A Guide on Modelling Synapses in CellBlender and MCell

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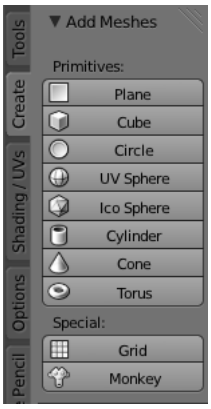
Abstract

1 Pre- and Postsynaptic Genomtry with Blender

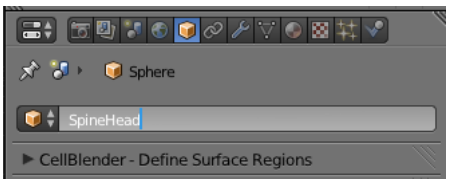
This section follows the paper written by Czech et. al. closely.

1.1 Creating a Spine Head

1. Open Blender. In the '3D View' pane, delete the default object (shortcut: x)
2. Create a sphere. Select the 'UV Sphere' option from the sidebar. Below a pane called 'Add Circle' appears; set 'Segments' and 'Rings' to 16, 'Radius to '0.25'.



3. Rename the sphere. Double-click the entry box below to change the default name to 'SpineHead'.



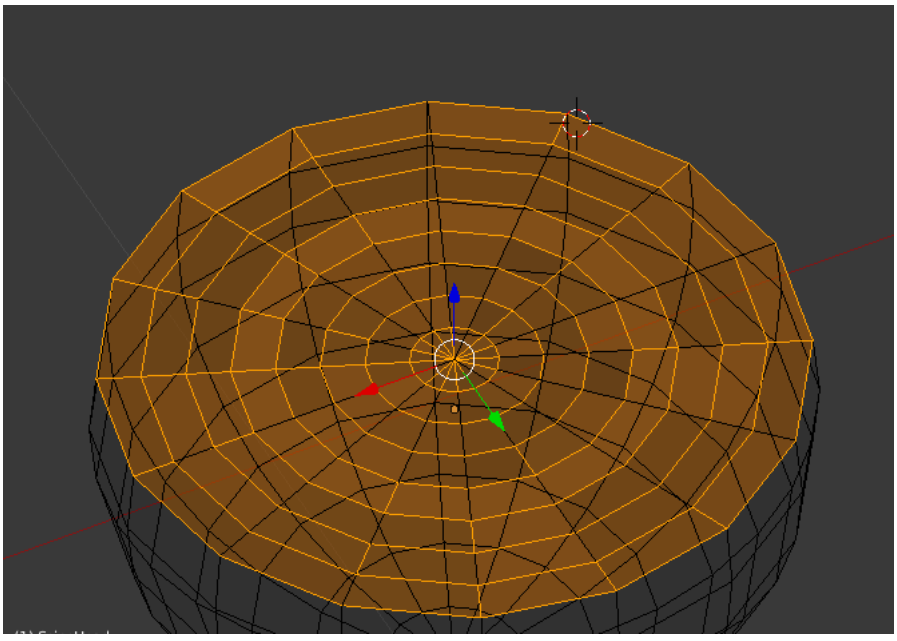
4. Change view to see the sphere from the 'Front' view. (shortcut: 1 on numpad)
5. Deselect the sphere (shortcut: a) and make it transparent (shortcut: z)
6. Select the vertices to be removed. First, switch from 'Object Mode' to 'Edit Mode'. Ensure that 'Edge select' is enabled. Then use box select (shortcut: b) to capture only the faces that make up the top half of the sphere. Delete these faces (shortcut: x) and select the 'Faces' option in the delete menu.

7. Close the opening. Select the topmost vertices (remaining in 'Edge select' mode) using box select (shortcut: b). Then, extrude (shortcut: e) and click 'Edges Only' under 'Extrude' in 'Mesh Tools'.

Set the extrude distance by pressing 0 and Enter to confirm. Scale the extrusion by pressing s, 0 and Enter to confirm. Select 'Remove Doubles' under 'Mesh Tools' to remove the duplicated vertices and reconnect the triangles. Blender should note that you remove 15 vertices as a result.

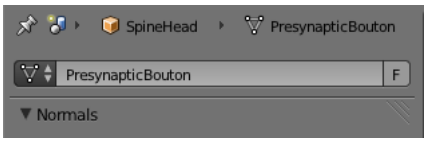
The object should now be closed by a flat top.

8. Subdivide triangles at the top. Unfortunately the 'Multicut tool' has been deprecated. To create set of concentric rings, first select the topmost vertices (shortcut: b). Then enter 'Knife' mode (shortcut: k), and hold down *control*. This locks the knife cut to the midpoint. Click around to make a circle cut, and then press *Enter* to complete the cut. Continue these cuts until the picture looks as below:

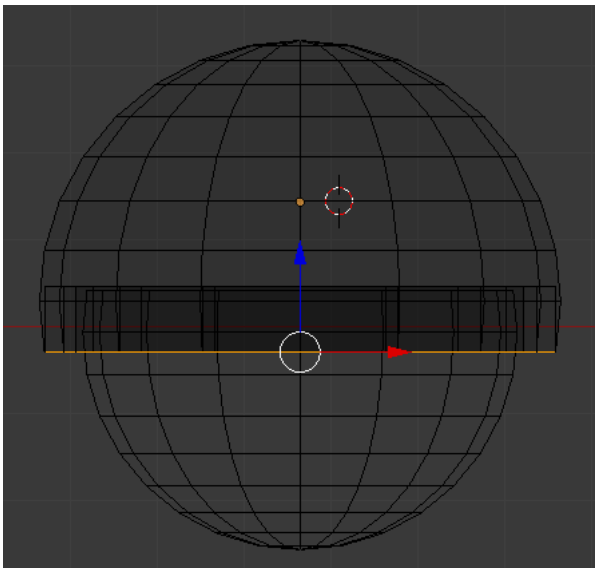


1.2 Creating a presynaptic bouton

1. Duplicate the *spine.blend* file as *bouton.blend*. in *bouton.blend* deselect all (shortcut: a).
2. Duplicate the spine head and rotate. First, switch to 'Front' view (shortcut: 1 on numpad). Duplicate (shortcut: Shift-d, Enter) and rotate 180 degrees (shortcut: r, 180, Enter). To separate the selection of the spine heads, press p and click 'Selection'.
3. Rename the item. Switch to 'Object Mode' (shortcut: Tab) and edit the name field to 'PresynapticBouton'.



4. Shift and scale the bouton. Grab the object (shortcut: g), constrain movement to the z-axis (shortcut: z) and type 0.15, *Enter* to move the object. Scale the object to be 20% larger by typing s, 1.2, *Enter*.
5. Creating the invagination. Switch to 'Edit Mode' (shortcut: Tab) and deselect everything (shortcut: a). Select the lowermost vertices (see below) and perform the 'Select Less' operation (shortcut: Control-Minus on numpad). Click the 'Extrude Region' button under 'Add' in 'Tools', press z to constrain, and type -0.075 to extrude it upwards.



1.3 Adding Axonal and Dendritic Extensions

1. Enter 'Edit Mode' (shortcut: Tab), and switch view to front (shortcut: 1 on numpad)
2. Zoom in on the top of the vertex. Select the vertex by right-clicking on it, ensuring that 'Vertex mode' selection is enabled. Perform two 'Select More' operations (shortcut: Control-Plus on numpad) until two rings are highlighted. Press x, select 'Faces' on the menu (

Enter to confirm). Press b and select the vertices on the top edge using 'Box select'. Press e, click on 'Edges Only' in 'Tools' (left pane), then type z, 3.0, *Enter*. This should produce an axon on the presynaptic bouton.

3. Select the spine head. Hit *Tab* to enter 'Object Mode' and right click the spine head (the bottom half-sphere) to select it. *Tab* back into 'Edit Mode'

4. Create a cylindrical spine on the spine head. As in the earlier step, select the bottom vertex, perform two 'Select More' operations, press x and select 'Faces' on the 'Erase' menu. Hit b and select the vertices that line the hole in the bottom. Press e, select 'Edges Only' in 'Tools', press z, type -2.0, *Enter*.