Controlled vocabulary examples

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1. Introduction

This document contains examples of controlled vocabularies that have been used to control input to fields in a database implementation of ArMet. These vocabularies describe:

1. Growth development stages.
2. Tissue types.
3. Types of lighting for controlled growth environments.
4. Types of growth medium.
5. Types of container for plant growth and sample storage.

Except for the growth development stages, which have come directly from the literature, these vocabularies were designed alongside a database to support plant metabolomics experiments performed on *Arabidopsis thaliana* and potato plants. They are presented here to serve as examples and to provide the basis for discussion and development of such vocabularies.

2. Growth Development Stages

For controlling the contents of development stage fields the following scales of development stages were taken from the literature:

- *Arabidopsis thaliana*[1]
- Potato[2]

3. Tissue Types

This vocabulary defines and explains the terms of the morphology of a plant and has been designed, primarily, for *Arabidopsis thaliana* and potato plants. The morphology hierarchy is not intended to be a fully comprehensive breakdown of plant structure, rather it aims to provide a hierarchy of common plant parts that may be excised from a living plant at various growth stages. The cell types hierarchy has been omitted as it is thought to provide more detail than is required to describe a physical plant part that may be disected from a living plant. This vocabulary therefore describes a hierarchy of plant morphogenesis, describing physical structures that arise as the plant develops. (See [3-7], Plant Anatomy Glossary online at http://www.uri.edu/artsci/bio/plant_anatomy/glossary.html, and http://schnablelab.plantgenomics.iastate.edu/research/hypothesis/root.shtml for sources used in the compilation of this vocabulary).

Plant morphology:

- whole plant: The entire plant, comprising root and shoot
- shoot: The above ground plant material
- vegetative: Non-flowering part of the shoot system
- stem: The main axis of the plant, produced by the shoot apical meristem
- leaf: Lateral appendage of the stem
- leaf bud: A structure on the stem where leaves develop
- stipule: One of two leaf like structures at the base of a stem
- simple leaf: A leaf organ that is composed of only one leaf structure
- petiole: The stalk attaching the leaf to the stem

- tendril: A modified petiole, to coil around other stems or objects
- leaf lamina: Leaf tissue containing no major vascular tissue
- major veins: The major vascular bundles of the leaf
- midrib: The large central leaf vein
- compound leaf: A leaf organ that is composed of more than one leaf structure
- rachis: The central stalk of the compound leaf structure
- leaflet: One of the many individual leaf structures that make up the compound leaf
- petiolule: The stalk attaching a leaflet to the rachis
- sexually reproductive: The part of the plant system that gives rise to flowering and sexual reproduction
- apical bud: A bud appearing at the tip of a stem
- apical shoot: A shoot developing at the tip of existing shoots, which will develop reproductive structures
- axial bud: A bud appearing along the stem, at the joint between an existing leaf and the stem
- axial shoot: A shoot developing at the joint between an existing leaf and the stem, which will develop reproductive structures
- inflorescence: Flower head
- peduncle: The stalk of the flowerhead
- flower: Reproductive organ
- pedicel: Small short stalk of a fixed organ
- petal: Modified leaf, several of which form the corolla of the flower
- sepal: Modified leaf, several of which form the calyx of the flower
- stamen: Male reproductive organ
- anther: Pollen producing part of the stamen
- filament: Stalk which bears the anther
- pollen: The fine grains produced by anthers, each grain encloses a male gamete
- carpel: Female reproductive structure
- pistil: The collective carpels of the flower
- stigma: Upper portion of the carpel which receives the pollen
- style: Connects the stigma with the ovary
- ovary: Enlarged portion of the carpel which contains the ovules. After fertilization develops into the fruit
- ovule: The structure which develops into the seed after fertilization
- embryo sac: The mature female gametophyte, consisting of the egg cell and companion cells
- egg cell: Female gamete

- root system: The portion of the plant axis produced by the root apical meristem
- primary root: Develops from the root apical meristem in germinating embryoseminal root from scutellar node iin first days of seedling growth
- tap root: Long straight primary root
- lateral root: A root developed from the pericycle in differentiated roots
- seminal root: The first formed root, developed from the radicle of the seed
- perennating organ: An outgrowth from a plant which gives rise to new plants
- swollen tap root: An enlarged primary root used for carbon storage
- tuber: A swollen underground stem with surface buds
- corm: Swollen underground internoded stem tissue covered in a layer of scales
- bulb: Underground reproductive structure consisting of a short stem and bearing fleshy swollen leaf bases, which encluse next years bud.
- stolon: A creeping plant stem ('runner') capable of producing a new individual plant
- rhizome: An underground horizontal stem, capable of producing roots and shoots
- adventitious root (shoot origin): Root structures arising from the stem at various stages of growth
- adventitious root (root origin): Root structures arising from the existing root structures at various stages of growth

Seed morphology:

- testa: The seed coat
- endosperm: Nutritious tissue surrounding the embryo
- hypocotyl/radicle axis: Structure from which the embryonic root and shoot develops
- cotyledon: Embryonic leaf
- scutellum: Modified cotyledon of the grass seed
- epicotyl: Part of the embryonic axis above the attachment point of the cotyledons
- coleoptile: Protective sheath surrounding the embryonic shoot
- hypcotyl: Part of the embryonic axis below the attachment point of the cotyledons
- radicle: The developed embryonic root, which emerges from the embryonic axis
- coleorhiza: The protective sheath surrounding the radicle

Fruit morphology (tissue types):

- exocarp: The fruits outer layer (skin). May also be termed the epicarp
- mesocarp: Layer of fleshy tissue inside the exocarp
- endocarp: The innermost layer of tissue surrounding the seeds
- pericarp: Fused exocarp, mesocarp and endocarp layers into a single layer in dry fruits

Fruit morphology (structure):

- aggregate: From many carpels on a single flower (eg. magnolia, blackberry)
- multiple: From carpels of many flowers fused together (eg. pinapple, mulberry)
- drupe: Ovarian derived fleshy tissue, hard endocarp, superior overy and single seeded (eg. cherry, olive, coconut)
- berry: Ovarian derived fleshy tissue, fleshy or slimy endocarp, usually many seeded (eg. tomato, grape, papper)
- hesperidium: Ovarian derived fleshy tissue, leathery outer layer containing oils (eg. orange, lemon)
- pepo: Ovarian derived fleshy tissue, with a thick rind without oils (eg. pumpkin, cucumber, watermelon)
- pome: Receptacle derived fleshy tissue (eg. apple, pear)
- follicle: Dry fruit, splits on maturity, seeds released through longitudinal seams, split occurs along one seam (eg. milkweed)
- legume: Dry fruit, splits on maturity, seeds released through longitudinal seams, split occurs along two seams and seeds on one half of the split ovary (eg. pea, peanuts)
- silique: Dry fruit, splits on maturity, seeds released through longitudinal seams, split occurs along two seams and seeds on a partition between overy halves (eg. mustard, radish)
- capsule: Dry fruit, splits on maturity, seeds released through pores or multiple seams (eg. poppy, lily)
- nut: Dry fruit, does not split, hard thick pericarp with a cup at the base (eg. acorn, chestnut)
- schizocarp: Dry fruit, does not split, soft thin pericarp, paired ovaries (eg. parsley, carrot)
- samara: Dry fruit, does not split, soft thin pericarp, single ovary, winged pericarp(eg. maple, elm)
- achene: Dry fruit, does not split, soft thin pericarp, single ovary, unwinged pericarp, seed attached to pericarp at the base only (eg. sunflower)
- caryopsis: Dry fruit, does not split, soft thin pericarp, single ovary, unwinged pericarp, seed fully attached to pericarp (eg. cereal grains)

4. Types of Lighting

This vocabulary describes the quality and nature of the light sources used in greenhouses and controlled growth rooms.

Greenhouses:

- 400w SON-T high pressure sodium lamps
- 400w SHP-T high pressure sodium lamps
- Mobile: 20 AgroSonT + 20 HPIT, fixed 9 SDWT
- 62 AgroSonT
- 9SDWT, 15 HPIT, 40 AgroSonT
- AgroSonT/HPIT

- 72 HPIT
- 70 HPIT

Controlled growth rooms:

- Daylight Delux 55w PLL
- Coolwhite Delux 55w PLL
- Warmwhite Delux 55w PLL
- Warmwhite 40w linear
- Coolwhite 40w linear
- Gro-lux 40w linear
- fluorescent tube (generic)
- AgroSonT + HPIT
- AgroSonT
- MTW

Light supplements:

- Tungsten

5. Types of Growth Medium

This vocabulary describes the medium in which plants are grown.

- Field soil
- John Innes 1 compost
- John Innes 2 compost
- John Innes 3 compost
- Levingtons Universal potting compost
- Levingtons Universal Extra potting compost
- Levingtons F1 potting compost
- Levingtons M1 potting compost
- Levingtons M2 potting compost
- Cactus compost (sand/peat/grit)
- Orchid compost (bark/moss)
- Perlite – Fine
- Perlite – Course
- Vermiculite
- Hydroponics
- GS 90 soil with vermiculite 1:1 (v/v)
- GS 90 soil with quartz sand 2:1 (v/v)
- Einheitserde P type

- Agar

6. Types of Container

This vocabulary describes the containers in which plants are grown and stored. All measurements are in millimeters.

- standard simple tray (244 x 368 x 50)
- half simple tray (170 x 229 x 50)
- large tray (350 x 450 x 50)
- small tray (280 x 470 x 50)
- tray 24 inserts (50 x 48 x 52)
- modular standard tray 24 inserts (50 x 50 x 50 per insert)
- modular standard tray 15 inserts (76 x 76 x 50 per insert)
- square plastic pot (100 x 100 x 110)
- square plastic pot (100 x 100 x 110) covered in plastic mesh
- round organic pot (diameter by inch)
- round plastic pot (diameter by inch)
- round plastic pot (diameter by cm)
- field plot
- Eppendorf 0.5 ml
- Eppendorf 1.5 ml
- Eppendorf 2.0 ml
- Eppendorf 2.2 ml
- glass vial with metal lid
- aluminium foil packet
- paper envelope
- wax paper envelope

7. References

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