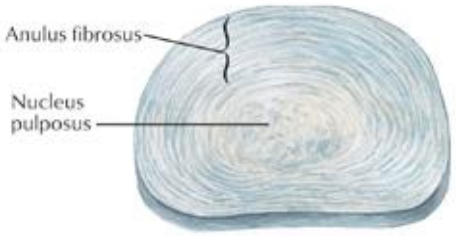
Anatomists draw fiat boundaries

Surface structures which have a name are considered to be inside the organ

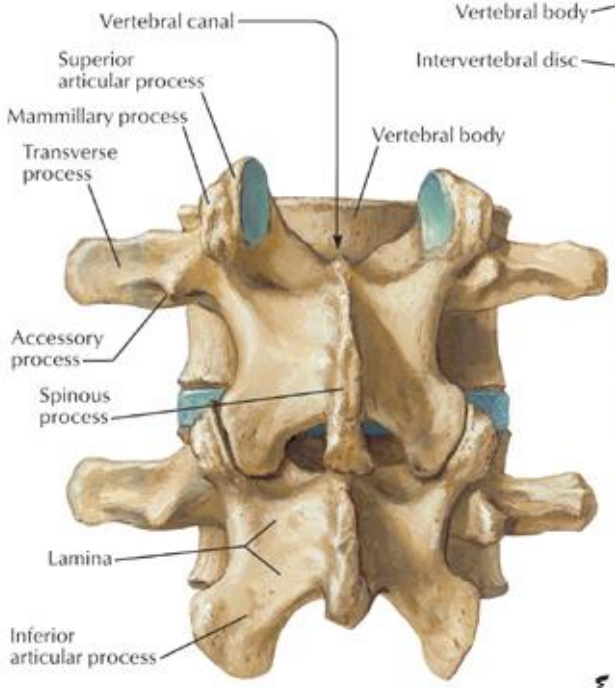




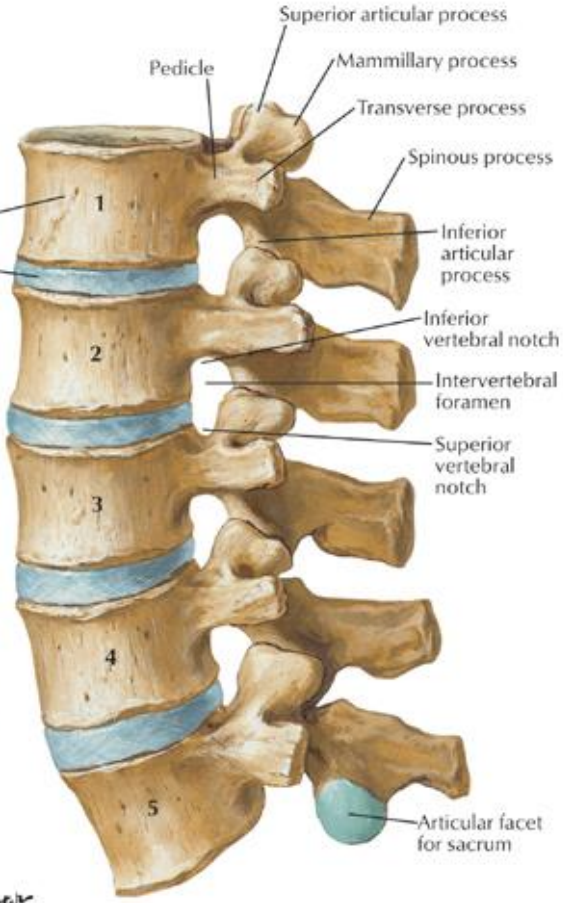
L2 vertebra: superior view



Intervertebral disc



L3 and L4 vertebrae:



Lumbar vertebrae, assembled:

Algebraic Properties: *Part-Of | Has-Part vs. part-of | has-part*

- Instance level :

  $part\text{-}of\ (a, b),\ part\text{-}of\ (b, c) \rightarrow part\text{-}of\ (a, c)$ ***Transitivity ?***

  $part\text{-}of\ (a, b) \rightarrow \neg\, part\text{-}of\ (b, a)$ ***Asymmetry***

  $part\text{-}of\ (a, b) \rightarrow a \neq b$ ***Irreflexivity ?***

  $part\text{-}of\ (a, b) \rightarrow has\text{-}part\ (b, a)$ ***Inverse Relation***

- Class level*:

  $Part\text{-}For\ (A, B),\ Part\text{-}For\ (B, C) \rightarrow Part\text{-}For\ (A, C)$

  $Part\text{-}For\ (A, B) \rightarrow \neg\, Part\text{-}For\ (B, A)$

  $Part\text{-}For\ (A, B) \rightarrow \neg\, Is\text{-}A\ (A, B)$ ***?***

  $Part\text{-}For\ (B, A)$ does not necessarily imply $Has\text{-}Part\ (A, B)$

  $Possible\text{-}Part\ (B, A)$ implies $Has\text{-}Possible\text{-}Part\ (A, B)$

  $(\ldots)$

Part-Of in Anatomies: Consensus required about

- Domain and range of part-of relations
- Algebraic properties of part-of relations
- Intended meaning of part-of relations in the domain of biology and medicine

instance level

Different notions of part-of

- Time-independent:
  - Compositional
  - Functional
  - Topological
- Time-dependent:
  - *a part-of b* at any point of time → *a part-of b* at every point of time
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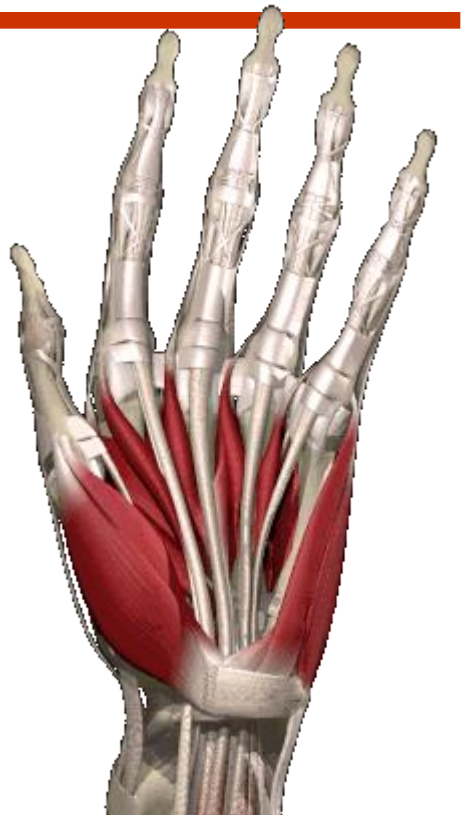
Parts as Components

Parts "build"
the whole



part-of (Finger, Hand)

part-of (Bone Marrow, Bone)

part-of (Sodium Ion, Cytoplasm) ?

part-of (Sarcomer, Muscle)

part-of (Heart, Human Body)

"Intuitive" notion of part. Controversial

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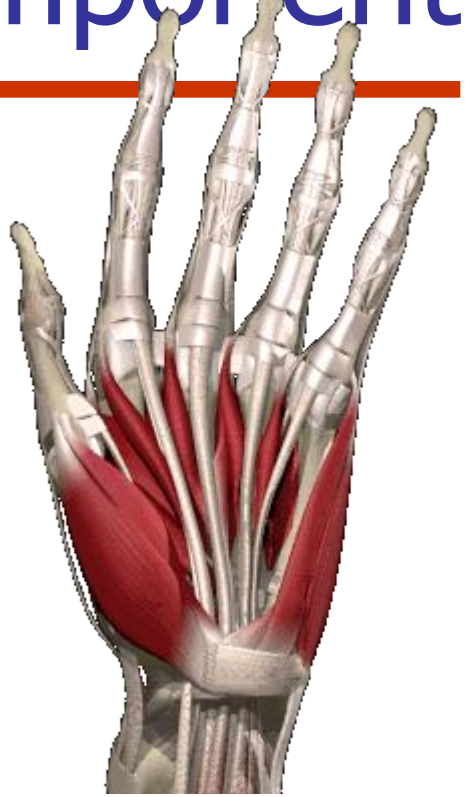
Parts as Functional Components

Part contributes to the function of the whole



part-of (Finger, Hand)

part-of (Lymph Node, Lymphatic System)

part-of (Cell Nucleus, Cell)

part-of (Tendon, Muscle)

part-of (Tooth, Jaw)

More restricted, may conflict with notions of connection

instance level

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no clear distinction !

instance level

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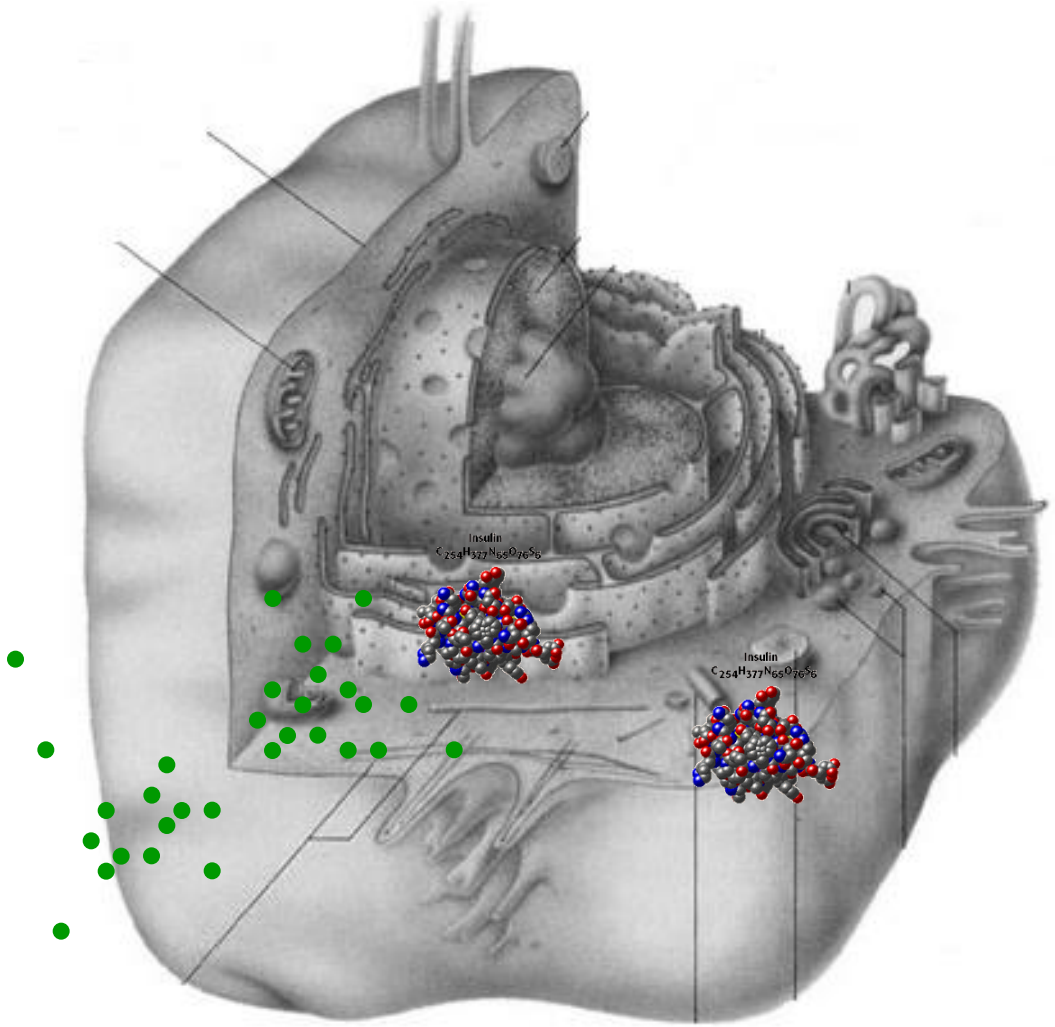
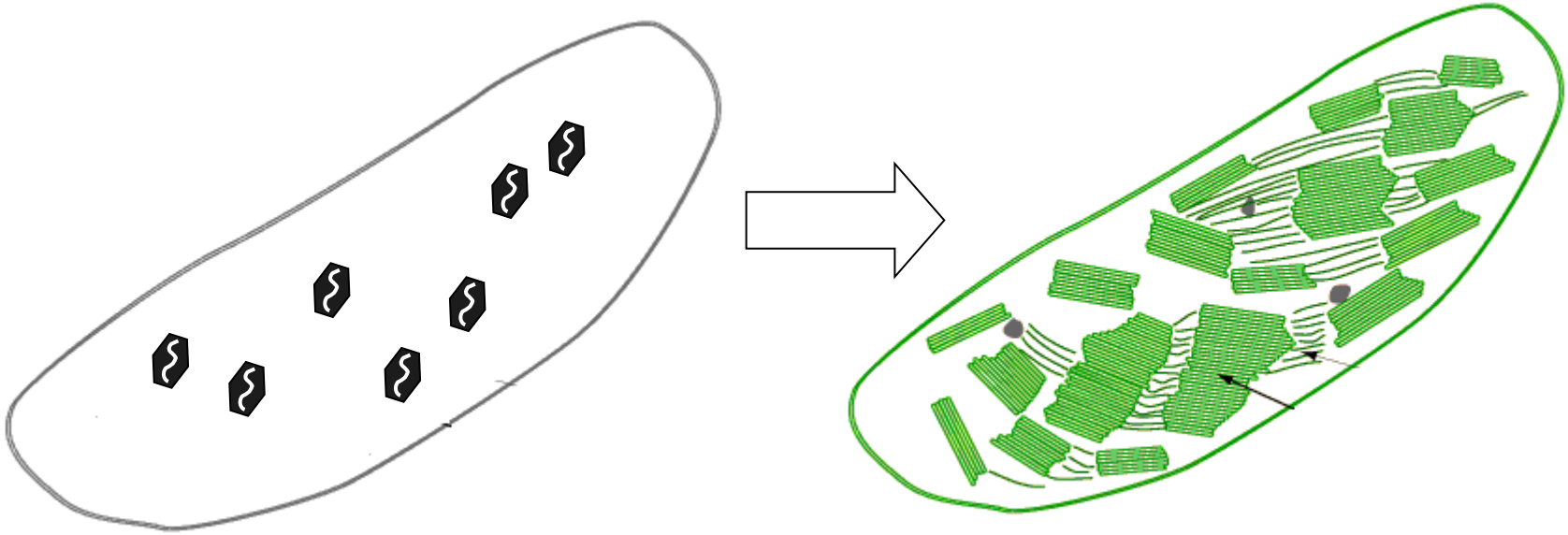
Continuous exchange of matter



Endosymbiont Hypothesis

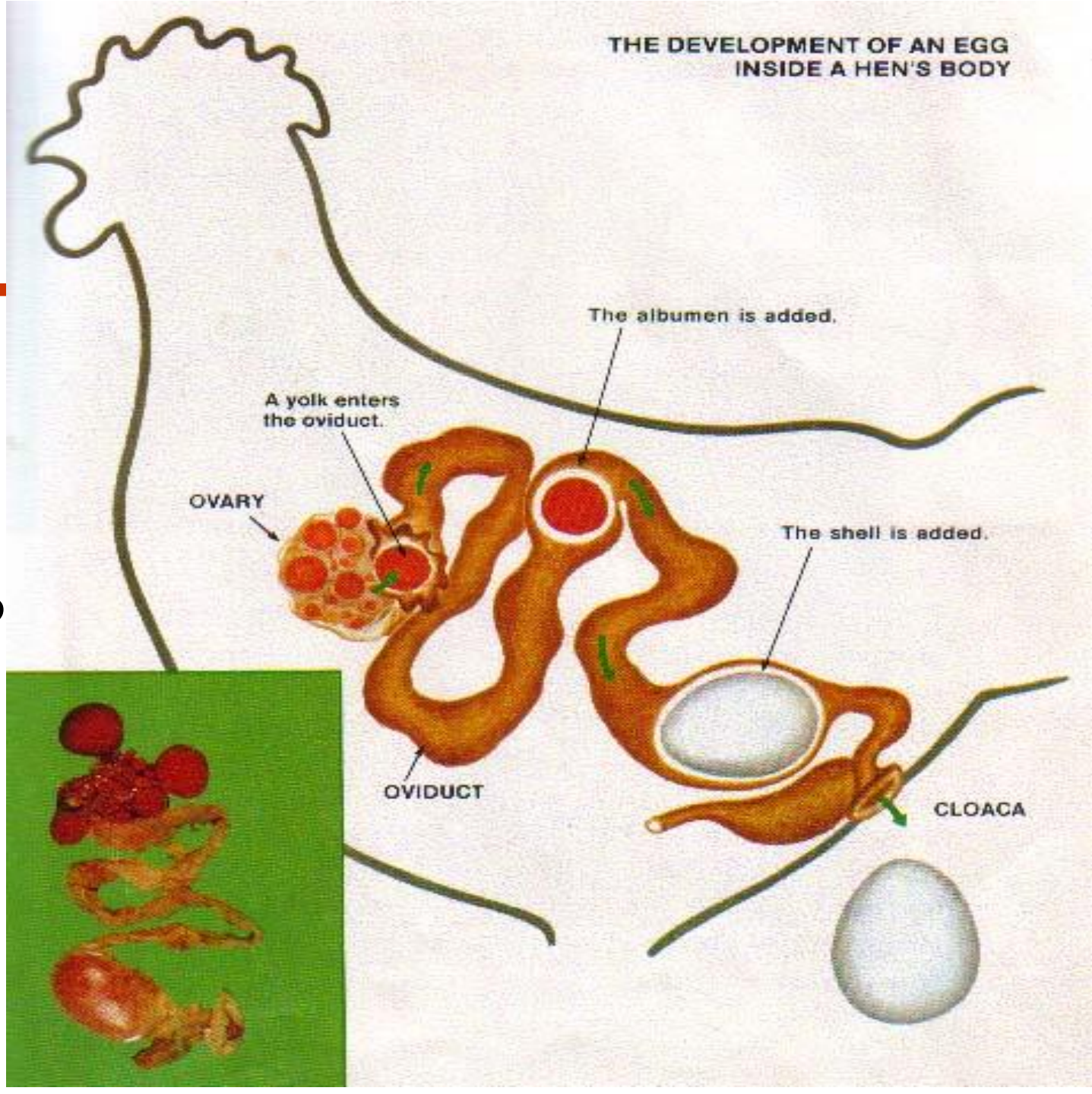
2.5 billion years ago:
Primitive cell with
bacterium-like symbionts

Today:
Chloroplasts (Plants)
Mitochondria



Are the organells part of the cell

- Which eggs are part of the body ?



Topological parts

Located within the boundaries of an object

part-of (Mitochondrium, Cell)
part-of (Brain, Head)

part-of (Brain, Cranial Cavity) ?

part-of (Ovum, Oviduct) ?

part-of (Finger, Hand)

part-of (Amount of Blood, Right Ventricle) ?

has-location instead of *part-of* ?

Topological parts

Located within the boundaries of an object

has-location (Mitochondrium, Cell)
has-location (Brain, Head)

has-location (Brain, Cranial Cavity)

has-location (Ovum, Oviduct)

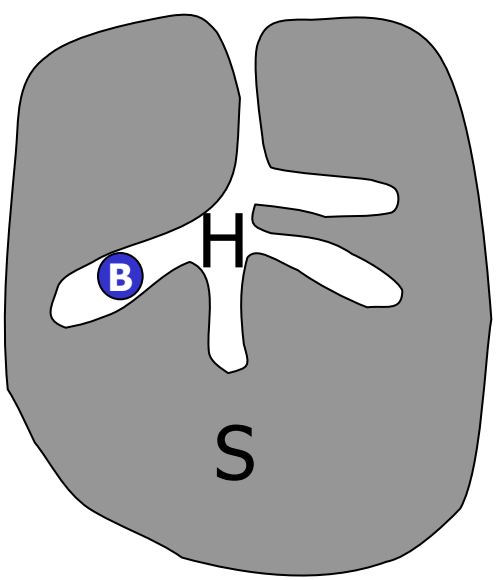
has-location (Finger, Hand)

has-location (amount of Blood, Right Ventricle)

has-location as a mereotopological primitive ?

Topological parts

How to deal with hollow spaces ?



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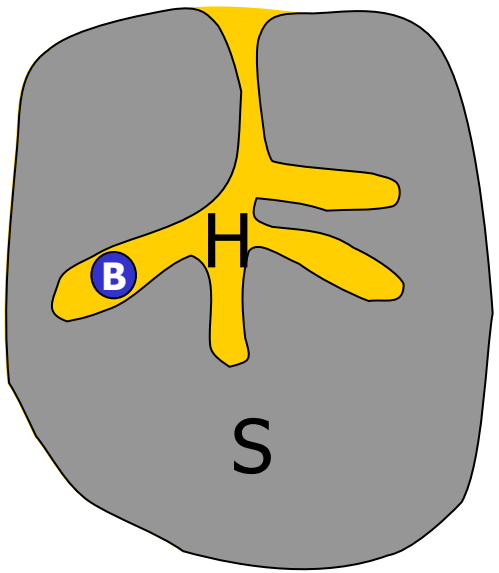

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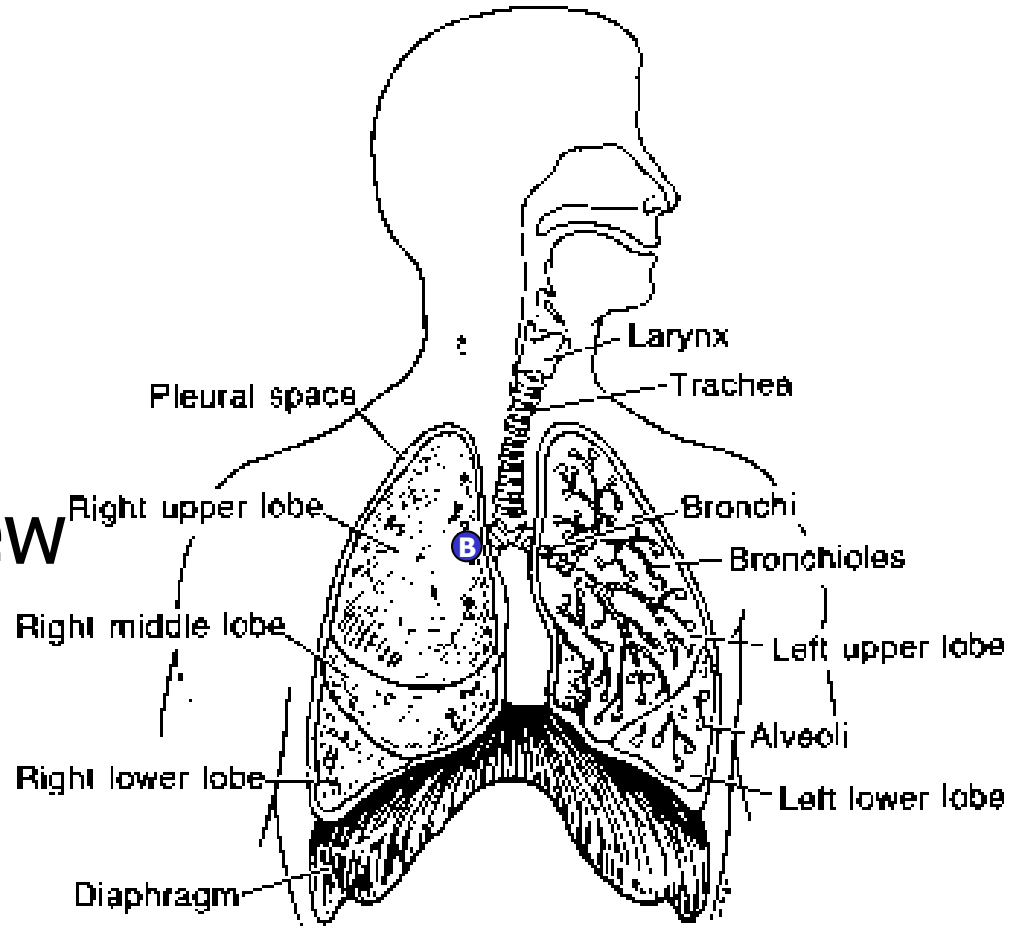

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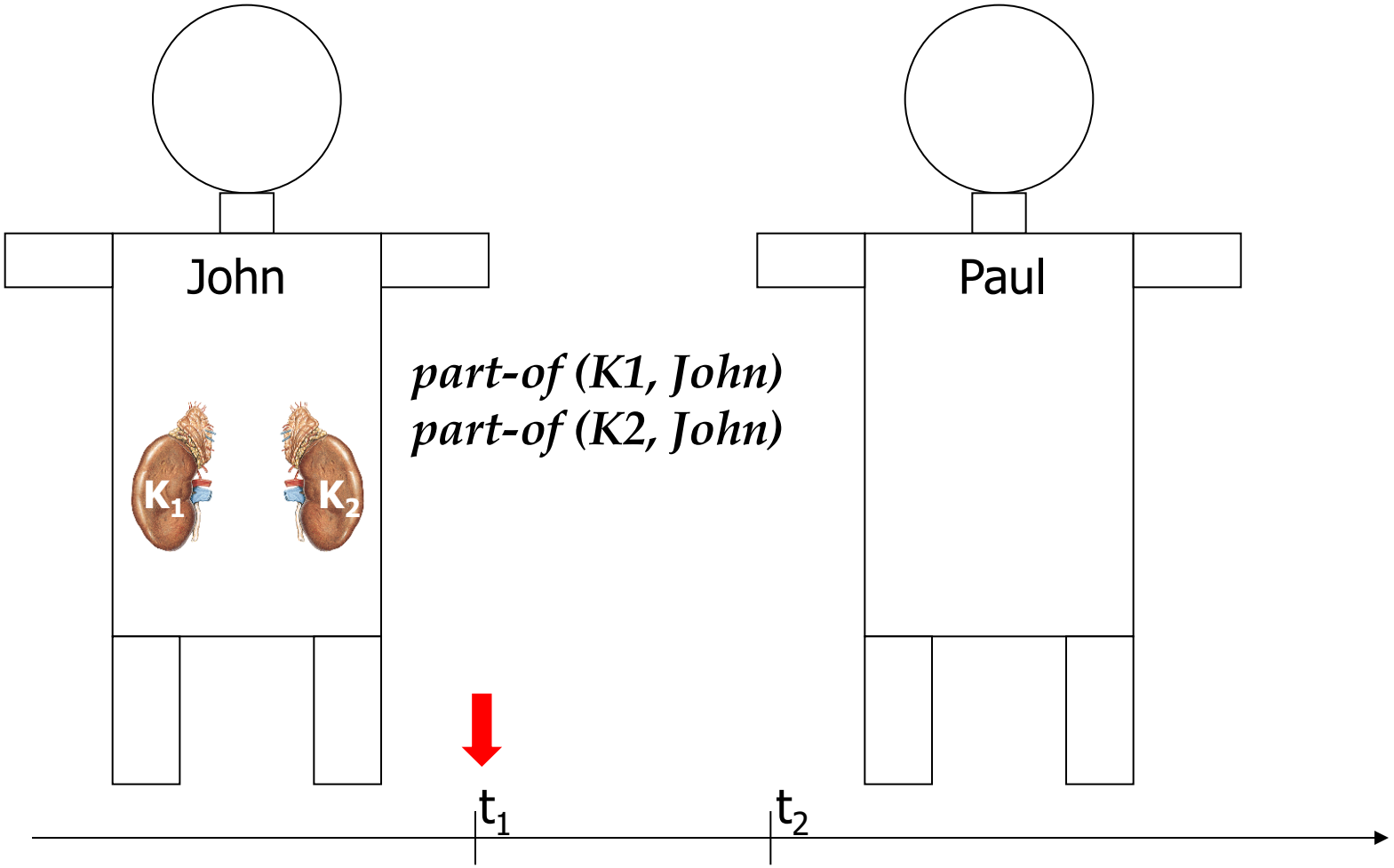
Example: Transplantation



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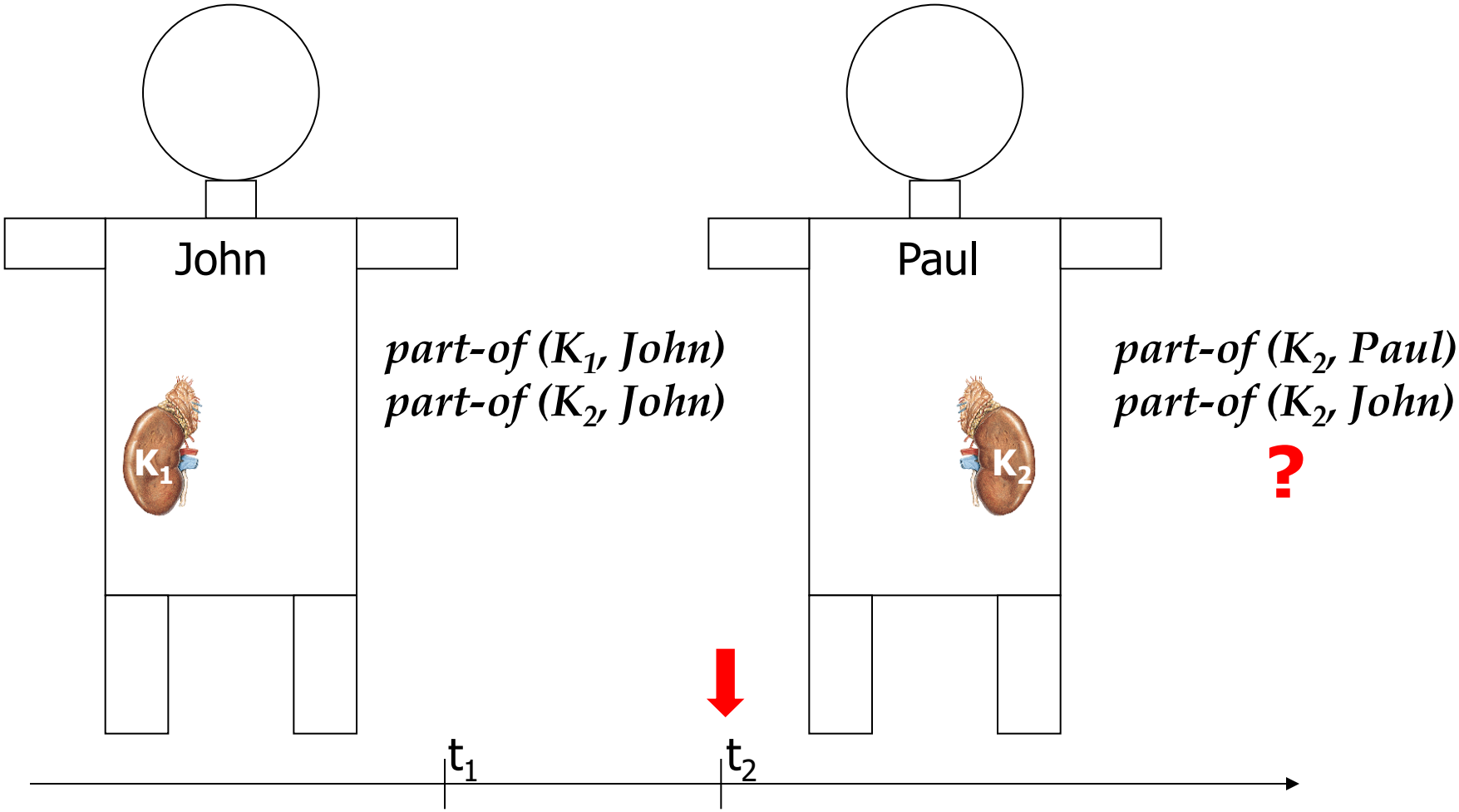
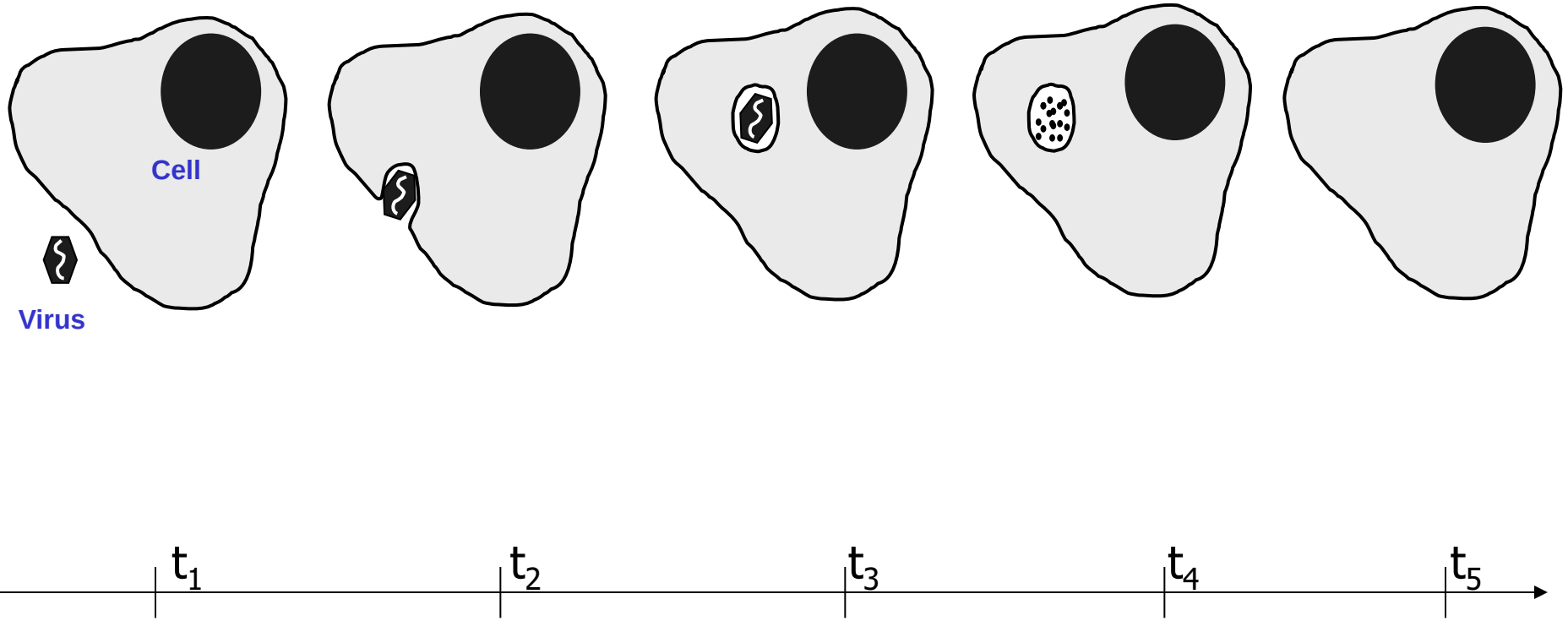
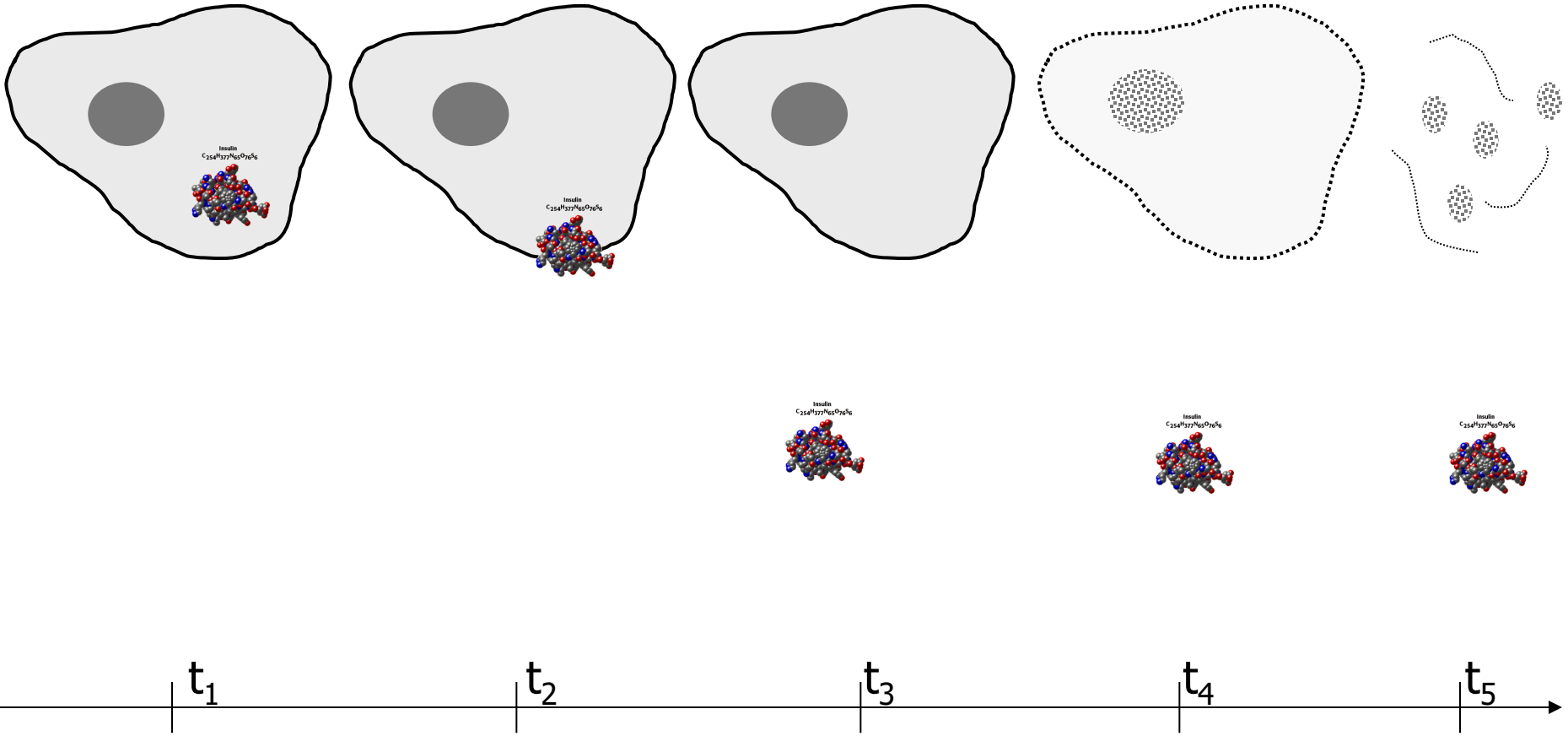


Phagocytosis / Digestion



Secretion



Conclusion

- Part-of: example, how many different interpretations co-exist
- Standardization: need to eliminate ambiguity by precise characterization of foundational primitives (properties, relations)
- Solid theoretical basis is needed, e.g. mereotopology: Simons, Casati, Smith, Varzi,…