

Adobe® Illustrator® CS5 How-To Guide

Myasthenia Gravis at the Neuromuscular Junction

by Mark M. Miller

From his home outside Kansas City, Missouri, Mark M. Miller runs a medical illustration business that caters to a variety of national and international clients, and depicts a wide range of medical, biological, scientific, and veterinary subjects. From textbook illustration to online medical resources, Mark creates visually amazing instructional materials in line, tone, and color, using both traditional media and his Mac.

An early interest in both art and medicine led Mark to combine a BFA in Fine Art with an MA from the Department of Art as Applied to Medicine at the Johns Hopkins University School of Medicine, where he subsequently held a faculty position for a number of years. Upon settling in Missouri, Mark's business has grown and he can be found hard at work in his attic office when he's not casting custom concrete rocks on his property or taking a break at the pub. Laughing, Mark told us that his experience sculpting and casting prosthetic ears and eyes is coming in handy with his new landscaping project.

What is Myasthenia Gravis?

Myasthenia gravis is a chronic autoimmune disease that causes varying degrees of weakness of the skeletal muscles of the body.

This artwork depicts a microscopic view of a neuromuscular junction, where the long arm (the axon) of a single nerve cell comes into contact with a muscle cell.

Normally, when a nerve impulse travels down the axon of the neuron, it releases a chemical called acetylcholine at this junction. The chemical moves across the open space and attaches to receptors in the muscle cell membrane. These receptors, having received this chemical signal, now open a channel which allows sodium to flow into the muscle cell. The sodium then triggers muscle contraction.

With MG, antibodies attach to these receptors, blocking the acetylcholine, thus the signal is not relayed to the muscle and the muscle can't contract.

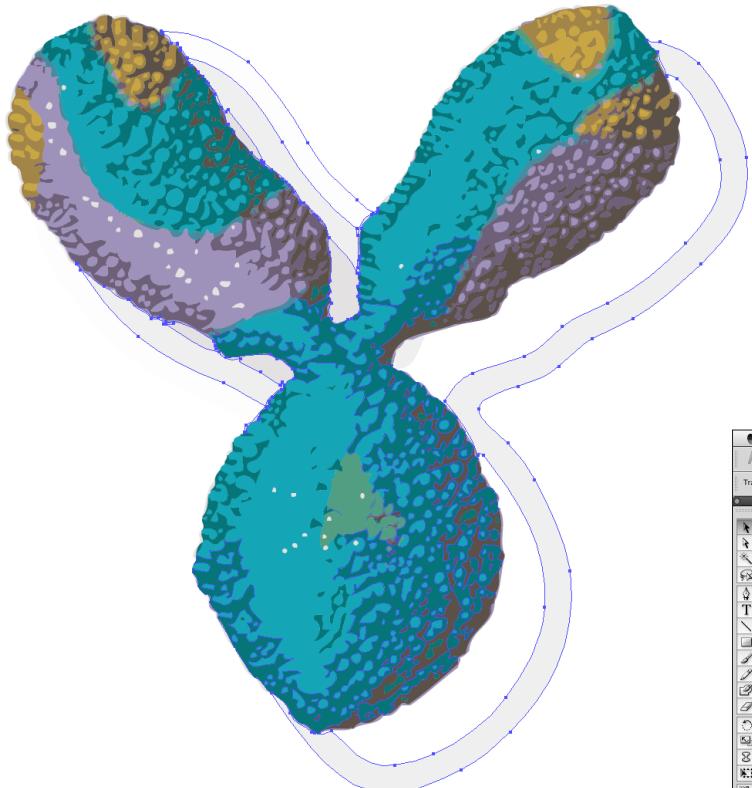
How I work

For me, illustration begins with a love of science. It excites me that with each new project I have an opportunity to pass on a little of my passion to the audience.

The way I work depends upon the subject. If it's a straight-forward anatomical drawing, then I jump right into the sketch with pencil on paper after reviewing the subject through various texts that I have in my office. If it's a subject requiring more creativity such as an editorial illustration, then it works best if I allow a few days to ruminate on the subject, letting the best concepts arise spontaneously.

For this project I wanted to focus on subcellular or molecular processes because these are excellent subjects for Adobe Illustrator. Highly complex organic molecules can be reduced to their visual essence to make complex interactions easy to appreciate and understand. Using vectors, the elements in the art can be easily manipulated and used repeatedly, speeding the creation process.

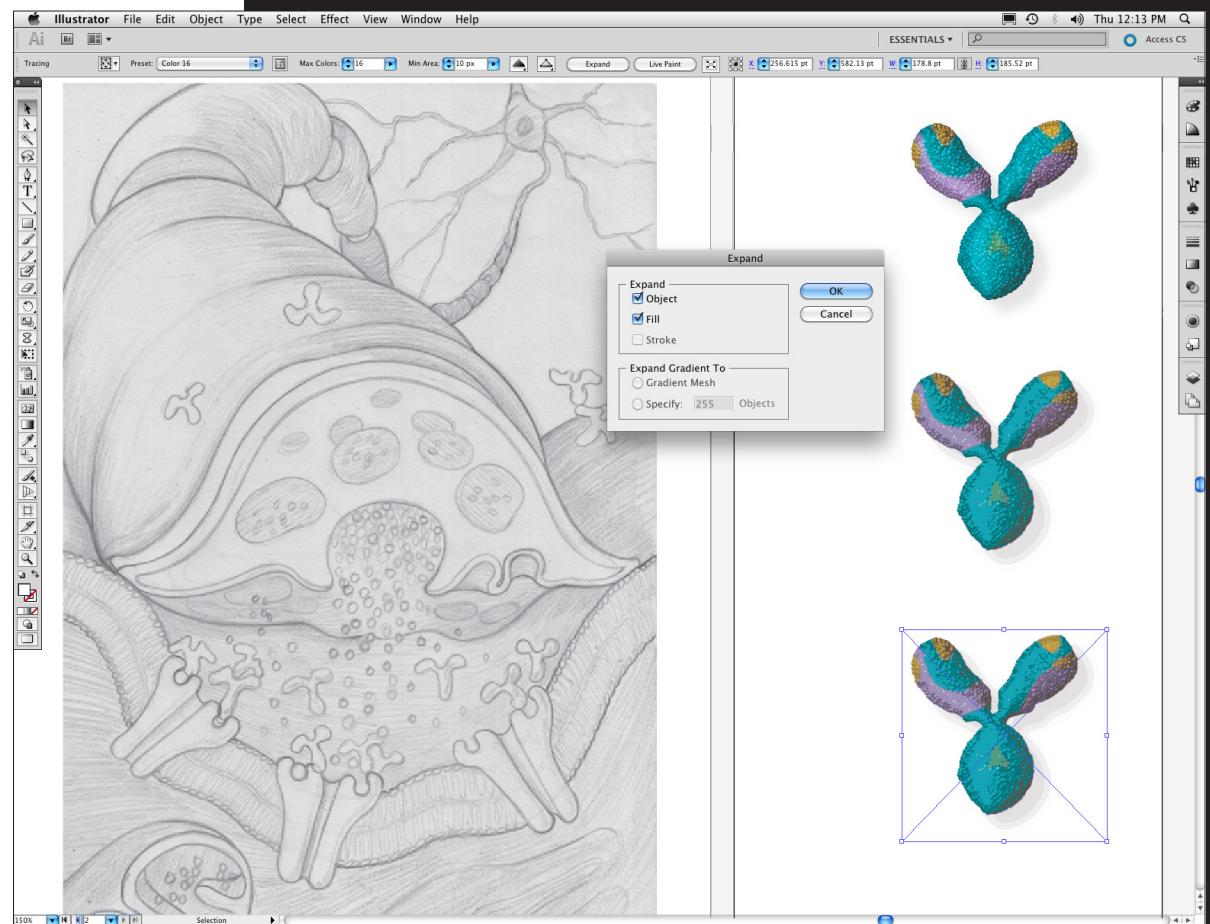




Getting started with antibodies

I first scanned my rough sketch, then placed it on a new Illustrator artboard, using a separate artboard for the creation of complex elements such as these antibody molecules.

For the antibodies, I imported raster art from another project. In Illustrator, I used Live Trace with the "Color 16" preset to create vectors for a single molecule. I expanded and ungrouped the artwork to get rid of cast shadows, and used the Eraser tool to clean up the perimeter of the shape.

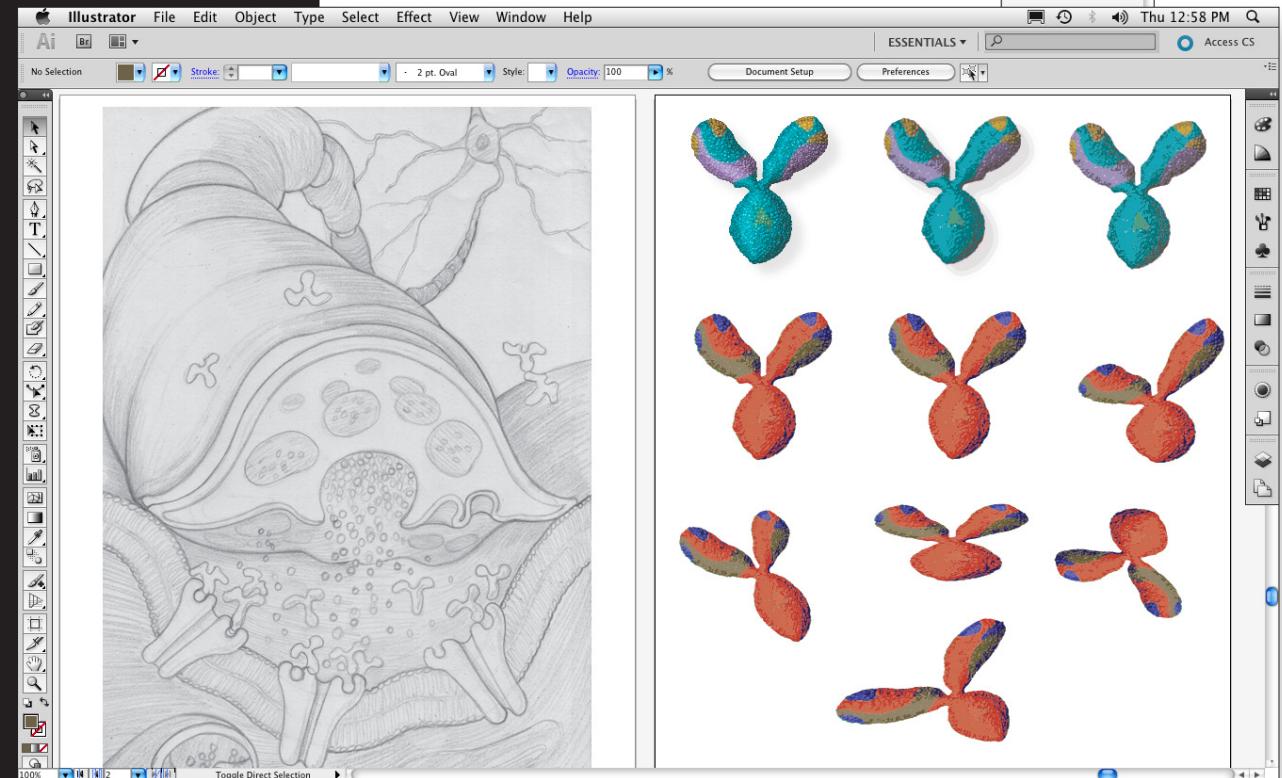


"My primary goal as a medical illustrator is simple, and that is to teach. An aesthetically pleasing medical illustration is a failure if it doesn't portray the science in an accurate and understandable manner.

However, that's not to say that a medical or scientific illustration can't be both beautiful and effectively instructional—this is what I strive for."

For color variations I used Live Color, messing around in the Recolor Art panel to change the entire scheme of the colors all at once.

Then I used the Free Transform tool to change the antibody shapes and the Illustrator 3D Effects to rotate the shapes in perspective. I saved a variety of differently-shaped and distorted antibodies to use later.



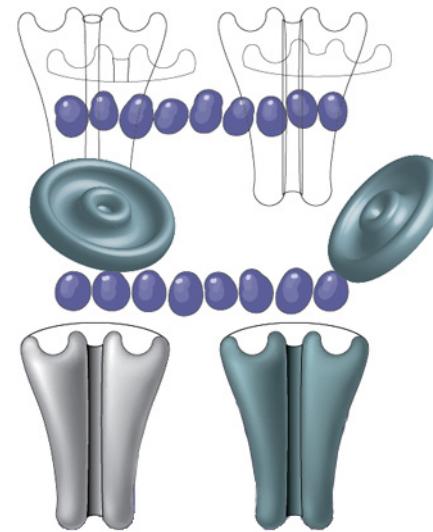
Receptor molecules

Next up was to create receptor molecule shapes. The new Shape Builder tool turned out to be the perfect way to join and remove areas to create the wrench-like shapes that represent the halves of the receptor molecule.

I started by drawing a thick vertical line using the Line Segment tool, with a width of 60 points and with rounded ends. I used the new Width tool to modify the line to vary the stroke width and make more of a teardrop shape. I drew one large circle on top and two more congruent circles, using Smart Guides to align them with the other shapes. I then united the shapes to create a single shape that looks somewhat like a wrench.

It was then easy to rotate and reflect the shapes to make the other side and create the connecting shapes using ellipses and the Shape Builder tool.

I created the green surfaces using the Mesh tool, going for a 3D look on the two wrench shapes, with a highlight, a shadow, and reflected light. I filled the central channel with a linear gradient.



Science:

Receptor molecules rest in the cell membrane with one end outside the cell and the other on the inside. They act as gates to selectively allow, or disallow, certain other molecules to enter the muscle cell.

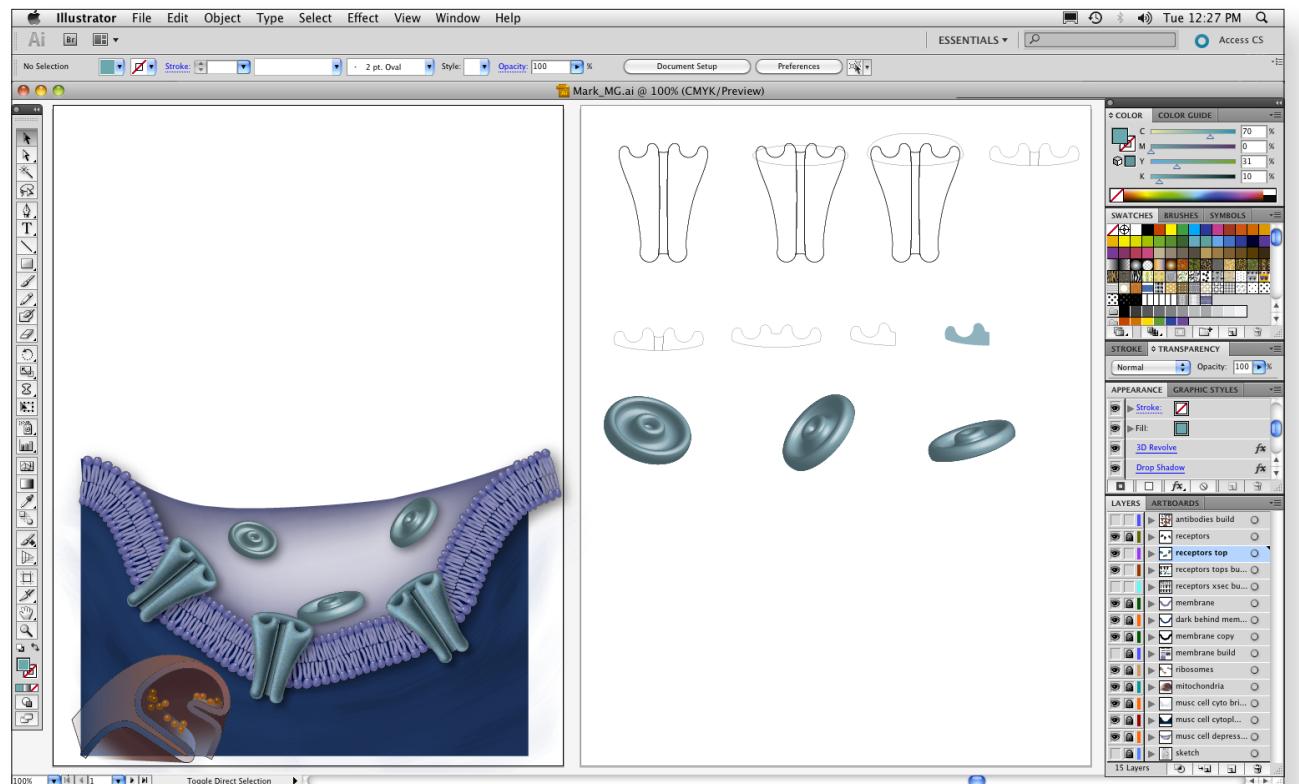
Receptor molecule tops

These are the green button-looking shapes sitting on top of the muscle cell membrane surface.

I started by creating an oval at the top of the receptor cell objects for reference, sizing it to encircle the parts that I wanted to show above the membrane. I used the Shape Builder tool to trim away the parts I didn't want.

Using the 3D effects tools in Illustrator, I revolved the shapes to create the 3D disk objects.

I finished the receptor tops off by applying a drop shadow effect to each of them and positioning them on the muscle cell membrane surface.



Membrane molecules

For the muscle membrane cross-section, I created the closely set series of molecules. I started with the Blob Brush tool, using it to make two rows of organic blob shapes, nudging them close together and aligning them to the edges of a box used as a guide.

I created a 3-color radial gradient for each of the blob "heads" and positioned the highlight at the upper left corner.

For the "legs" of the molecule I used a 9-point round calligraphic brush and drew two legs per head. I did this in Draw Behind mode.

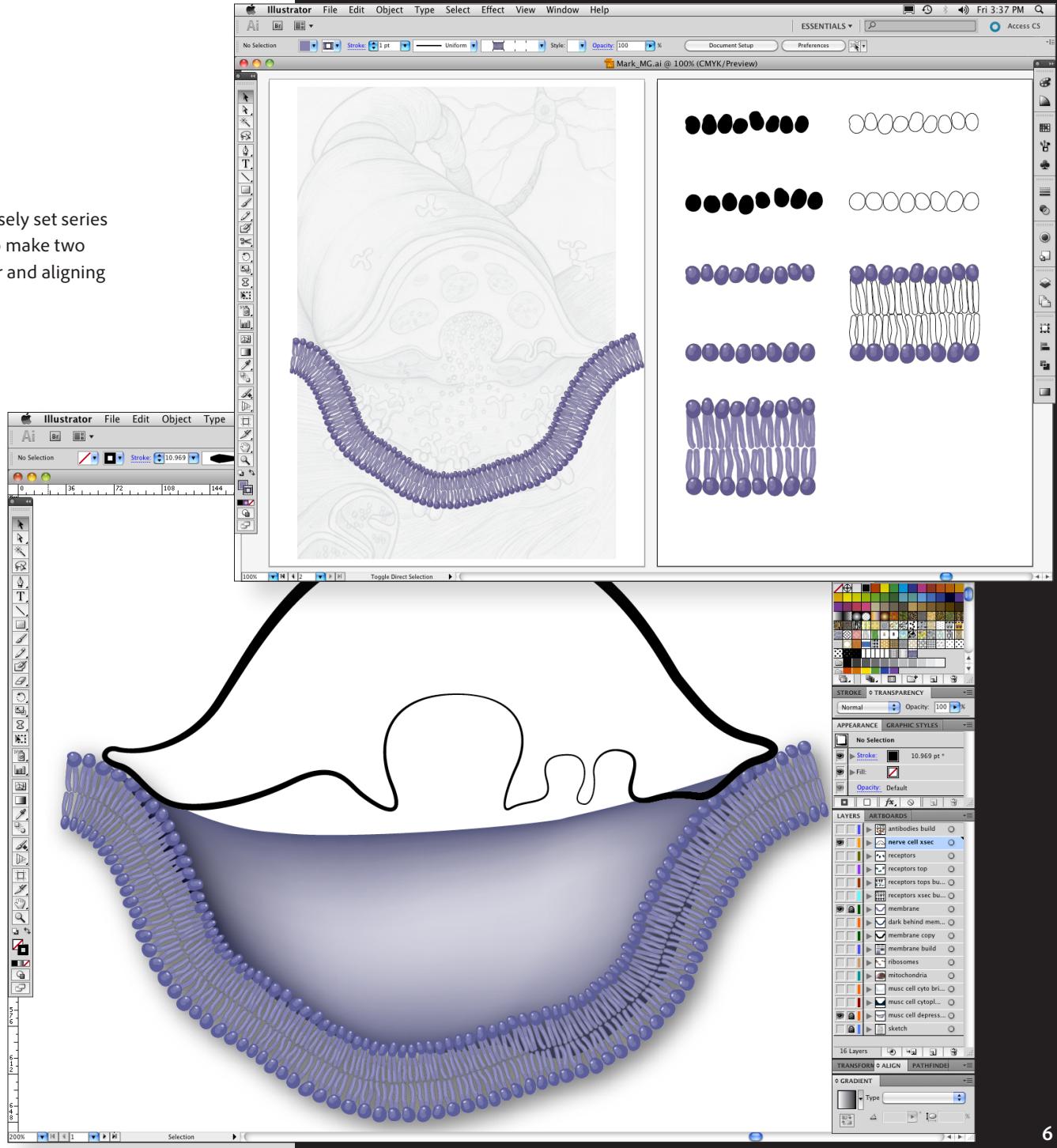
I colored the legs with a subtle highlight using the pencil tool and added a tint of purple color.

To easily duplicate the molecules, I defined the group of 18 heads and legs as a pattern swatch. I created a pattern brush with it and stroked it along a path drawn with the pen tool to create the cell membrane, scaling the pattern to fit.

To set off the membrane, I backed it with a solid dark blue shape to contrast against the membrane legs, and I finished by adding a drop shadow effect to the entire membrane.

Science:

Cell membranes have a classic, well-defined structure, with molecular "heads" on the outside of the membrane, and leg-like molecules on the interior.



Science:

A cell is like a bag filled with fluid. The bag itself is the membrane and the fluid is called cytoplasm.

Muscle cell cytoplasm

On a layer beneath the membrane and receptor layers, I made a shape using the Pen tool and filled it with a dark blue color. This layer was duplicated and set to 25% transparency for use later to modulate the appearance of the cytoplasm.

Using the Bristle Brush shape of a flat fan, I made large strokes with a slight tint of the blue to give the cytoplasm a painterly, organic feel.

Membrane depression

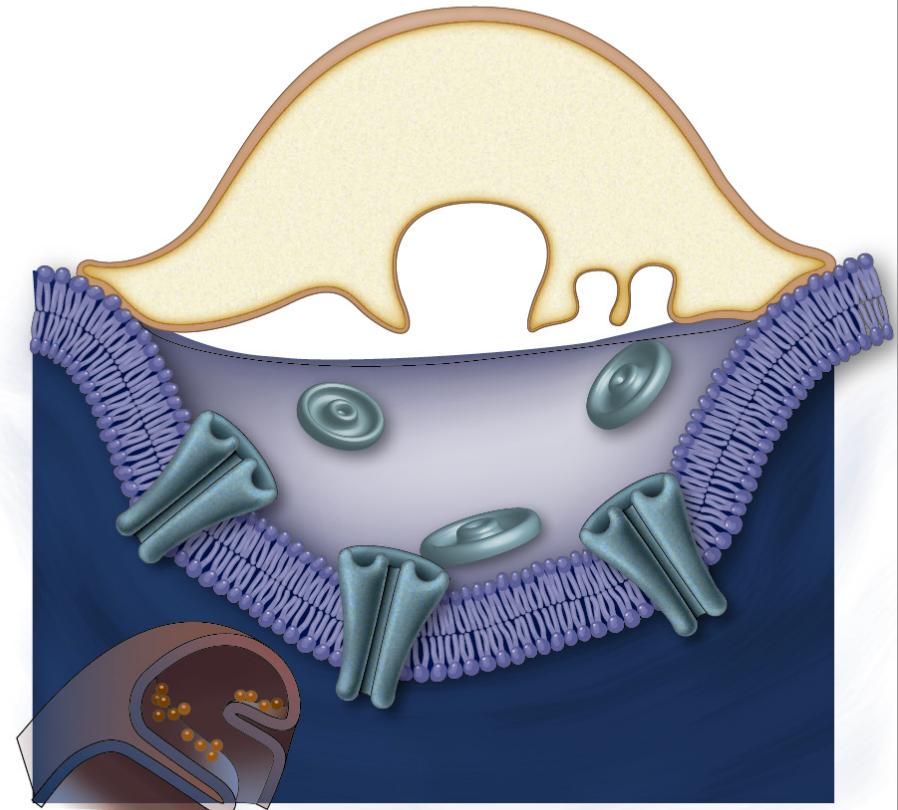
For the lighter colored dished area, I drew a shape and filled it with purple. Using the Mesh tool, I created a gradient mesh to modulate the surface and adjusted the mesh manually to get the look of dimension.

Mitochondrion

The mitochondrion in the lower left corner was drawn with the Pen tool and objects cut out using the Shape Builder tool. I added linear gradients with the transparency of each gradient adjusted to help the mitochondrion blend into the blue background.

Science:

The part of the muscle cell membrane where the nerve cell axon attaches is a slight depression, or cleft. Chemicals, called neurotransmitters, flow from the nerve cell to the muscle cell through this cleft



Science:

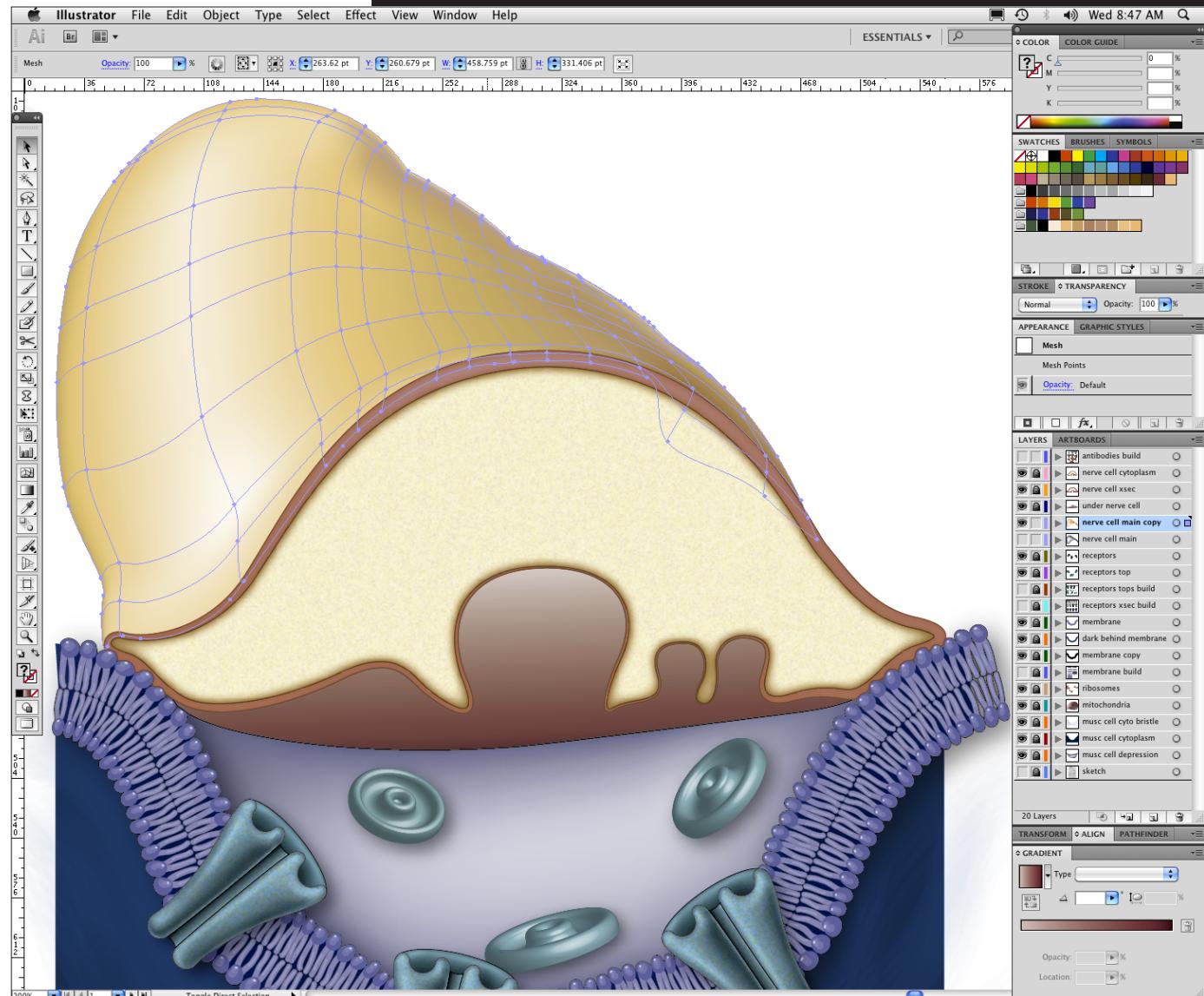
A mitochondrion is an organelle that provides energy for the cell.

Neuron, the nerve cell

For the neuron membrane, I drew a path with the Pen tool, using my sketch as an approximate guide. I used the Width tool to modulate the width of the edge to give it a more organic shape.

I gave the neuron membrane a dark yellow fill, added an inner glow effect, and deepened the color to a brown. I then duplicated the membrane to create a shape for the inside of the nerve cell, giving this a light yellow fill and three effects: two inner glows and one grainy, clumped texture.

For the outside of the nerve cell, I created a gradient mesh, added mesh points and adjusted the gradients to give the nerve a 3D volume. I repeated this for each of the neuron axon segments as they appear to move away into the distance.



"I really enjoyed the Shape Builder tool, which is intuitive and very useful in creating complex objects out of simple shapes."

Far background

I drew the neuron body in the far background at the upper right using the Pen tool. For the dendrites (the spidery legs), I used a pressure-sensitive brush first, then hand stroked the paths and joined the branches together.

The background gradient from yellowish at left to deep blue at right was created on a couple of layers and has the texture of an artistic sponge. One Illustrator feature that was important for this area was Recolor Artwork, which I used to change the color of all the background layers at once to get a richer, cooler shade.

Foreground elements

The foreground contains a number of different molecular elements. These are the endosomes, which are the orange ellipses inside the neuron. They contain acetylcholine, represented by small orange spheres. Due to their small size, I created these by stacking a few successively smaller, tinted spheres on each other rather than using gradients. I then made the spheres into a symbol and used the Symbol Sprayer tool to spray them into the gap between the cells and into the larger endosomes.

I then duplicated the antibodies presented earlier in this guide and placed them where I wanted them; rotating, resizing, and adjusting their transparency.

For the last step, I added the arrows and used the new arrowhead controls in the Strokes panel to scale the arrowheads quickly and position them to finish off the composition.

Myasthenia Gravis at the Neuromuscular Junction
was commissioned by Adobe and
created using Adobe Illustrator CS5.

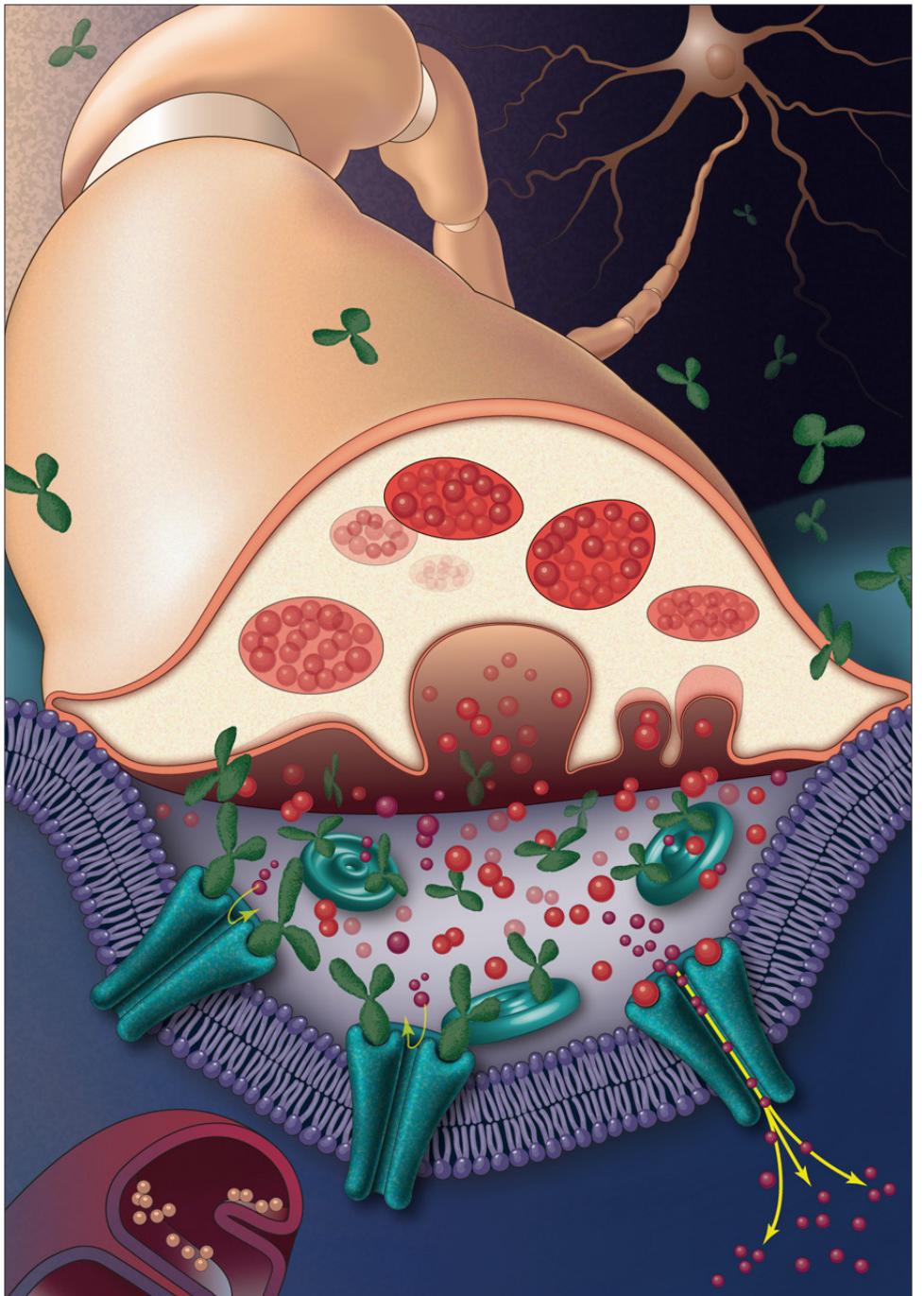
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