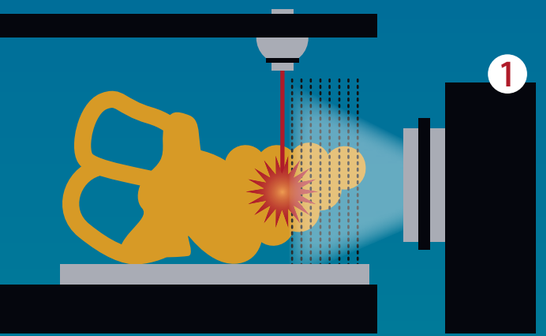
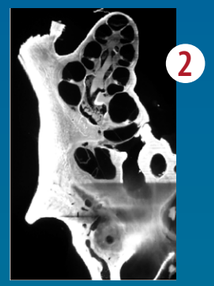
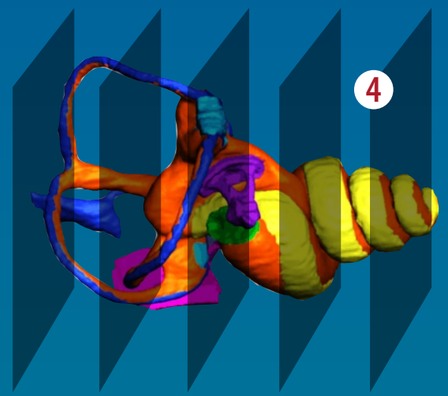
CHARTING THE LABYRINTH

Computerized reconstruction of the inner ear structure in animals points the way to modeling drug movements in the ears of humans

The complex three-dimensional spaces of the inner ear — called the labyrinth for good reason — include some of the uncharted frontiers of anatomy. Small, convoluted and deep within the skull, these structures evade detailed physical inspection, making it hard to comprehend how all the parts relate to each other. Computerized scans now allow the generation of dynamic simulations of the inner ear, letting researchers "fly inside" and visualize spaces never seen before.





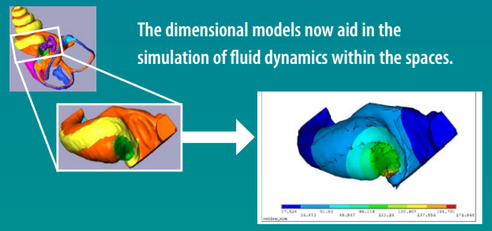


Digitizing a new view

The intact inner ear is optically sectioned using OPFOS (orthogonal-plane fluorescence optical sectioning) (1), producing a series of images (2). These images are then painstakingly mapped by hand (3) in order to link congruent spaces. The computer translates this series of data into three dimensions (4), which allows scrutiny inside and out and provides a basis for simulations of drug movements in the fluid spaces (facing page).

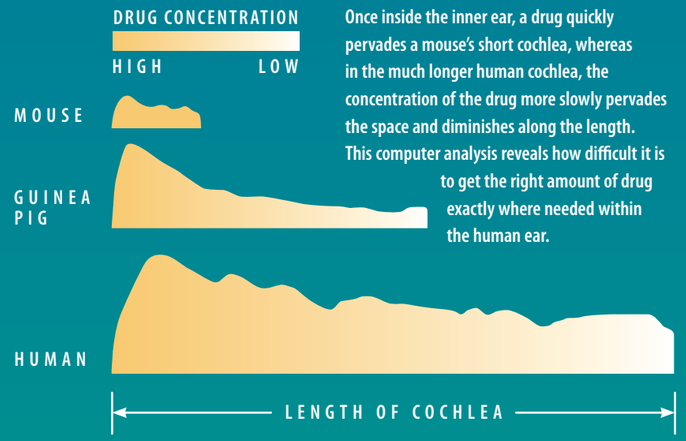
Pharmacokinetics: Drugs in motion

When delivering drugs within the body there are two options: the scattershot approach of systemic delivery (most injections and pills) and the pinpoint accuracy of localized delivery. The latter puts the correct dose in the exact spot where it is needed, which becomes critical when the substance could harm other areas. However, in the inner ear there are complicating factors of size, structure and fluid dynamics. Scientists seek to know how drugs can move through the inner ear — and how they can leak out.

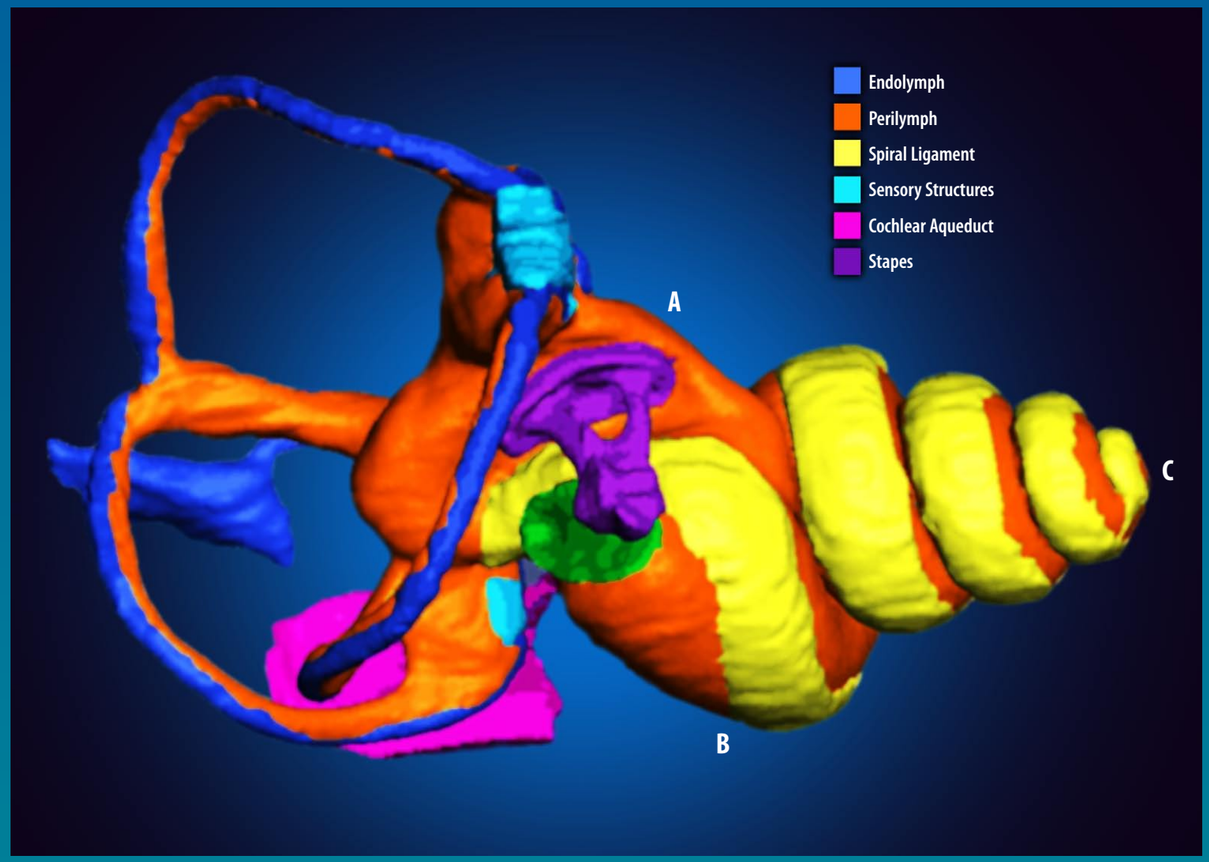


The dimensional models now aid in the simulation of fluid dynamics within the spaces.

Modeling the dynamics of drug distribution



Once inside the inner ear, a drug quickly pervades a mouse's short cochlea, whereas in the much longer human cochlea, the concentration of the drug more slowly pervades the space and diminishes along the length. This computer analysis reveals how difficult it is to get the right amount of drug exactly where needed within the human ear.



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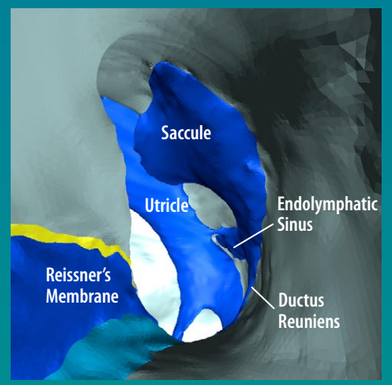
The completed computer model allows researchers to examine the structure from all angles, inside and out.
The ability to "fly through" the shapes, as revealed in the samples below, has proven particularly valuable for visualizing tiny unseen spaces within the cochlea.



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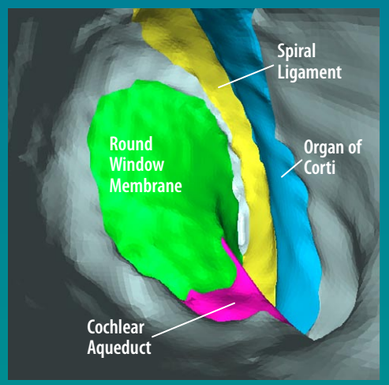

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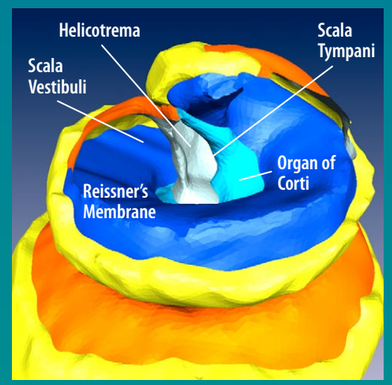

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