# BioTopLite:
# An Upper Level Ontology for the Life Sciences
# Evolution, Design and Application


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# Good reasons for highly constrained upper-level ontologies (ULOs)

- Guidance of ontology engineering process
- Standardization of ontology artefacts
- Decrease degrees of freedom

  → increase in interoperability
- Prevention of design errors
- Enforcement of a coherent upper-level view on the world
  - Example: division continuants – occurrents

    information entities – real entities

# Existing ULOs have shortcomings for use in the biomedical domain

- DOLCE: focussed on cognitive science, atemporal models
- BFO, current version 1.1 has no relations, unintuitive labels, version 2.0 under development, controversial issues
- GFO-Bio: difficult to understand
- UMLS Semantic network, GALEN upper level, Semanticscience Integrated Ontology: overly pragmatic, no principled criteria for upper-level divisions, more language-oriented than philosophy-oriented

# Evolution of BioTop since 2006 (I)

- Inspired by GENIA ontology: fixing of issues and broadening of scope
- Design characteristics
  - OWL-DL
  - Mutually exclusive upper-level categories
  - Limited set of relations
  - Highly constrained
  - Understandable naming
- Focus on cell biology and biomolecules

# Evolution of BioTop since 2006 (II)

- Use for ontology building in large EU projects:
  - @neurist (neurology, neurosurgery)
  - DebugIT (nosocomial infections)
- Need for increased performance
  - Separation of many biochemistry related classes → ChemTop (no further maintained, due to evolution of ChEBI)
- Alignment with UMLS Semantic Network
  - Addition of medicine-related classes
  - External criterion for scoping
- Alignment with upper-level ontologies
  - BFO, RO, DOLCE

# Evolution of BioTop since 2006 (III)

- Creation of "lite" version BTL
- Testing in ontology tutorials
- Basis for Guideline for "Good ontology design"
- Use in experimental ontologies in the SNOMED CT development process
- New requirements, e.g.
  - Causation
  - Inherent ambiguity of medical terms, e.g.
    "Fracture" structure or process
    "Allergy" process or disposition
  - *Condition* equivalentTo
    *MaterialObject* or *Disposition* or *Process*

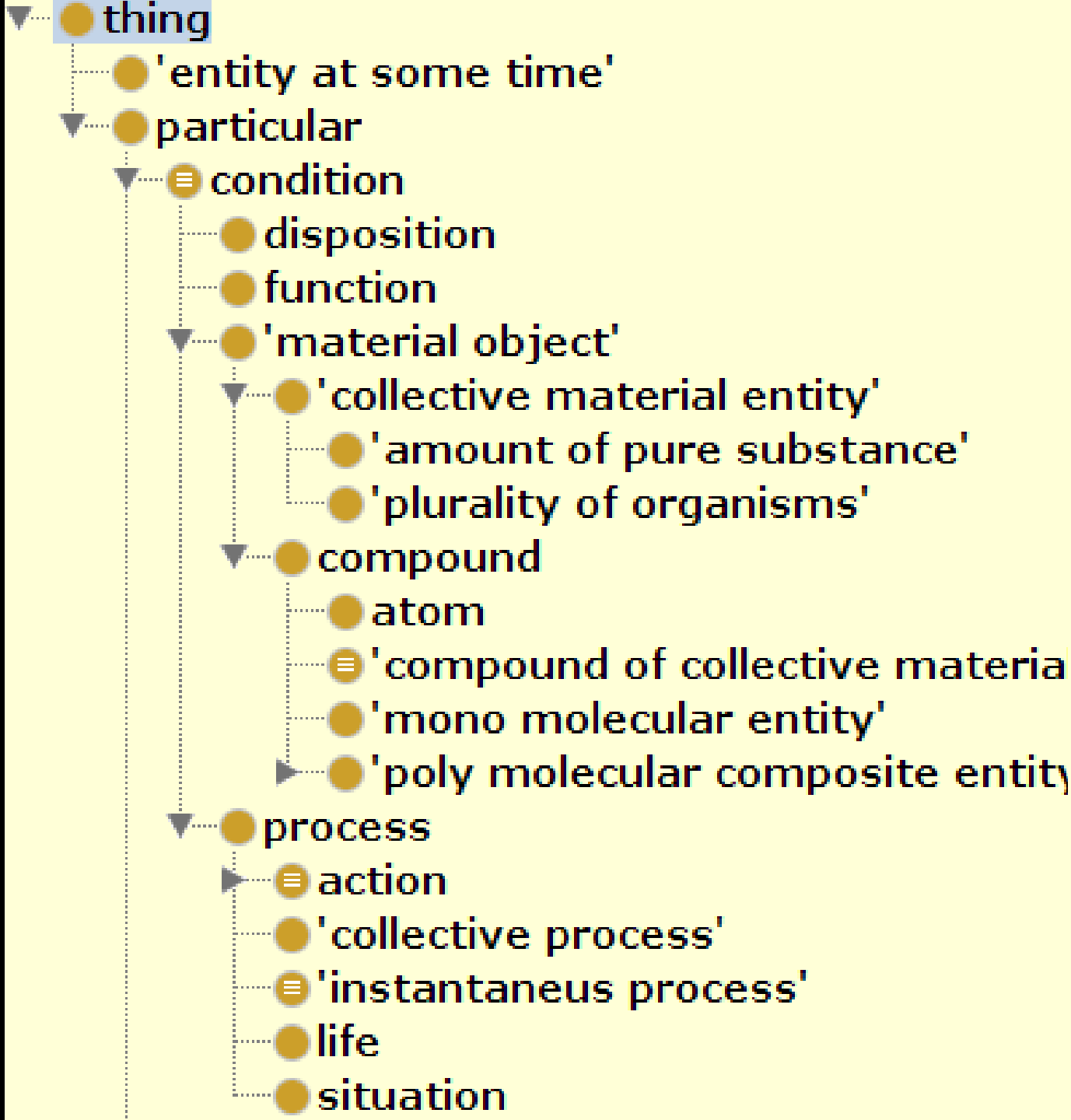
# BioTopLite -> BioTopLite2
# Main principles

- Pragmatic realist view
- Agnostic stance with regard to the existence of universals
- Compulsive use of top-level: domain classes must be placed under them
- Flat hierarchy, no top-level classes like *Continuant*, *Occurrent*
- Intuitive naming of classes and relations ('has locus' -> 'is Included in')
- Information object as toplevel class
- Set of relations (object properties) considered as closed. Relational predicates to be reified form process subclasses
- Further reduction of object properties ('processual part of' -> 'part of')
- All instances are considered to be temporally qualified
  (since ternary relations like 'part of' (a, b, t) not possible)

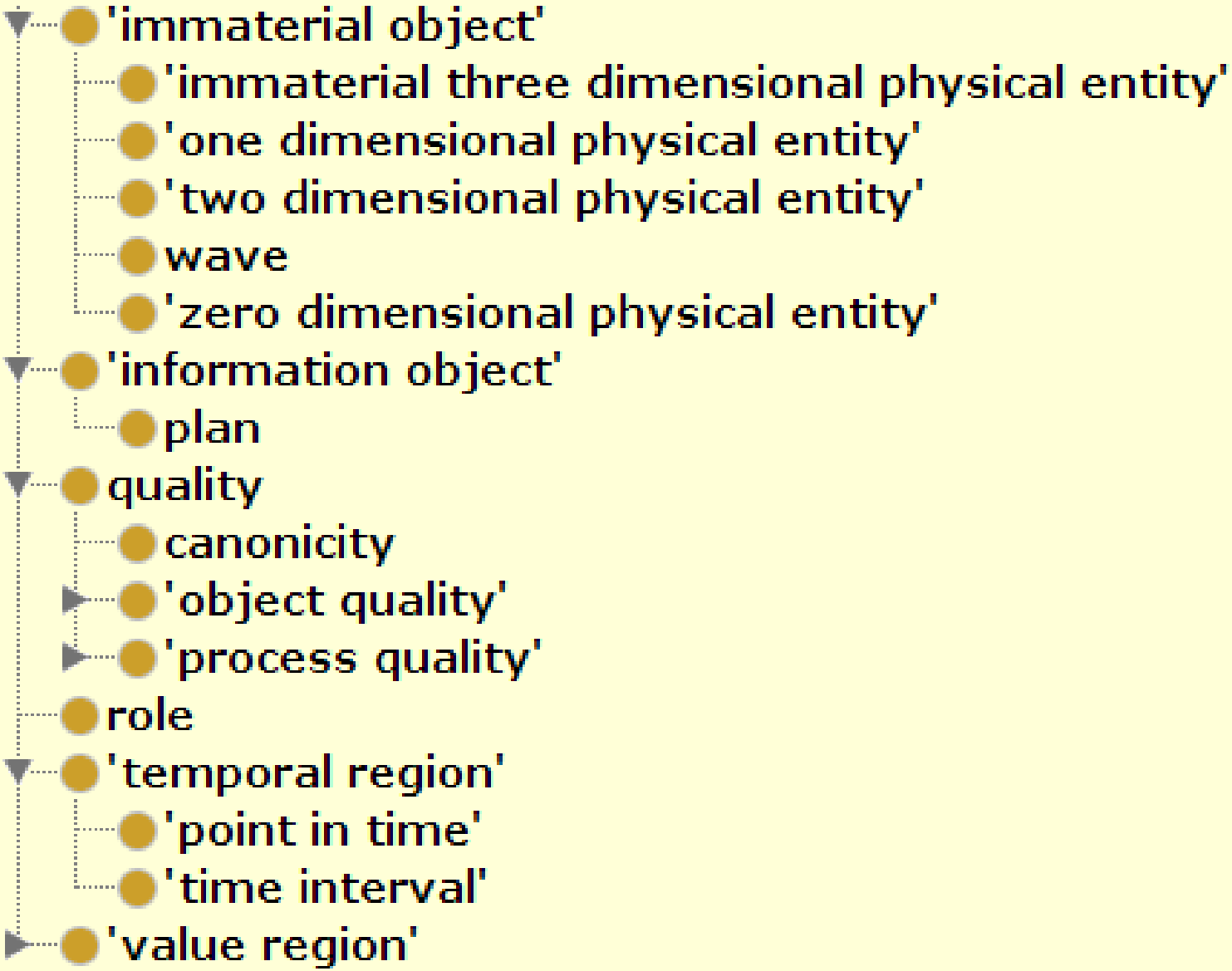
# BioTopLite2 : Characteristics

| Metrics | Count |
|---|---|
| Classes | 53 |
| Object properties | 37 |
| Logical axioms | 240 |
| - Subclass axioms | 172 |
| - Equivalence axioms | 5 |
| - Disjointness axioms | 14 |
| - CGI | 14 |
| - SubObjectProperty axioms | 25 |
| - Property chains | 2 |

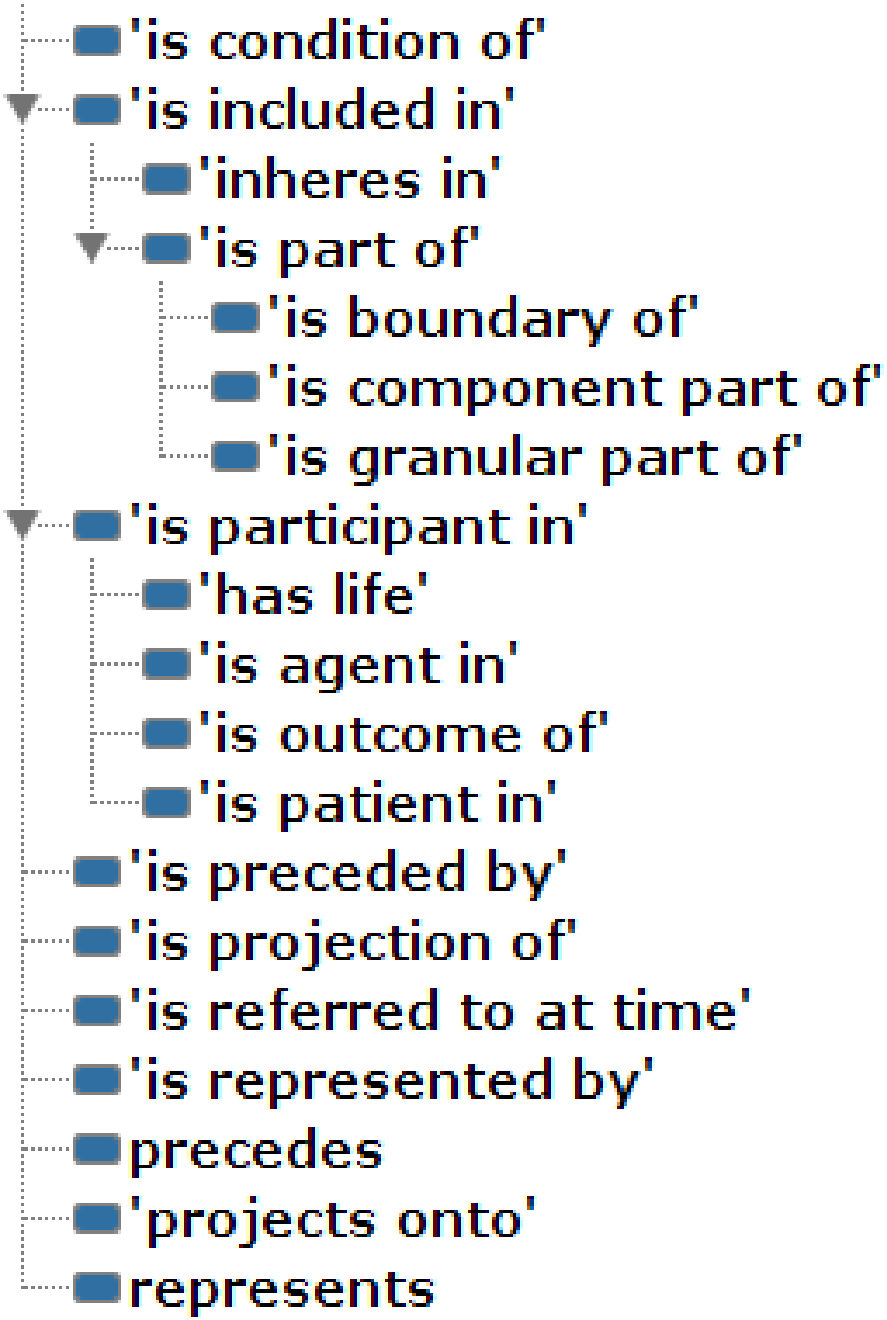
# BioTopLite2: Classes



# BioTopLite2: Classes



# BioTopLite2: Object Properties



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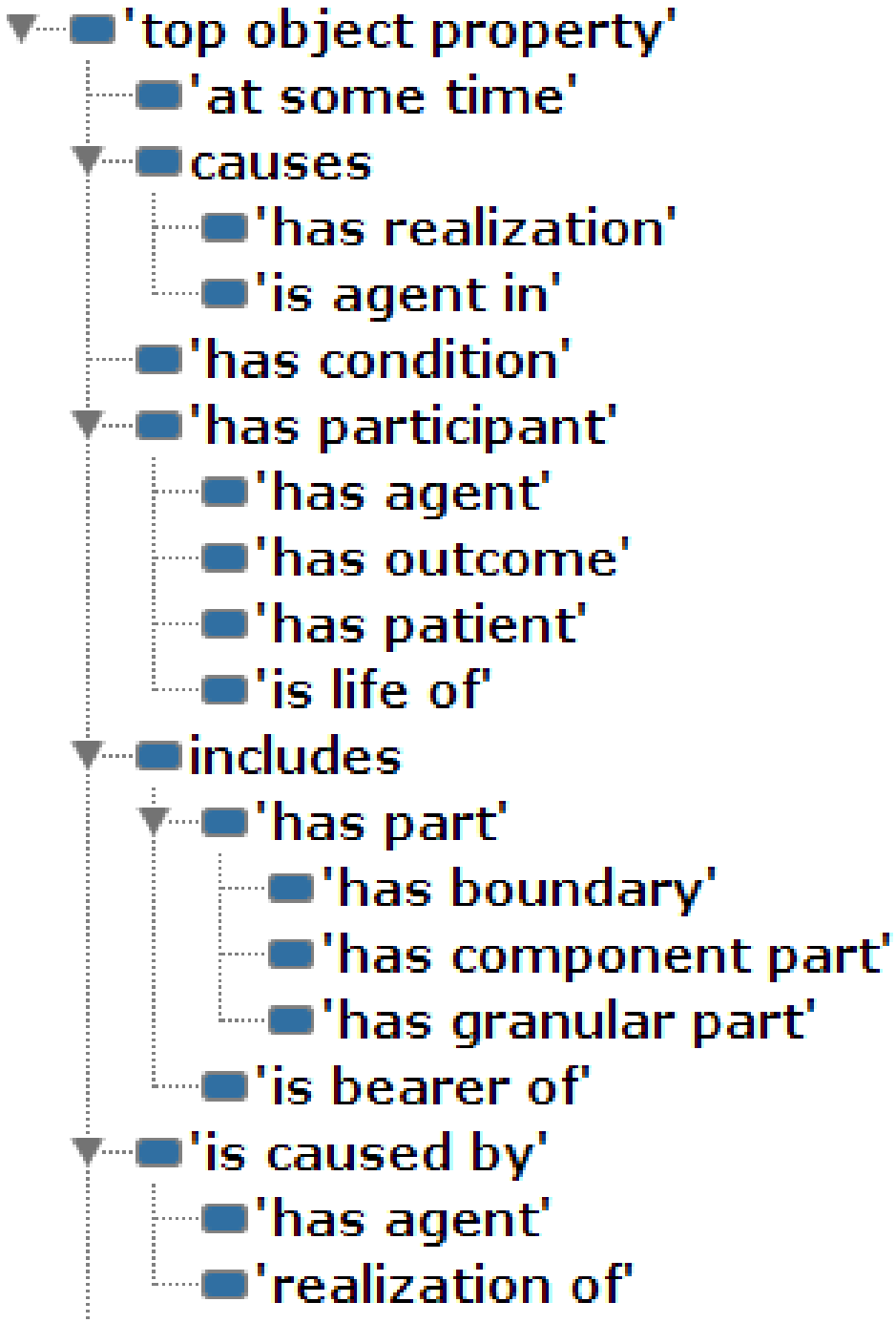

# BTL2 example: Axioms for "material object"

- 'has component part' only 'material object'
- 'has granular part' only 'material object'
- 'has life' only life
- 'has life' some life
- 'has part' only ('material object' or 'immaterial object')
- 'is bearer of' only (disposition or 'information object' or 'object quality' or function or role)
- 'is included in' only 'entity at some time'
- 'is part of' only 'material object'
- 'is participant in' only process
- 'projects onto' only ('immaterial three dimensional physical entity' and 'entity at some time')
- 'projects onto' some 'immaterial three dimensional physical entity'
- includes only (disposition or function or 'immaterial object' or 'information object' or 'material object' or quality or role)
- includes only 'entity at some time'
- particular
- ≡ condition

bClass Of (Anonymous Ancestor)

- 'is represented by' only
  ('entity at some time'
  and 'information object')
- 'is condition of' only situation
- disposition
  or function
  or 'material object'
  or process

# Temporally qualified entities (I)

- Problem: relations between continuant (endurant) objects are time-dependent, e.g.
  - part-of (Heart#1234, John, 20130101)
  - part-of (Heart#1234, Jack, 20130103)
- OWL object properties are only binary
- Proposed solution (implemented in BTL2, currently under discussion for BFO2):
  - Instances of continuant entities are considered to be temporally qualified, such as

    Heart#1234@20130101 rdf:Type Heart

    Heart#1234@20130103 rdf:Type Heart

# Temporally qualified entities (II)

- Consequences of temporally qualified continuants at the class (Tbox) level:
  - Class *Entity at some* useful as a means to enforce that instances of time-dependent classes be placed in a temporal context
  - '*Material object*' subClassOf

    '**is included in**' only '*Entity at some time*'
- Advantage: expression of temporary relatedness:
  - '*Structured biological entity*' subClassOf

    '**at some time**' some ('**is part of**' some *Organism*)
  - '**at some time**' relates a temporally qualified continuant with any of its temporally qualified "siblings"

# Current use of BTL / BTL2

- SemanticHealthNet EU Network of Excellence:
  Upper level for information model and clinical terminology (SNOMED CT)
  http://www.semantichealthnet.eu
- CELDA: ontology of cell types, in vitro as well as in vivo, based on species, anatomy, subcellular structures, developmental stages and origin
  http://cellfinder.org/about/ontology
- International Health Terminology Standards Development Organization: in several experimental ontologies (event, condition, episode; observables)

# Access to BioTop and BioTopLite

- Website: http://purl.org/biotop
- Mailing list: https://groups.google.com/forum/#!forum/biotop
- Feedback welcome!

# Acknowledgements


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