Levels of Modeling Olfactory Cortex

1. Granger-Lynch model: very abstract.
   - Misses a lot of the anatomy and physiology; makes many assumptions.
   - Model actually does something interesting: learns to discriminate among odors.
2. Wilson-Bower model: closer to real biology.
   - Reproduces more of the real neurophysiology, including 40 Hz oscillations.
   - Hard to get the model to do much information processing.
3. Freeman-Baird model: larger scale phenomena.
   - Role of chaos and oscillations in olfactory bulb.
   - Yet another associative memory.

Olfactory Cortex

- Olfactory (piriform) cortex is also called *paleocortex*.
- Parallel phylogenetic development to hippocampus (*archicortex*).
- Early, primitive brain areas found in amphibians and reptiles as well as mammals.
- Generally three-layered structure in mammals.
- The six-layered *neocortex* is present only in mammals.

Some Numbers

- 50×10^6 olfactory sensory neurons enter the bulb, arranged into 2,000 glomeruli.
- 50,000 mitral cells, 100,000 tufted cells.
- Roughly 1 million periglomerular cells.
- Roughly 2.5 to 5 million granule cells.
- Roughly 50,000 short axon cells.

Short-Axon Cells

- Found in glomerular and granule cell layers.
- Come in a variety of types:
  - Blanes' cell
  - Clandins' cell
  - Golgi cell
  - Hensen's cell
  - Schwann cell
  - van Gehuchten cell
- Excitatory connections onto granule cell spines.

Granule Cells

- Inhibitory interneurons without axons. Lots of spines.
- Superficial granule cells control superficial and middle tufted cells.
- Deep granule cells control mitral cells.
- A third population interacts with both tufted and mitral cells.
- Granule cells receive input from:
    - tufted/mitral cells, via dendrodendritic synapses.
    - centrifugal axons from thalamus, limbic system, basal forebrain, midbrain.
- Only output is onto the dendrites of tufted/mitral cells.
- Hence, these must be powerful synapses.

Periglomerular Cells

- Inhibitory neurons that surround the glomerulus.
- These are *short-axon cells:* axons don't leave the glomerulus.
- Receive some input from olfactory sensory neurons.
- Also receive input from mitral/tufted cells via reciprocal dendrodendritic synapses.
- Reciprocal synapses provide inhibition to mitral and tufted cells.
- The *synaptic triad:* input fiber, principal neuron, and intrinsic neuron.
- Axons also make inhibitory connections within the glomerulus.

Mitral and Tufted Cells

- These are the principal cells of the olfactory bulb.
- Receive input from olfactory sensory neurons.
- Receive excitatory input from recurrent collaterals.
- Receive inhibition from other cell types in the bulb.
- Project via the Lateral Olfactory Tract to the olfactory (piriform) cortex.
- Multiple parallel outputs within the main olfactory pathway:
    - Mitral = diffuse projection
    - Tufted = specific projection
    - Modified glomerular complex: separate pathway for odor cues related to suckling infants.
    - Vomeronasal-accessory pathway implicated in mating behavior.

Basic Circuitry of the Bulb

- Input: about 50×10^6 axons (rabbit) from olfactory sensory neurons.
- OSN axons are wrapped together in bundles, surrounded by Schwann cell mesaxon. Ephatic coupling is possible via K^+ extruded during action potentials.
- Principal cells of the bulb: tufted and mitral cells.
- Periglomerular cells: inhibitory neurons that surround the glomerulus.
- Granule cells: no axons, only dendrites. Inhibitory.
- Short-axon cells: found in glomerular and granule cell layers.
- Centrifugal inputs to the bulb: synapses from various other brain areas onto granule cells, and some periglomerular cells.
- Output of the bulb: axons of tufted/mitral cells form the Lateral Olfactory Tract that projects to olfactory cortex.

Basic Anatomy

- The olfactory system is, on an evolutionary scale, a very old part of the vertebrate nervous system.
- The olfactory bulb is an outgrowth of the forebrain.
- The bulb receives input from olfactory sensory neurons and projects to olfactory (piriform) cortex.
- The bulb is organized into structures called glomeruli, analogous to minicolumns in visual cortex or barrels in somatosensory cortex.

glo-mer-u-lus *n.* **1.** A tuft of capillaries situated at the origin of a vertebrate kidney. **2.** The twisted secretory portion of a sweat gland. [New Latin, GLOMERULE.]

glo-mer-ule *n.* **1.** *Botany.* A compact cluster of flowers. **2.** Anatomy. A glomerulus. [New Latin *glomerulus,* from Latin *glomus* (stem *glomer-*), ball.]

mi-ter *n.* Also *chiefly British* **mi-tre**. **1.** A tall, pointed hat with peaks in front and back, worn by bishops and some other ecclesiastics.

Olfactory Bulb and Piriform Cortex

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COMPUTATIONAL MODELS OF NEURAL SYSTEMS

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