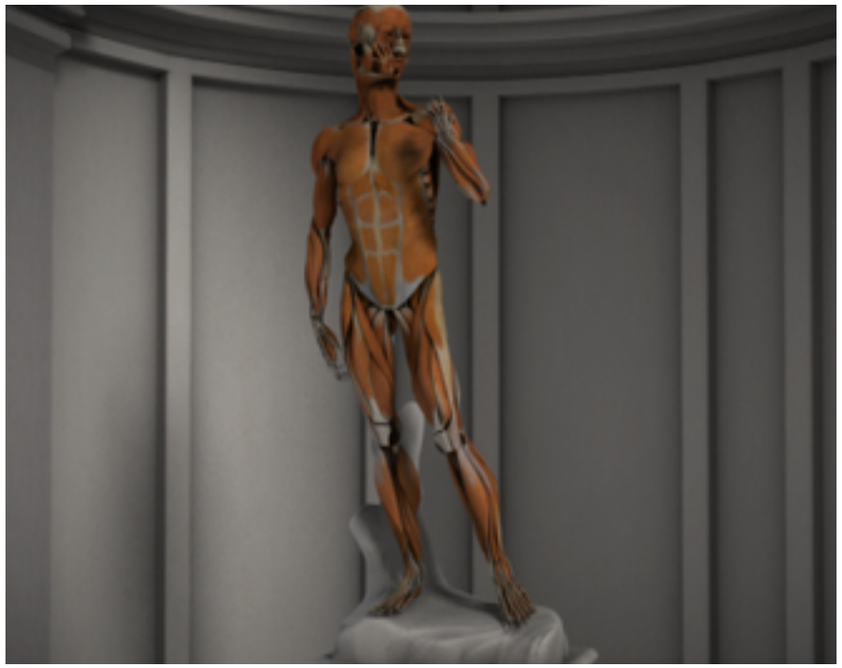
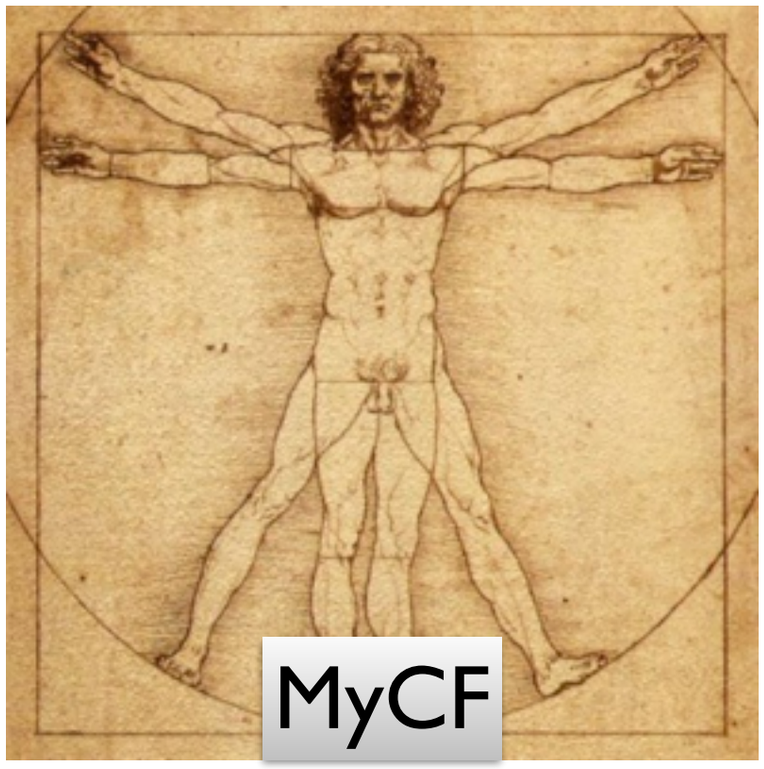


My Corporis Fabrica

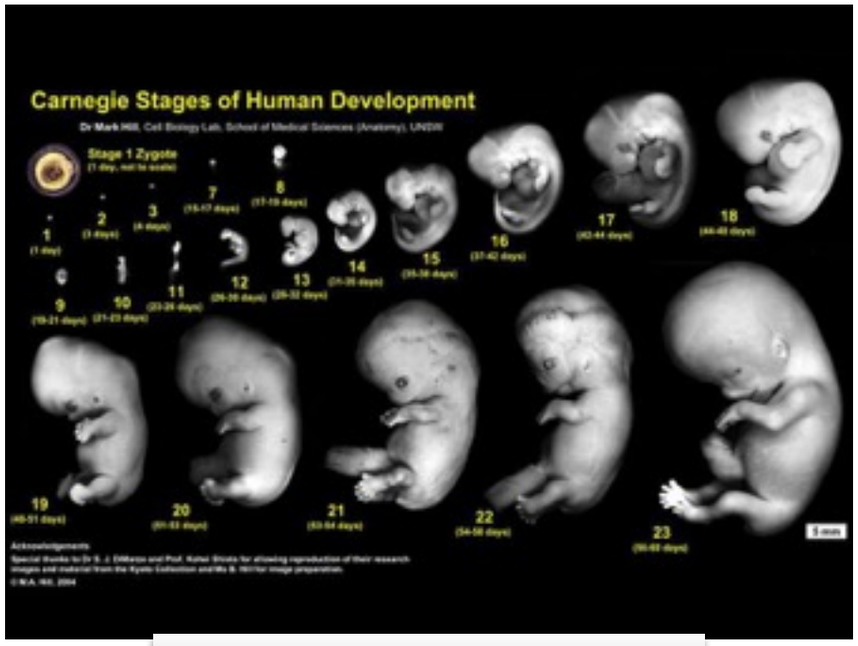
(Intérêt et utilisation d'une ontologie en lien avec des images,
et enrichissement avec des règles simples)

Federico Ulliana
LIRMM - UM2 - INRIA GraphIK

My Corporis Fabrica



MyCF



MyCF Embryo

Team

Anatomy

- Olivier Palombi (CHU-Grenoble)
  Favier Valentin
  Pierre-Yves Rabattu

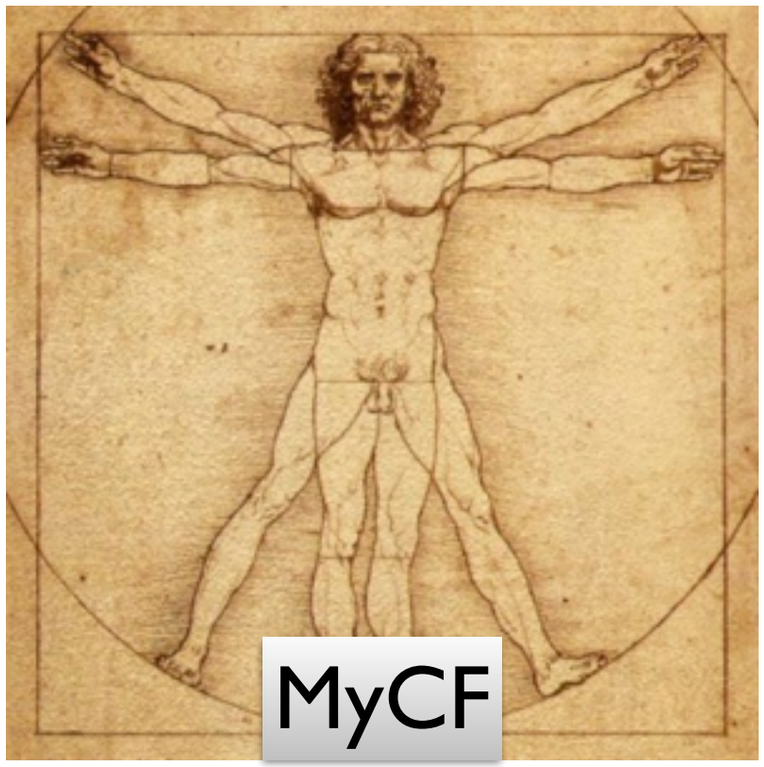
Computer Graphics / Mechanics

- François Faure, Jean-Claude Léon (INRIA Rhone-Alpes)
  Damien Rhomer, Benoît Masse

Knowledge Representation / Databases

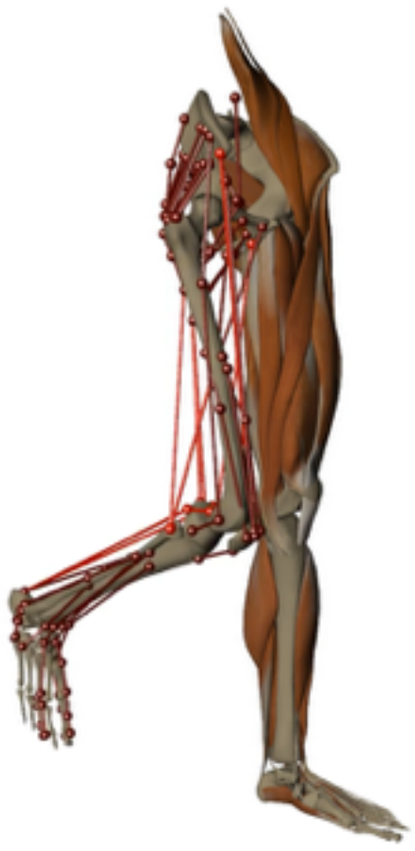
- Marie-Christine Rousset, myself (LIG Grenoble, LIRMM)

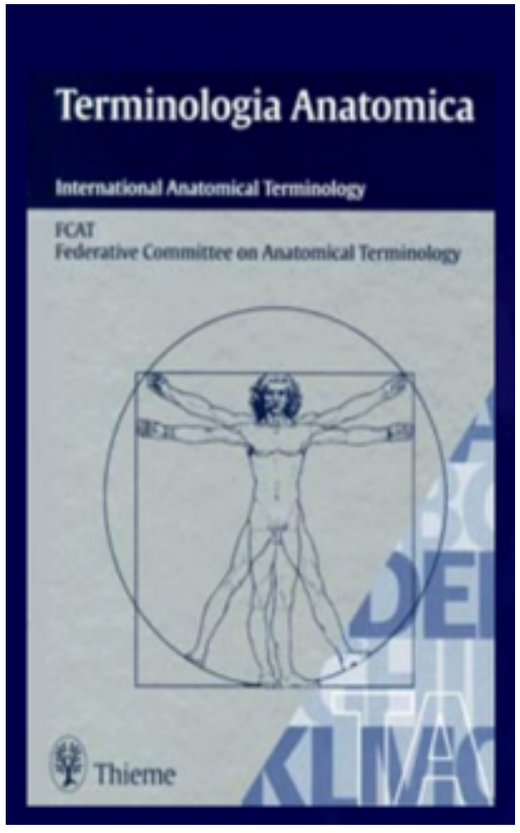
My Corporis Fabrica



MyCF Goal

Simulation of patient-specific 3D models





Needs coherence between 3D and canonical anatomy

The Glue is an Ontology

Anatomy

finger, knee, hand

Physiological Functions

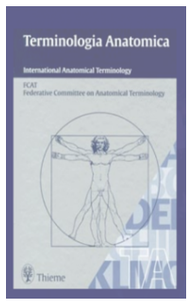
breath, gait, stability

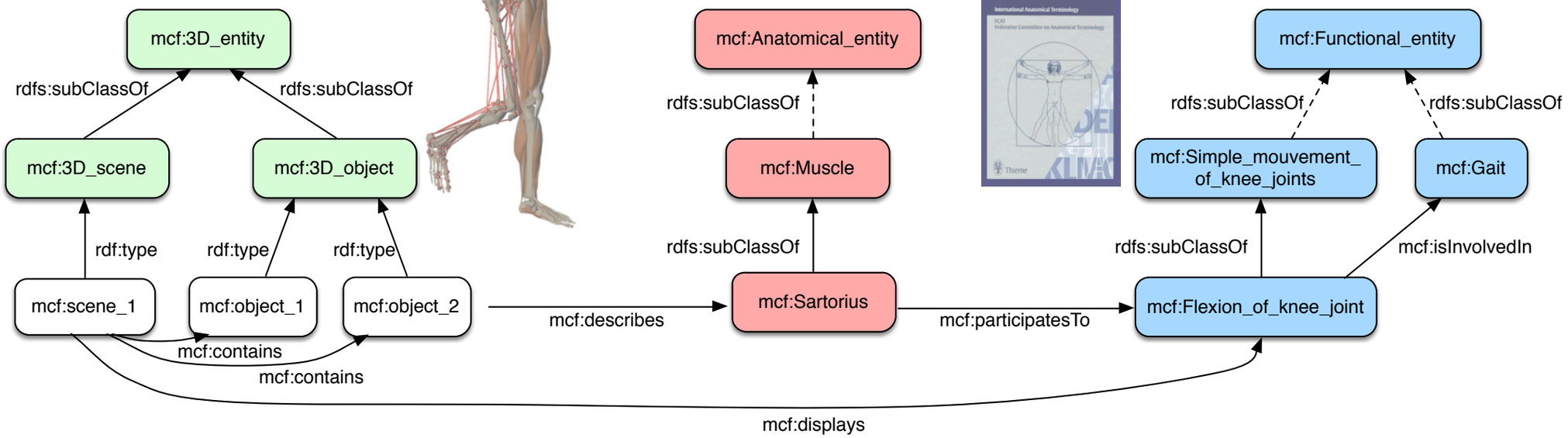
3D models

“object1 *describes* the **Sartorius Muscle**
which *is* a **Muscle** *inserted on* the **Pelvis**
that *participates to* the **Plantar Flexion of the Foot”**

The Glue is an Ontology

[J. of Biomedical Semantics'14]





3D

<mcf:scene_1, mcf:contains, mcf:object_2>

<mcf:object_2, mcf:describes, fma:Sartorius>

Anatomy

<fma:Sartorius, rdfs:subClassOf, fma:Muscle>

Physiological functions

<fma:Sartorius, mcf:ParticipatesTo, mcf:Flexion_of_knee_joint>

<mcf:Flexion_of_knee_joint, mcf:isInvolvedIn, mcf:Gait>

Deductive RDF Triplestores
RDF + Datalog [AAAI'15]

RDF to manage vocabulary in collaborative environments

- Meta-modeling/punning: classes/properties as instances

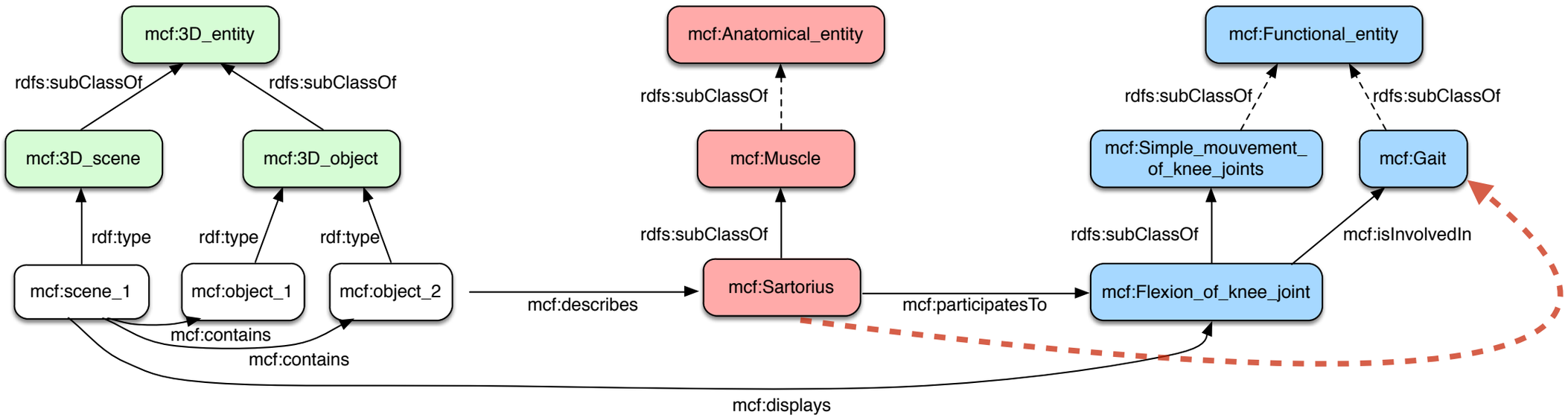
  <fma:Sartorius, rdf:type, owl:Class>

  <fma:Sartorius, mcf:ParticipatesTo, mcf:Flexion_of_knee_joint>

- Needed to safely reuse the FMA Ontology

Deductive RDF Triplestores

RDF + Datalog [AAAI'15]



Inference rules à la Datalog

MyCF : 15 domain-specific rules

$$(x, \text{PartOf}, y), (y, \text{PartOf}, z) \rightarrow (x, \text{PartOf}, z)$$

$$(x, \text{PartOf}, y), (x, \text{subClassOf}, y) \rightarrow \bot$$

$$(x, \text{participatesTo}, y), (y, \text{isInvolvedIn}, z) \rightarrow (x, \text{participatesTo}, z)$$

Visualization by Query

<femur, subClassOf, bone>
<bone subClassOf, organ>
<model1, type, femur>
...

```
select   ?object ?color
where {  mcf:Sartorius , mcf:InsertOn   , ?bone   .
                ?object , mcf:describes , ?bone   .
                ?object , mcf:color     , ?color    }
```

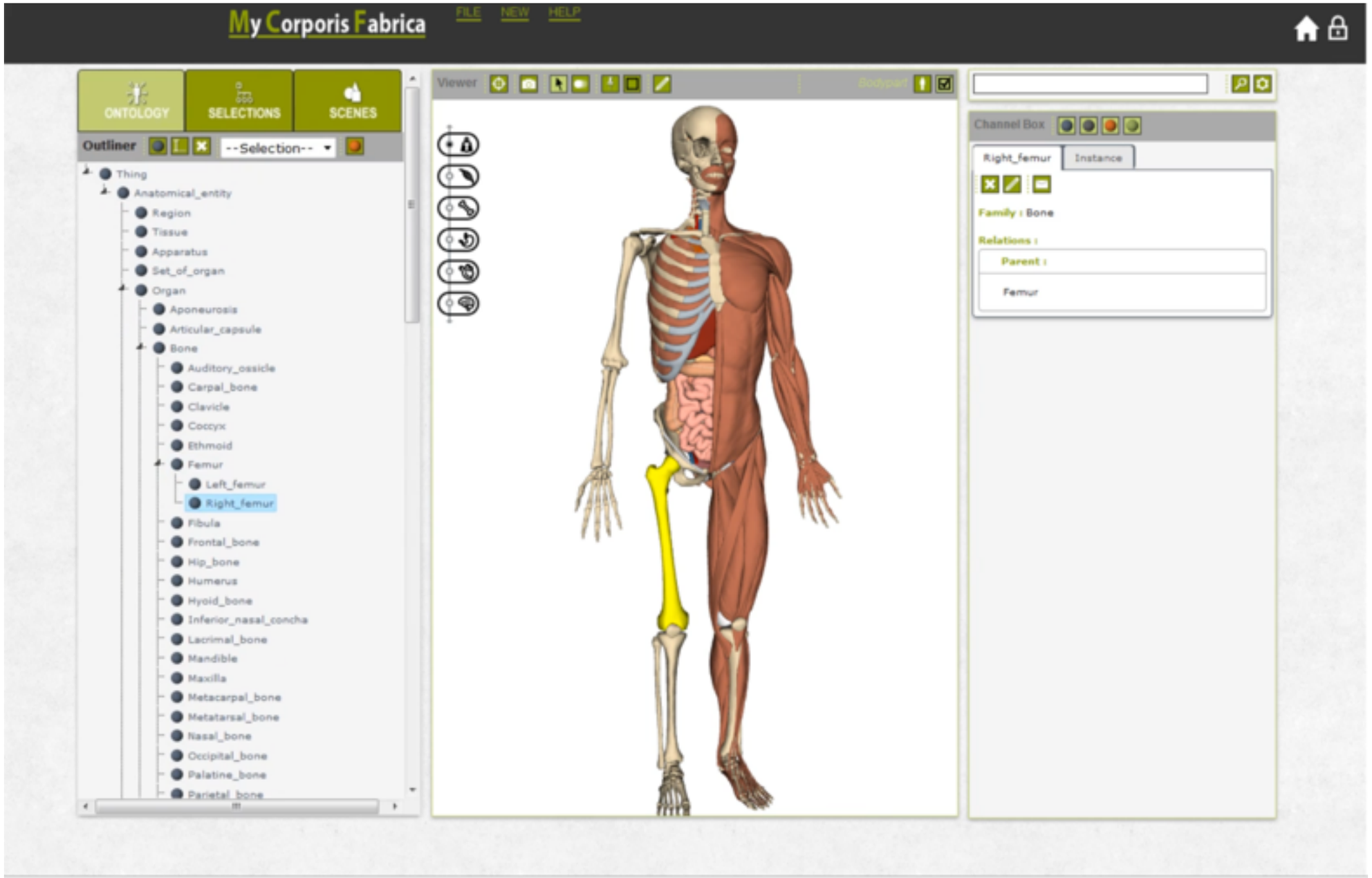
Visualization by Query

<femur, subClassOf, bone>
<bone subClassOf, organ>
<model1, type, femur>
...

```
select   ?object
where {  ?muscle , mcf:ParticipatesTo , mcf:Knee_joint_flexion
         ?muscle , rdfs:subClassOf    , mcf:Muscle .
         ?object , mcf:describes      , ?muscle     }
```

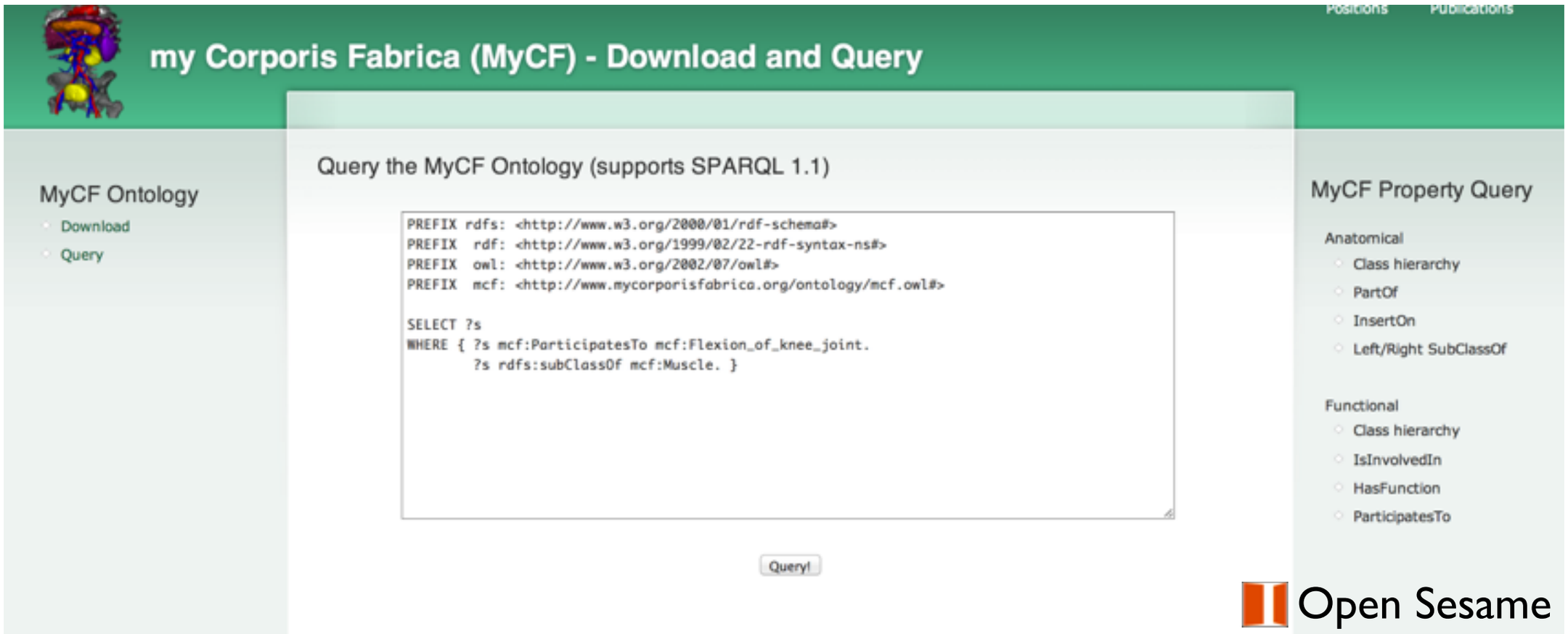
MyCF Browser

[SIGGRAPH'14 Demo]



MyCF Web

www.mycorporisfabrica.org

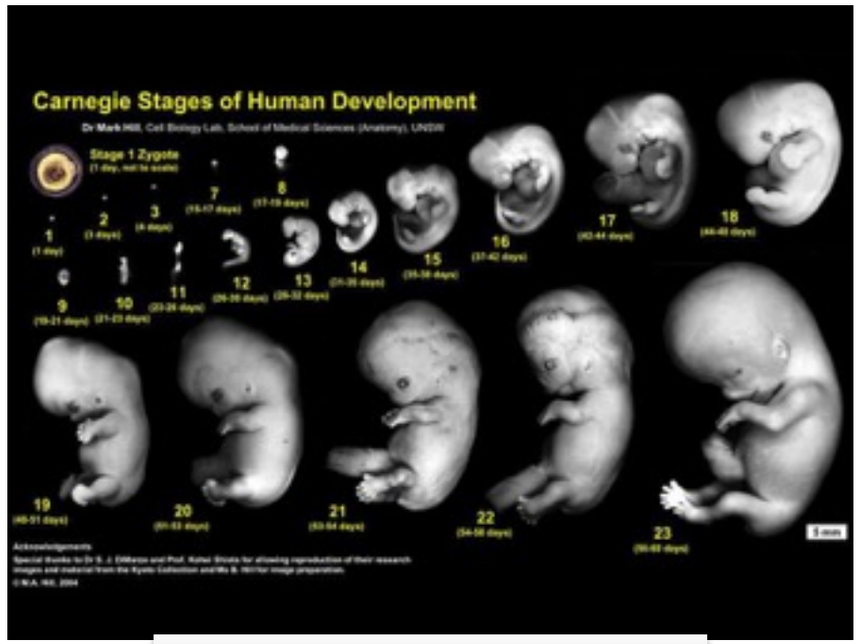


MyCF Ontology Integrates 70K FMA classes

+ 4K classes as new anatomy / functions

+10K triples using new relations

My Corporis Fabrica



MyCF Embryo

MyCF Embryo

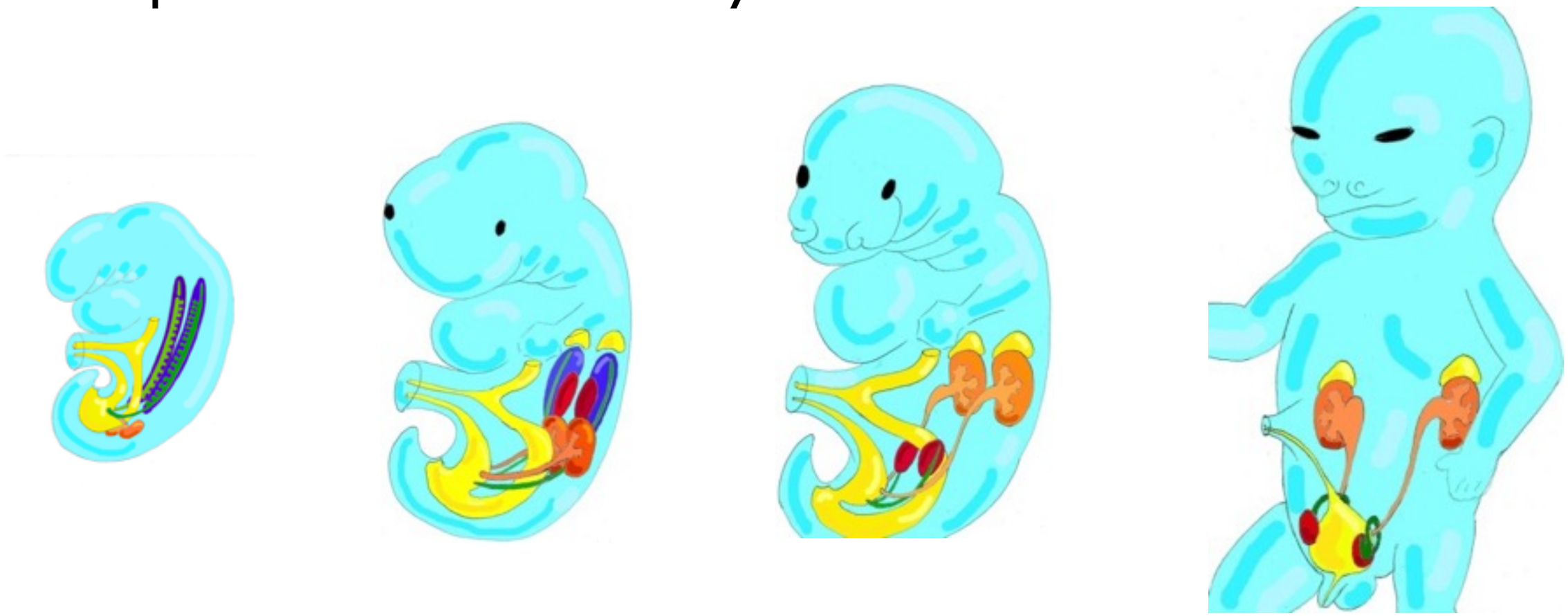
[P. -Y. Rabattu and B. Masse, M2R]

Motivations

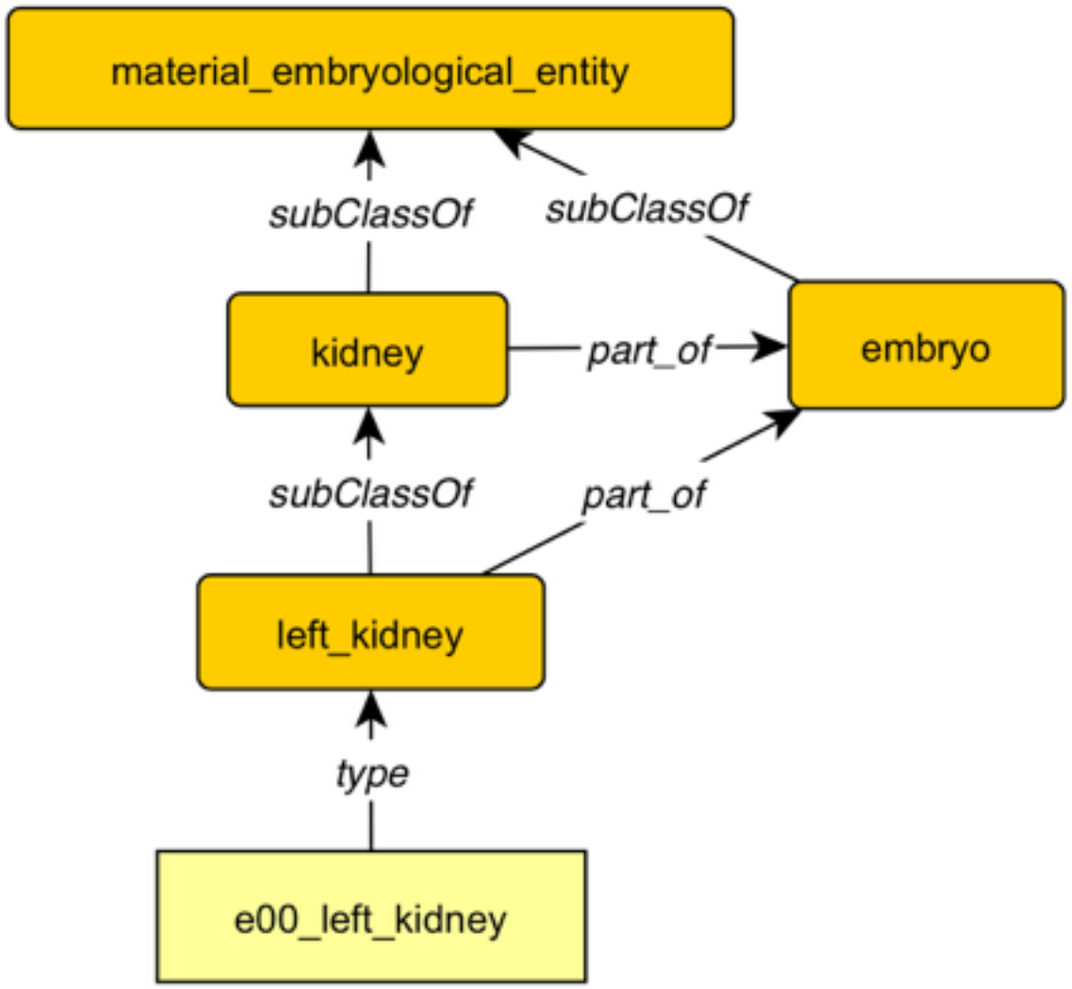
- Teaching embryology and teratology
- Research tools for studying the development of pathologies
- An open dataset to share with the medical community

Scope

- Appareil urinaire : migration rénale, développement des uretères, descente gonadique, division du cloaque et représentation de l'embryon.



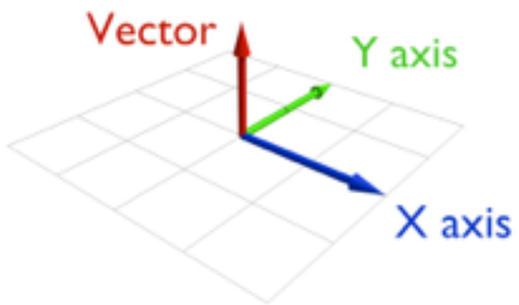
Embryo Anatomy

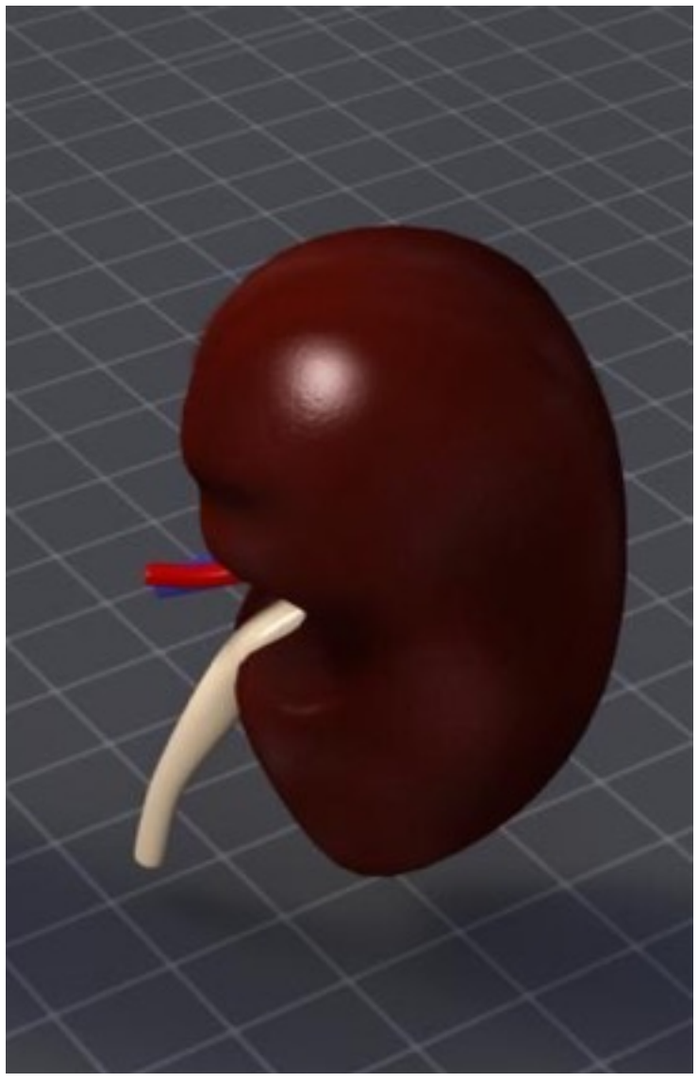


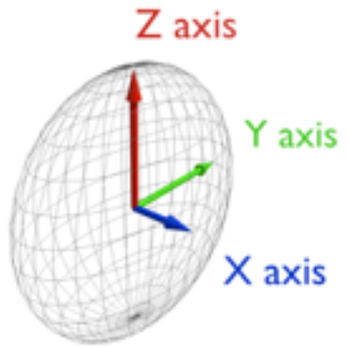
Integrates J.B. BARD Embryo Anatomy Ontology

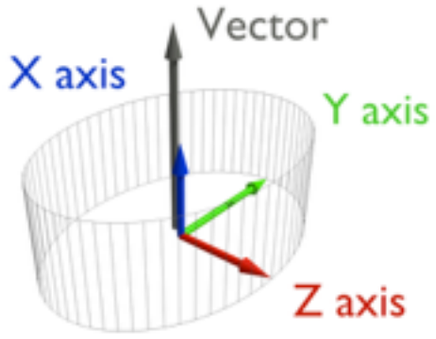
Organs as Geometrical Entities

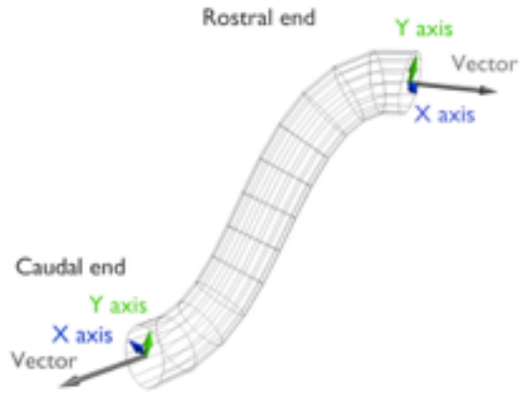
(point, line, ovoid, cylinder, duct, plan)



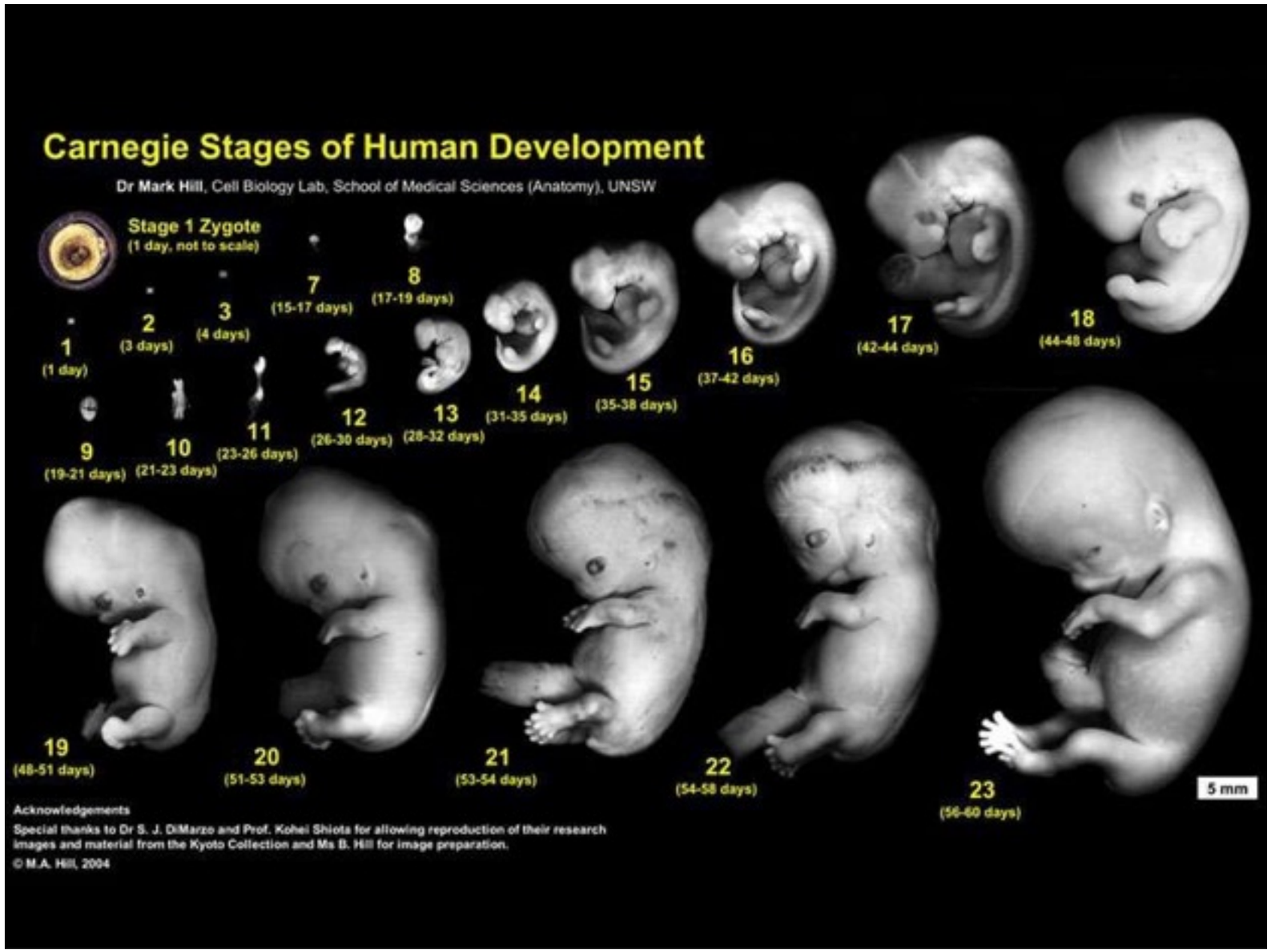








Time : Gestation Weeks



23 Carnegie stages modeled as classes

Kidney at Carnegie Stage 14

Space

< mcfe:kid_1_te14, rdf:type, mcfe:SpatioTemporalRepresentation>

< mcfe:kid_1_te14, mcfe:hasGeometricalRepresentation, mcfe:geom_1>

< mcfe:geom_1, rdf:type, mcfe:ovoid>

< mcfe:ovoid, rdfs:subClassOf, mcfe:GeometricalEntity>

< geom_1, mcfe:hasBaricenter, “x,y,z”>

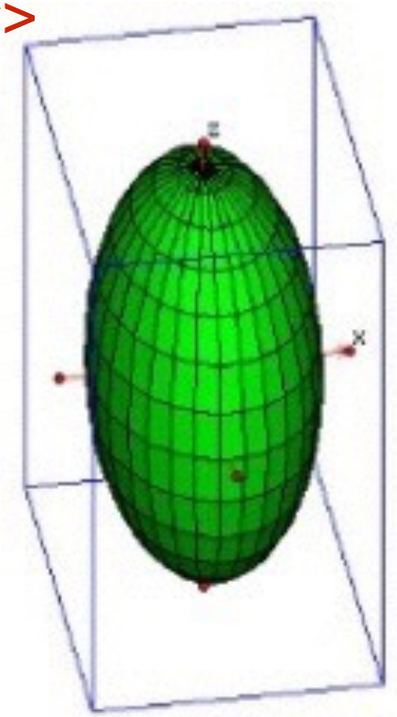
< geom_1, mcfe:hasAxisSize, “x,y,z”>

< geom_1, mcfe:vectorCoordinate, “x,y,z”>

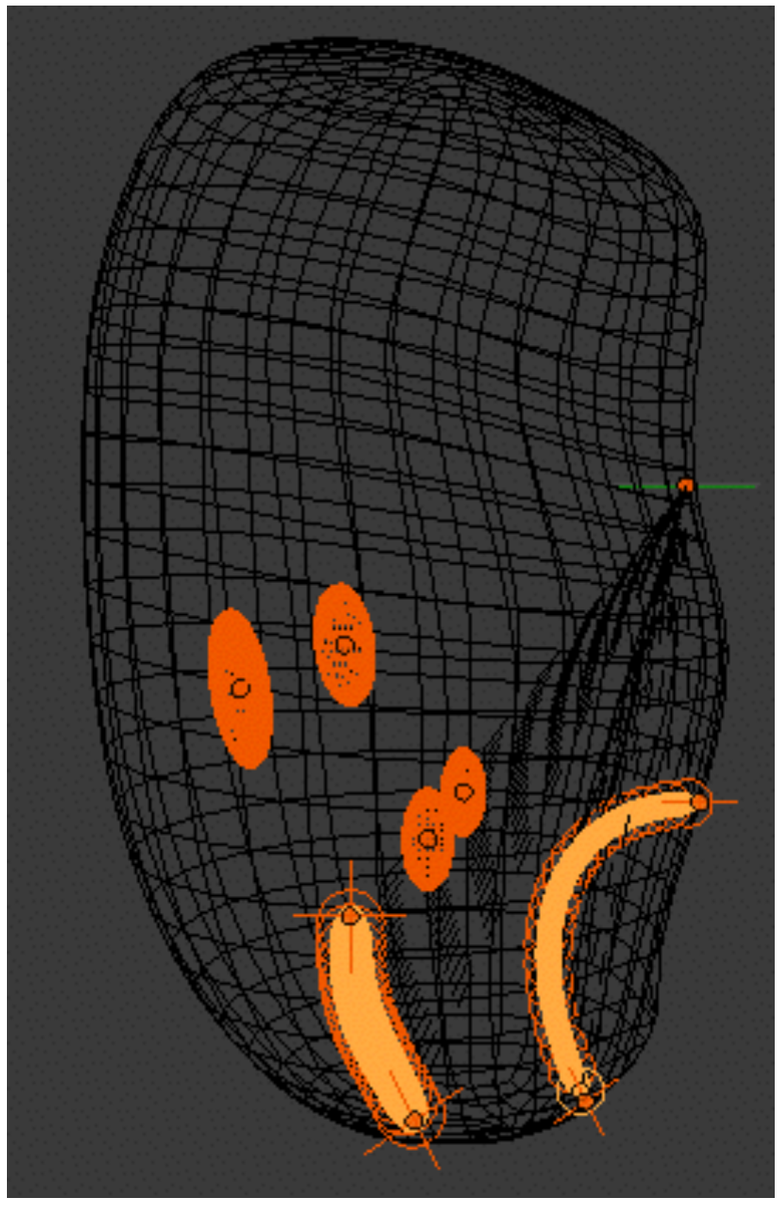
Time

< mcfe:kid_1_te14, mcfe:atStage, mcfe:TE14>

< mcfe:TE14, rdfs:subClassOf, mcfe:TemporalEntity>



Visualization by Query



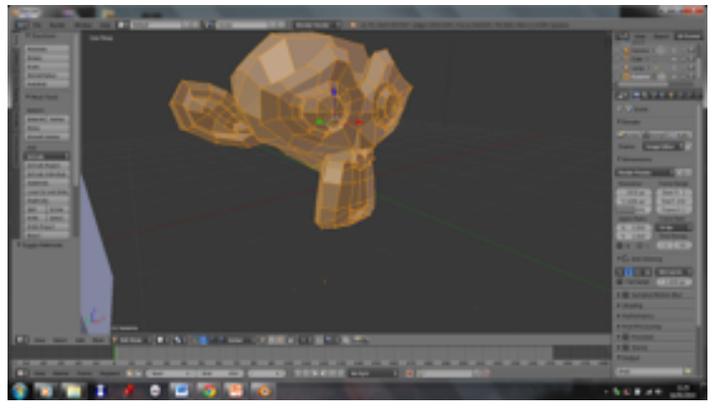
select “all 3D objects
for embryo organs
at stage 14”

↓

< geom_1, mcfe:hasBaricenter, “x,y,z”>
< geom_1, mcfe:hasAxisSixe, “x,y,z”>
< geom_1, mcfe:vectorCoordinate, “x,y,z”>

…

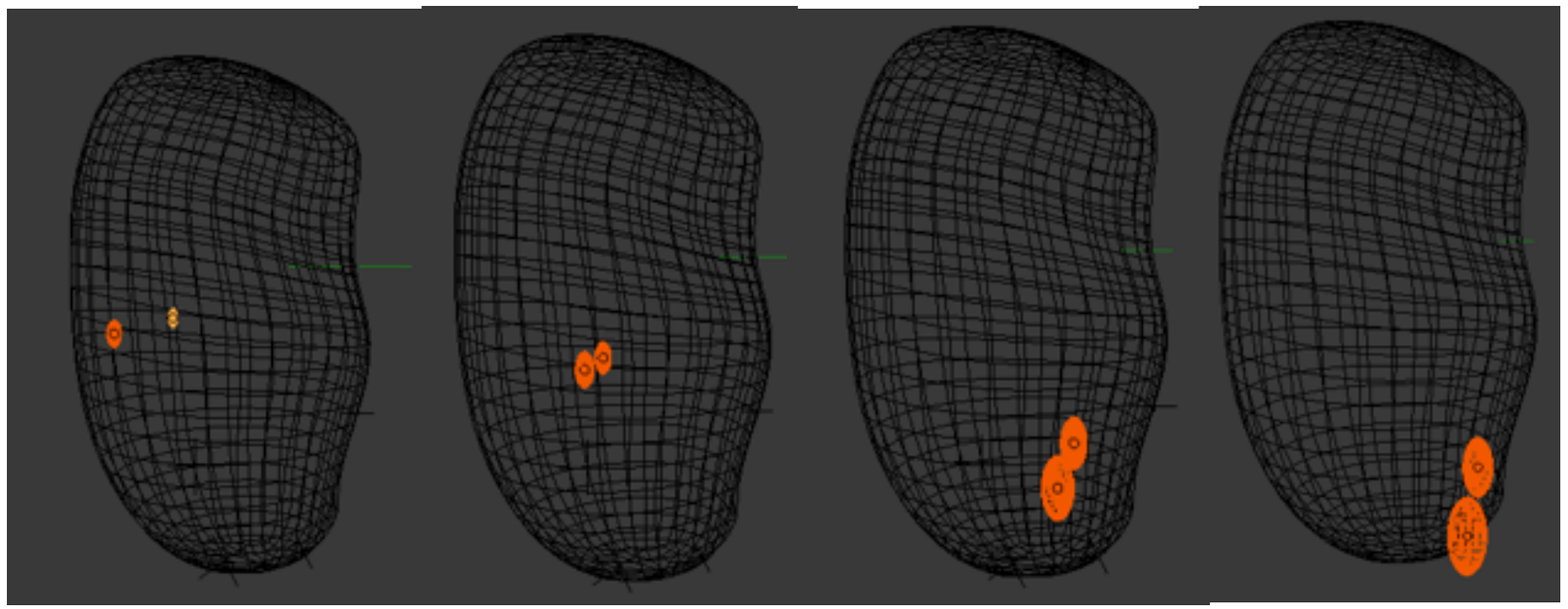
↓



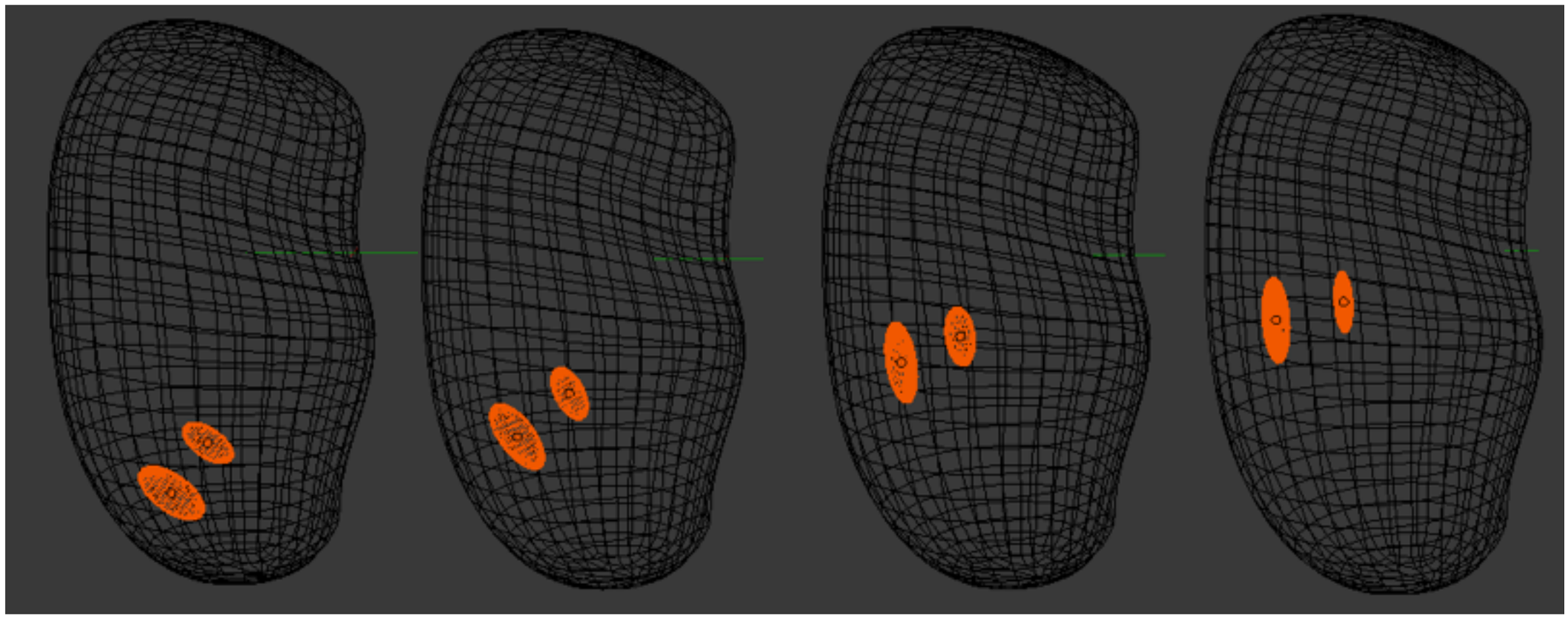
Python

blender

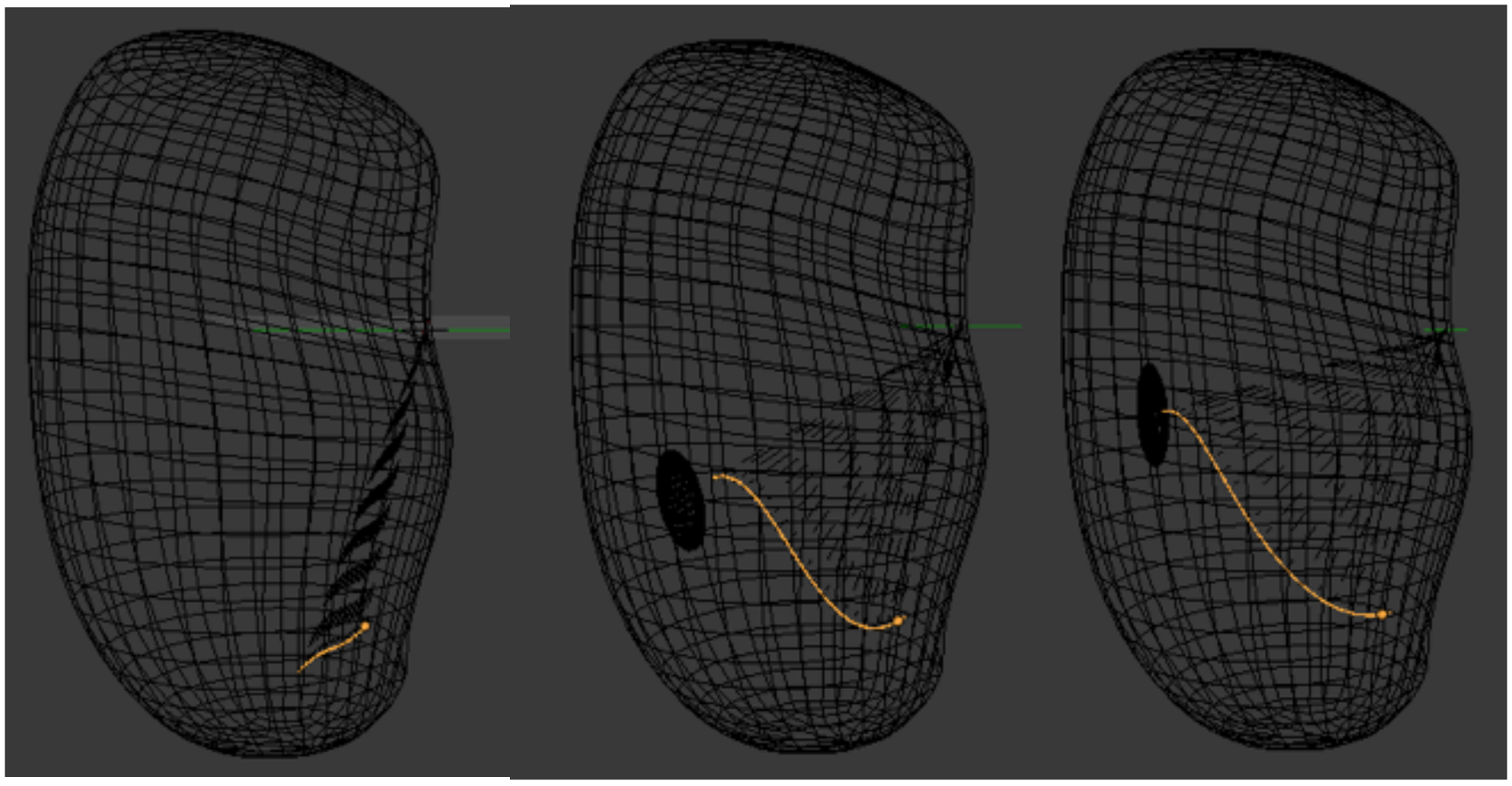
Simulation by Query
Gonad descent



Simulation by Query
Kidney ascent

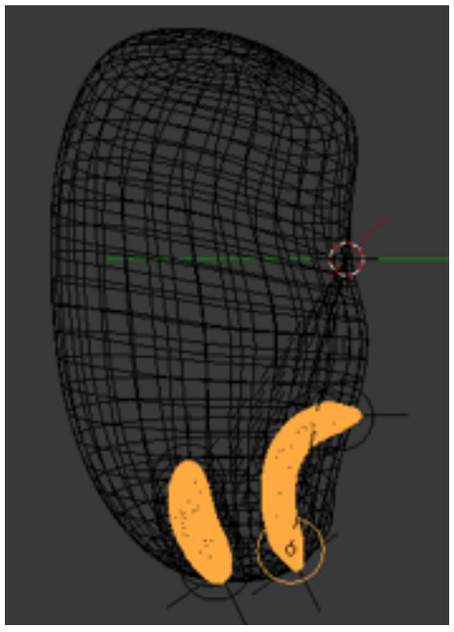


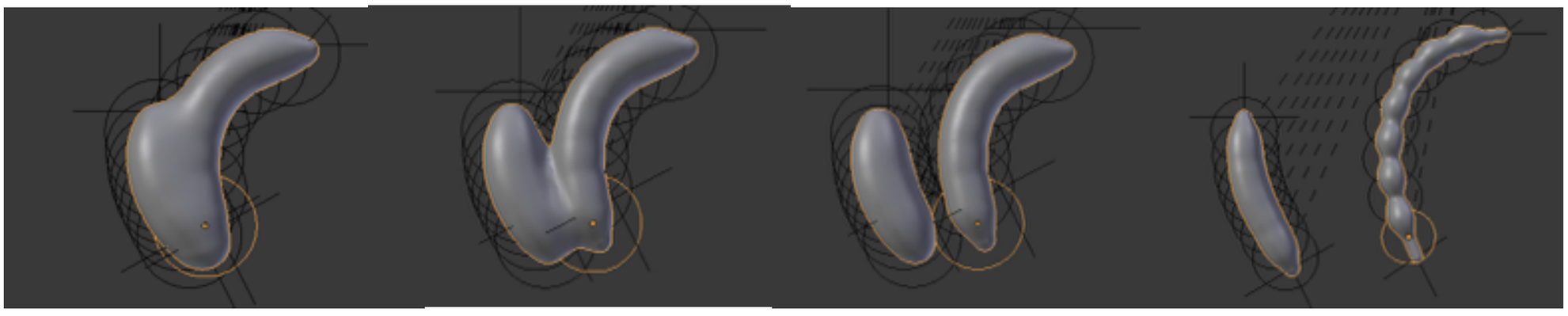
Simulation by Query
Ureter development



Simulation by Query

Cloaca division into bladder and rectum

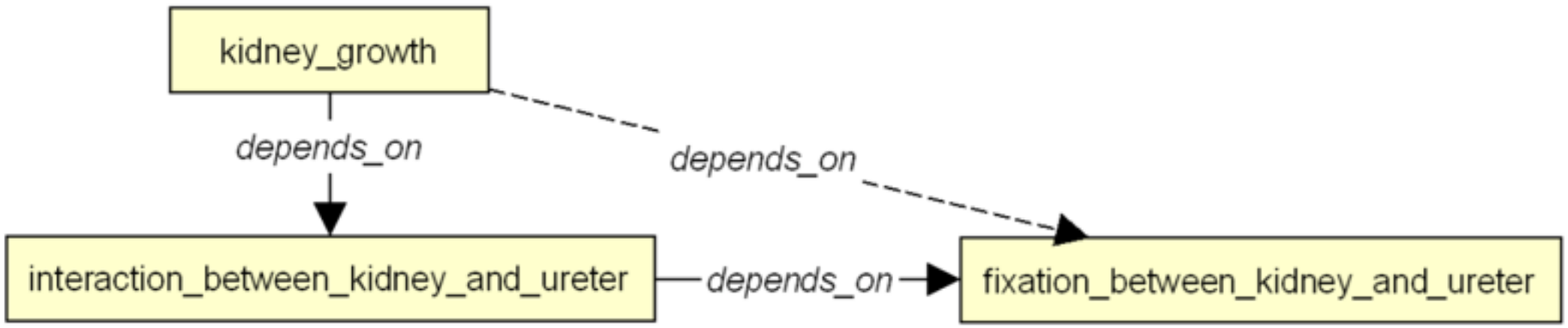




Embryo Evolution Processes

- Division (e.g., cloaca)
- Fixation (e.g., kidney-ureter)
- Growth (all organs)
- Interaction (e.g., kidney-ureter)
- Migration (e.g., kidney-gonad)
- Rotation (e.g., kidney)

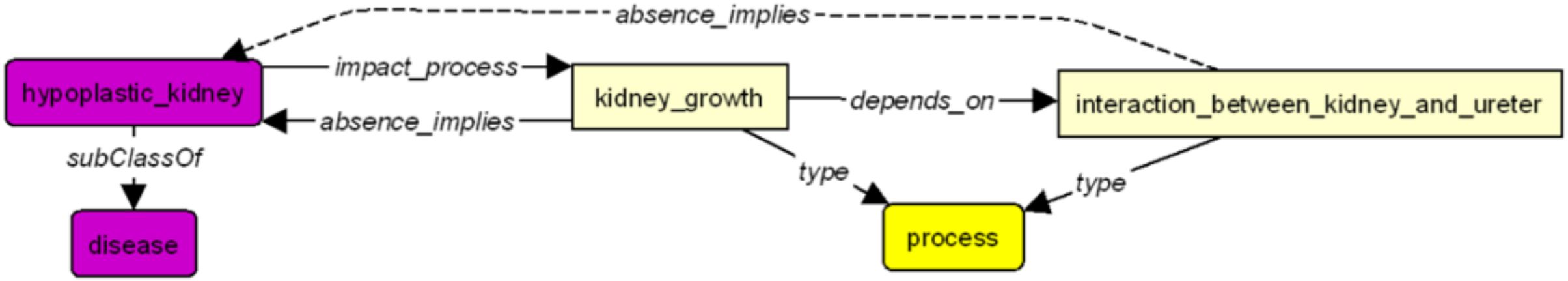
Process Interaction



(?x depends_on ?y) , (?y depends_on ?z) —> (?x depends_on ?z)

Inferring all dependencies between evolution process.

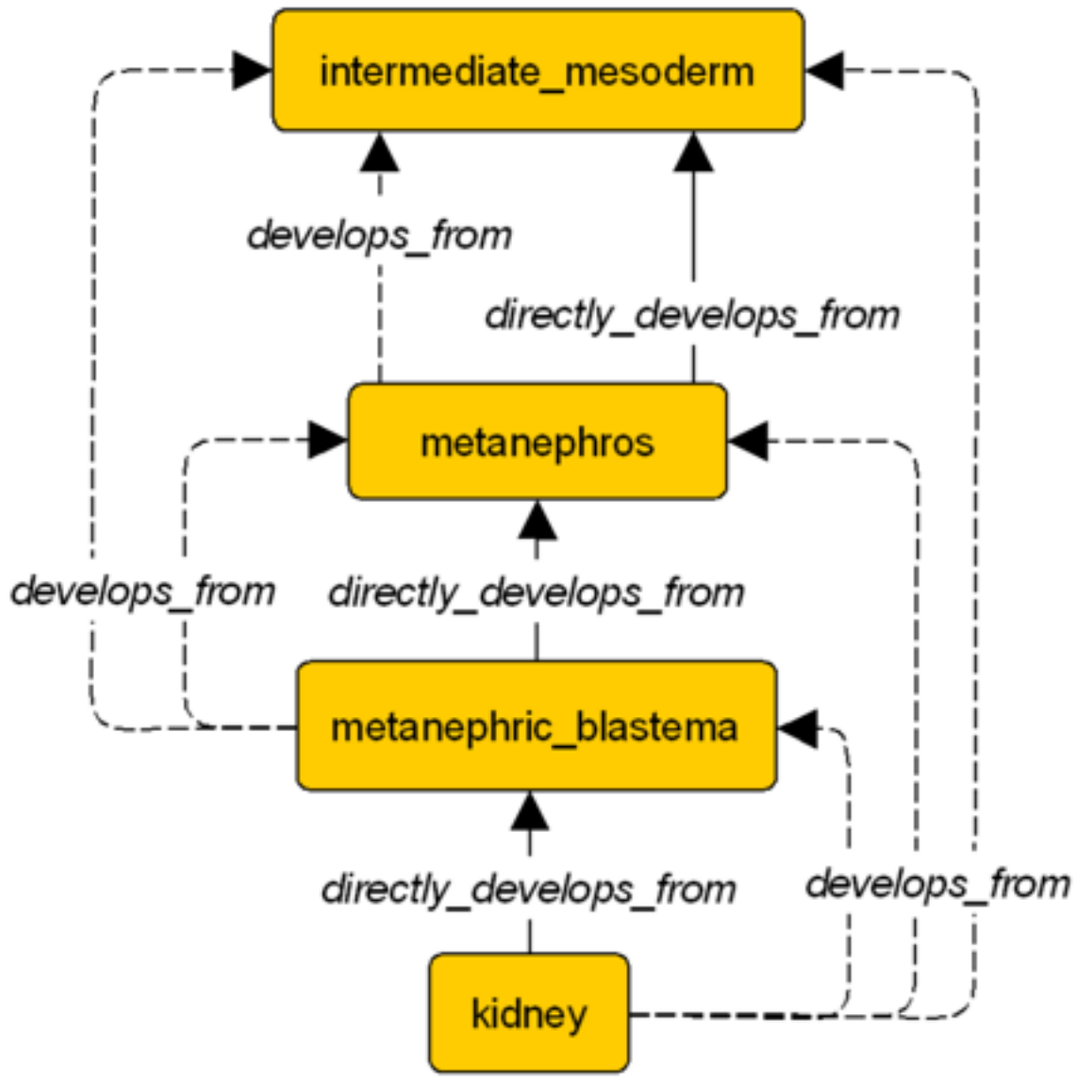
Pathology



(?x absence_implies ?y) , (?x depends_on ?z) —> (?z absence_implies ?x)

Inferring all processes (and organs) impacted by a disease.

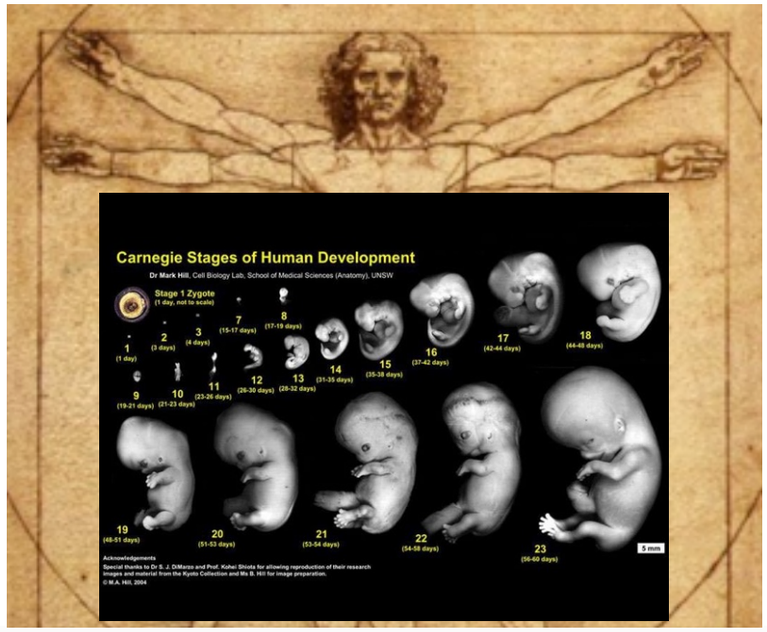
Development Lineage



(?x develops_from ?y) , (?y develops_from ?z) —> (?x develops_from ?z)

Inferring all dependencies between organs.

“My Ontology Fabrica”



My Corporis Fabrica
Anatomy, Embryology

My3D

My Product Fabrica

My Dramatis Fabrica