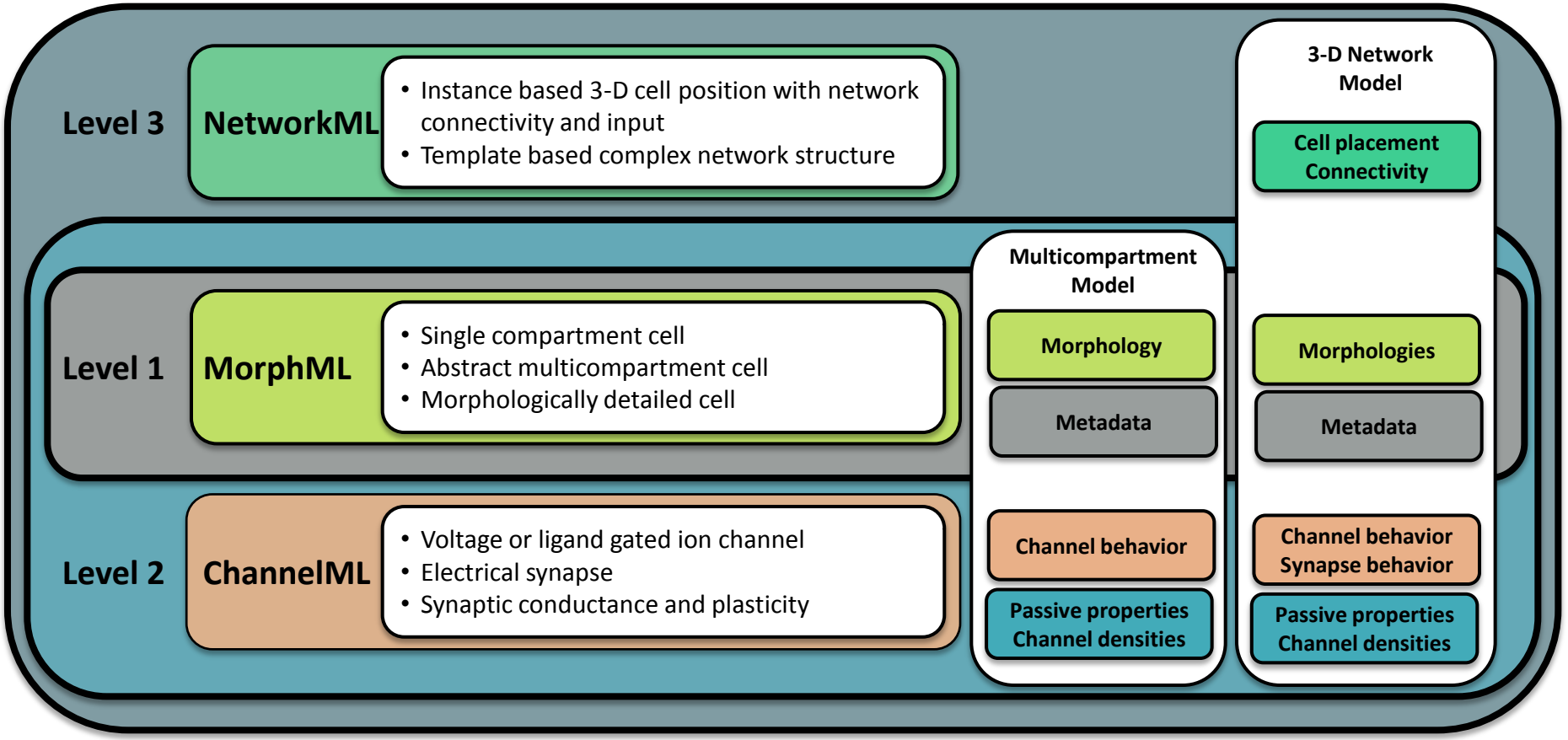
NeuroML 2.0: Morphology

Structure of NeuroML



```
<segment id ="0" name="Soma">    <!-- name is optional-->
    <!-- no parent => root segment -->
    <proximal x="0" y="0" z="0" diameter="10"/>
    <distal x="10" y="0" z="0" diameter="10"/>
</segment>

<segment id ="1" name="MainDendrite1" >
    <parent segment="0"/>
    <!-- Same proximal 3D point as parent but different diameter -->
    <proximal x="10" y="0" z="0" diameter="3"/>
    <distal x="20" y="0" z="0" diameter="3"/>
</segment>

<segment id ="2" name="MainDendrite2">
    <parent segment="1"/>
    <!-- no proximal => use distal (including diameter) of parent -->
    <distal x="30" y="0" z="0" diameter="1"/>
</segment>

<segment id ="3" name="Spine" >
    <!-- Electrically connected to point 0.5 along parent -->
    <parent segment="2" fractionAlong="0.5"/>
    <proximal x="25" y="0" z="0" diameter="0.2"/>
    <distal x="25" y="1" z="0" diameter="0.2"/>
</segment>
```

```
<segmentGroup id="soma_group" neuroLexId="sao1044911821">    <!-- Reserved/special name of a group -->
    <member segment="0"/>
</segmentGroup>

<segmentGroup id="thick_dendrites">
    <member segment="1"/>
    <member segment="2"/>
</segmentGroup>


<!-- The NeuroLex reference points to the concept of a spine -->
<segmentGroup id="spines" neuroLexId="sao1145756102">
    <member segment="3"/>
</segmentGroup>


<segmentGroup id="dendrite_group" neuroLexId="sao1211023249">     <!-- Reserved/special name of a group -->
    <include segmentGroup="thick_dendrites"/>
    <include segmentGroup="spines"/>
    <!-- <exclude ...> could be present here -->
</segmentGroup>
```

```
<segmentGroup id="middle">
    <path>
        <from segment="1"/>
        <to segment="2"/>
    </path>
</segmentGroup>

<segmentGroup id="tip">
    <subTree>
        <from segment="1"/>
    </subTree>
</segmentGroup>
```

```
<cell id="SpikingCell" metaid="HippoCA1Cell">

    <notes>A Simple Spiking cell for testing purposes</notes>

    <!-- Suggestion for annotation scheme based on reference to MIRIAM resource -->
    <annotation>
        <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:bqbiol="http://biomodels.net/biology-qualifiers/">
          <rdf:Description rdf:about="HippoCA1Cell">
            <bqbiol:isVersionOf>
              <rdf:Bag>
                <!-- This cell model is a version of a hippocampal CA1 pyramidal cell -->
                <rdf:li rdf:resource="urn:miriam:neurondb:258"/>
              </rdf:Bag>
            </bqbiol:isVersionOf>
          </rdf:Description>
        </rdf:RDF>
    </annotation>
```

NeuronDB

Back

User: Public

CA1 pyramidal neuron

Mode: **Overview** Data/Search plus Connectivity plus Classical References/Notes Models BrainPharm

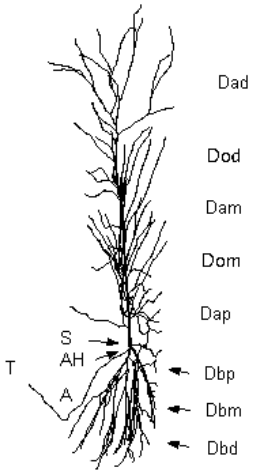
Region: Distal apical dendrite | Middle apical dendrite | Proximal apical dendrite | Distal oblique dendrite | Middle oblique dendrite | Distal basal dendrite | Middle basal dendrite | Proximal basal dendrite | Soma | Axon hillock | Axon fiber | Axon terminal | All Compartments

Properities: Receptors Channels Transmitters **All Properties**

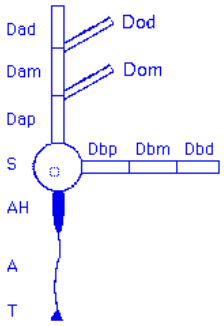
Interoperation: Gene and Chromosome Experimental Data (neurodatabase.org) Microscopy Data (CCDB)

Neuron Type: principal

Organism: Vertebrates



1. Distal apical dendrite
2. Middle apical dendrite
3. Proximal apical dendrite
4. Distal oblique dendrite
5. Middle oblique dendrite
6. Distal basal dendrite
7. Middle basal dendrite
8. Proximal basal dendrite
9. Soma
10. Axon
11. Axon hillock
12. Axon fiber
13. Axon terminal



Key: Region: D, dendrite; S, soma (cell body); AH, axon hillock-initial segment of the axon; A, axon; T, axon terminal. Type of dendrite: e, equivalent cylinder (for single dendrites and multipolar trees); a, apical; b, basal; o, oblique. Level of dendrite: (p) proximal, (m) middle, and (d) distal with respect to the cell body. For further explanations, see canonical representations.

Graphic from:GM Shepherd, Synaptic Organization of the Brain, New York: Oxford University Press 1978.

Legacy Elements:

sphere, polygon, polyhedron, path, manifold

Used to define:

Features -- fiducials or other anatomical features

cellBody -- detailed anatomical representation of soma for visualization

Also:

Spines: based on *segment* with optional *length*, *volume* and *shape* elements

Questions?

```
<xs:complexType name="Morphology">
    <xs:annotation>
        <xs:documentation>Standalone element which is usually inside a single cell, but could be outside and
                          referenced by id.</xs:documentation>
    </xs:annotation>

    <xs:complexContent>

        <xs:extension base="Standalone">

            <xs:sequence>
                <xs:element name="segment" type="Segment" maxOccurs="unbounded"/>
                <xs:element name="segmentGroup" type="SegmentGroup" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>

        </xs:extension>
    </xs:complexContent>
</xs:complexType>
```

```
<xs:complexType name="Point3DWithDiam">
    <xs:annotation>
        <xs:documentation>A 3D point with diameter.</xs:documentation>
    </xs:annotation>
    <xs:attribute name="x" type="xs:double" use="required"/>
    <xs:attribute name="y" type="xs:double" use="required"/>
    <xs:attribute name="z" type="xs:double" use="required"/>
    <xs:attribute name="diameter" type="xs:double" use="required"/>
</xs:complexType>
```

```
<xs:complexType name="Segment">
    <xs:complexContent>
        <xs:extension base="Base">

            <xs:sequence>
                <xs:element name="parent" type="SegmentParent" minOccurs="0"/>
                <xs:element name="proximal" type="Point3DWithDiam" minOccurs="0"/>
                <xs:element name="distal" type="Point3DWithDiam" minOccurs="1"/>
            </xs:sequence>

            <!-- TODO: Do we want to do away with numerical ids and just use unique strings/names in id attribute?? -->
            <!--<xs:attribute name="id" type="SegmentId" use="required"/>-->
            <xs:attribute name="name" type="xs:string" use="required"/>

        </xs:extension>
    </xs:complexContent>

</xs:complexType>

<xs:complexType name="SegmentParent">
    <xs:attribute name="segment" type="SegmentId" use="required"/>
    <xs:attribute name="fractionAlong" type="ZeroToOne" use="optional" default="1"/>
</xs:complexType>
```

```
<xs:complexType name="SegmentGroup">
    <xs:complexContent>
        <xs:extension base="Base">

            <xs:sequence>
                <xs:element name="member" type="Member" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="include" type="Include" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="path" type="Path" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="subTree" type="SubTree" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>

        </xs:extension>
    </xs:complexContent>
</xs:complexType>
```

```
<xs:complexType name="Member">
    <xs:attribute name="segment" type="SegmentId" use="required"/>
</xs:complexType>

<xs:complexType name="Include">
    <xs:attribute name="segmentGroup" type="NmlId" use="required"/>
</xs:complexType>

<xs:complexType name="Path">
    <xs:sequence>
        <xs:element name="from" type="SegmentEndPoint" minOccurs="0"/>
        <xs:element name="to" type="SegmentEndPoint" minOccurs="0"/>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="SubTree">
    <xs:choice>
        <xs:element name="from" type="SegmentEndPoint" minOccurs="0"/>
        <xs:element name="to" type="SegmentEndPoint" minOccurs="0"/>
    </xs:choice>
</xs:complexType>

<xs:complexType name="SegmentEndPoint">
    <xs:attribute name="segment" type="SegmentId" use="required"/>
</xs:complexType>
```