The Plant Ontology and the Trait Ontology

Resources for Plant Genomics

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www.plantontology.org
Plant Ontology Consortium

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Barry Smith: OBO Foundry, Department of Philosophy, University at Buffalo, NY
Ontologies for Plant Sciences:

- **Gene Ontology (GO)**
- **Plant Trait Ontology (PTO)**
- **Phenotype Quality Ontology (PATO)**
- **Plant Ontology (PO)**
- **Chemical Entities of Biological Interest (ChEBI)**

[Links to resources mentioned in the text]
The Plant Ontology is...  
...a controlled vocabulary

Each term has:

- primary name and synonyms
- unique PO ID and url
- definition vetted by experts, with community feedback

- two aspects
- terms cover the plant domain
Relations in the PO:

- **is_a** and **part_of** are the backbone of all anatomical ontologies.
- **has_part** allows the PO to describe structural variation among taxa.

New terms to describe multi-tissue plant structures released July 2012.
Phylogenetic diversity can result in inconsistency in nomenclature:

Instances of leaf: (PO:0025034)

- maple leaf
- pine needle
- palm frond

**Different names are used for the same structure**

Asteraceae

Poaceae

**Different structures can have the same name e.g. ‘floret’**

The PO provides consistent terminology for annotation of plant structures and growth and developmental stages across taxa.
The Plant Ontology is...  
...a database resource for plant science

Links to associations from:
- gene expression experiments
- EST and QTL datasets
- mutant phenotype screens

Release #18, July 2012
~2.2 million associations for 1457 PO terms covering 22 species
Collaborative development of the PO: terms and annotations

Recent Examples:

- Addition of 1.5 million new associations between *Zea mays* (maize) gene models and Plant Ontology terms (October 2011)

- ~80 new anatomy terms for the *Physcomitrella*–Moss Computational Biology Resource and added ~82,000 new annotations to Moss genomics data (Jan 2012)

- Upcoming: Working with the Grape Functional Genomics Project at the Univ. of Verona in Italy

- Grape Atlas Microarray ~4286 genes that are differentially upregulated in ripening stages
Over 80 new anatomical terms have been added for bryophytes and pteridophytes.

All tissue and cell types from the Moss Ontology have been incorporated into PO.

Additional terms were gathered from bryophyte reference books.

Examples: amphithecium, calyptra, foot, gametophore, hydroid, leaf apical cell, protonema, thallus, tmema.
New *Physcomitrella* annotations

Added ~82,000 new annotations to Moss genomics data (Jan 2012 Interim data release)
PO associations provide links to Cosmoss database:

Annotations to gametophore; PO:0030018 and its children

Get this data as RDF-XML.

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<th>Evidence</th>
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Link to source database: Cosmoss Gene Page
The PO as a teaching tool: Images

Term Information

- **Accession**: PO:0009033
- **Ontology**: plant structure
- **Synonyms**: None
- **Definition**: A phyllome that is part of a perianth in which all parts are similar in appearance and are neither petals nor sepals. [source: POC:curators]
- **Comment**: None

External References

- PlantSystematics.org (1)
  - tepal images
- SF (1)
  - 2972262

Tree View

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Tree View

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PlantSystematics.org KEYWORDS SEARCH RESULTS "tepal":

50 images with KEYWORDS, LOCALITY or CAPTION with "tepal": images 1 - 50

- **Alliaceae**
  - Allium giganteum
  - Allium schoenoprasum
- **Alliaceae**
  - Ipheion uniflorum
- **Alliaceae**
  - Neotessarctum
- **Annonaceae**
  - Antenna reticulata
  - Antenna reticulata
- **Antonaceae**
  - Asimina triloba
- **Antonaceae**
  - Cananga odorata
- **Antonaceae**
  - Cananga odorata
- **Antonaceae**
  - Asimina triloba
- **Berberidaceae**
  - Jeffersonia diphylla
  - Jeffersonia diphylla
- **Calyxanthaceae**
  - Calyxanthus borneensis
- **Cotniaceae**
  - Cotniaceae autumnale
- **Eremocallidaceae**
  - Eremocallis fulva
- **Iridaceae**
  - Tigrisora
- **Iliaceae**
  - Lillium
Cornell University Plant Anatomy Collection

**CUPAC** (Cornell University Plant Anatomy Collection) is an historically important collection of anatomical slide preparations of a wide array of plant parts. These slides include materials prepared by renowned Cornell Plant Anatomists, both for teaching and publication. Included are slides from the collections of Arthur Eames, Mary Wilde, David W. Bierhorst, Hal Moore and Natalie Uhl; and from other famous plant anatomists such as K. Esau, Johri and Maheshwari.

Slides are being imaged by volunteers and undergraduate student workers, and simultaneously barcoded and databased. Post-processing involves automated resizing and labeling as well as magnification calibration that allows online measurement tools to be used as overlays on the images.

**Search tools**

Keyword Search: [Enter]
Submit

Index by [taxon](#).
### Plant Trait Ontology

#### Originally developed and hosted by Gramene:

http://www.gramene.org/plant_ontology/ontology_browse.html

Includes annotations to data
Plant Trait Ontology

Organized into nine upper level classes:

- anatomy and morphology related trait
- sterility or fertility trait
- biochemical trait
- stress trait
- growth and development trait
- yield trait
- quality trait
- stature or vigor trait
- other miscellaneous trait
References PO Term awn and PATO term color to ‘pre-compose’ the trait terms
Plant Trait Ontology

TO hierarchy for fruit color:

- plant trait
  - quality trait
    - fruit quality trait
      - fruit color
        - fruit columella color
        - milled grain color
        - pericarp color
Revising and expanding the existing Trait Ontology

- International Consortium to develop a Reference Plant Trait Ontology

- Crop Ontology Workshop- @ OSU Sept 13-15th, 2012
Vision of a Reference Plant Trait Ontology (Ref-TO) to link the crop- and clade-specific trait ontologies

Arnaud, E., Cooper, L., Shrestha, R., Menda, N., Nelson, R. T., Matteis, L., Skofic, M., Bastow, R., Jaiswal, P., et al.
Towards a Reference Plant Trait Ontology For Modeling Knowledge of Plant Traits and Phenotypes.
International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management,
The broader vision is to develop a reference set of ontologies for all plants.

CROP: Common Reference Ontology for Plants

Special presentation Friday- Barry Smith
OBO Foundry
The Plant Ontology - A Collaborative Effort

Cornell University