The Nebraska retinal prosthesis project

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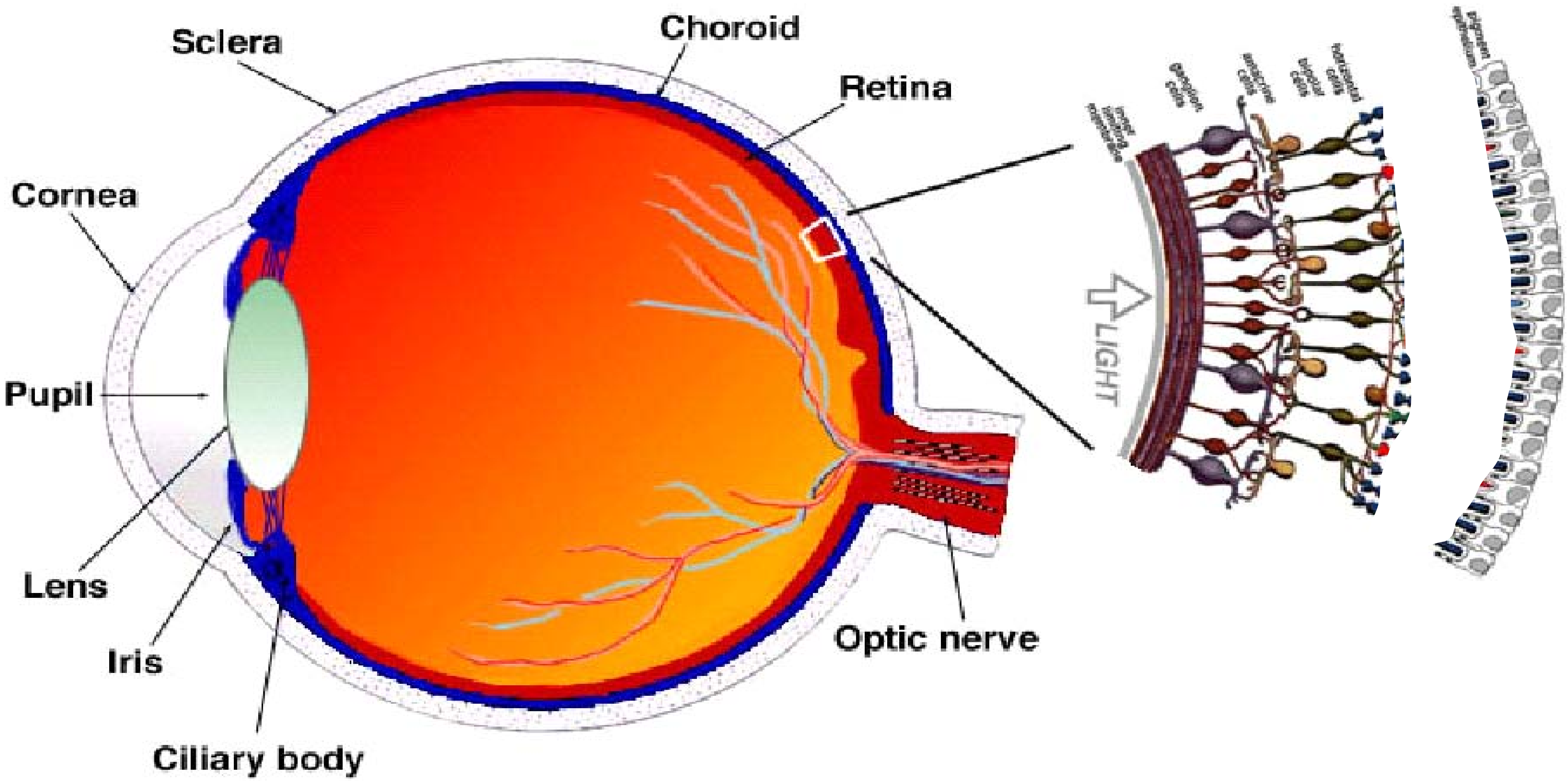
- More than 38 million Americans suffer from vision loss with one million legally blind.
- Two of the more common blinding retinal diseases are **retinitis pigmentosa (RP) and age-related macular degeneration (AMD)**.
- There are approximately 1.5 million people affected by RP worldwide and it is the leading cause of inherited blindness occurring in 1/3,500 live births.
- AMD is the main cause of vision loss among adults over age 65 in western countries. Annually, ~700,000 new patients in the USA lose vision due to AMD and 10% of those with the disease become legally blind each year.

The retina is located at the back of the eye. In AMD and RP (“outer retinal” diseases), vision loss is due to death of photoreceptor cells (rods and cones).

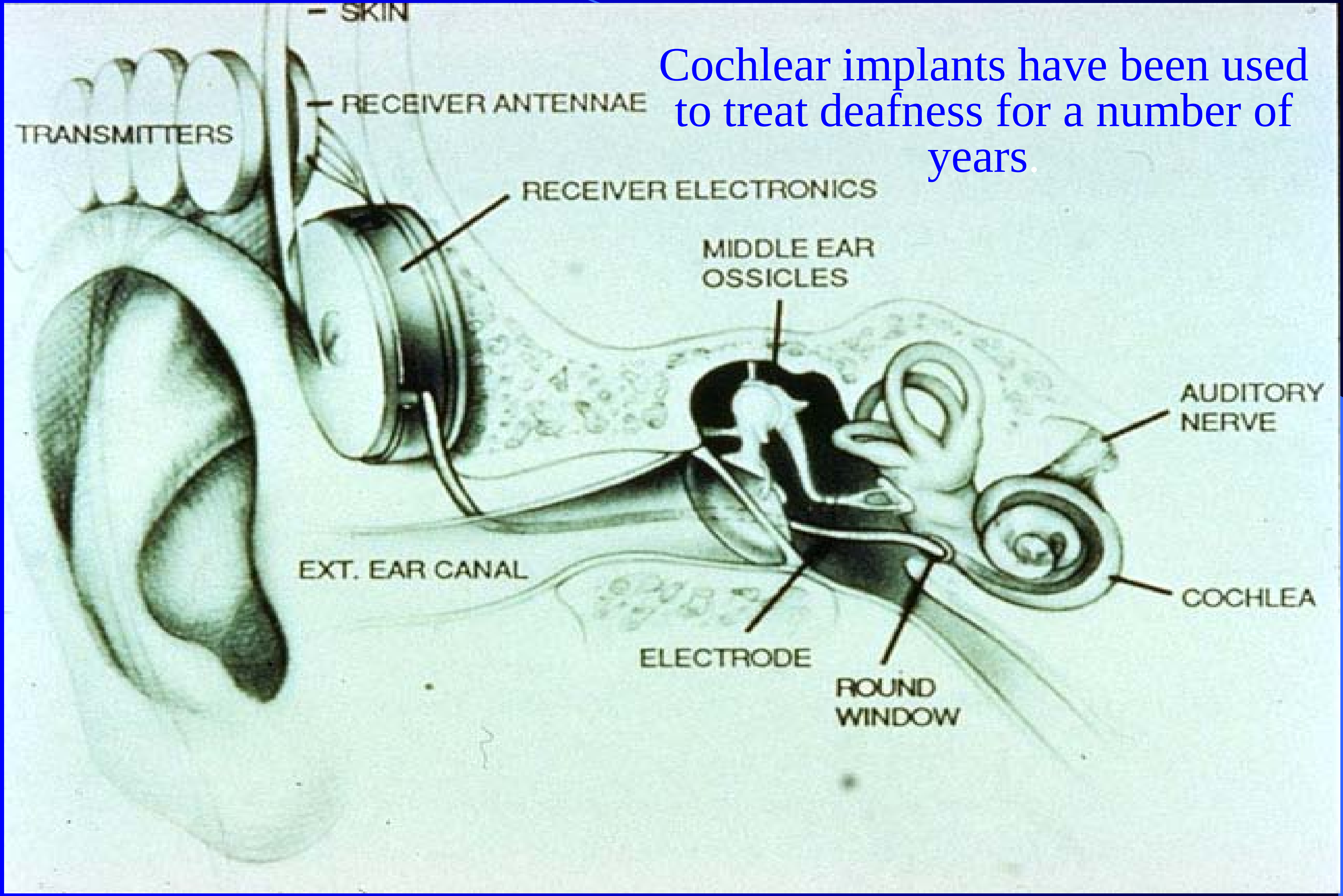


Strategies to treat outer retinal disease

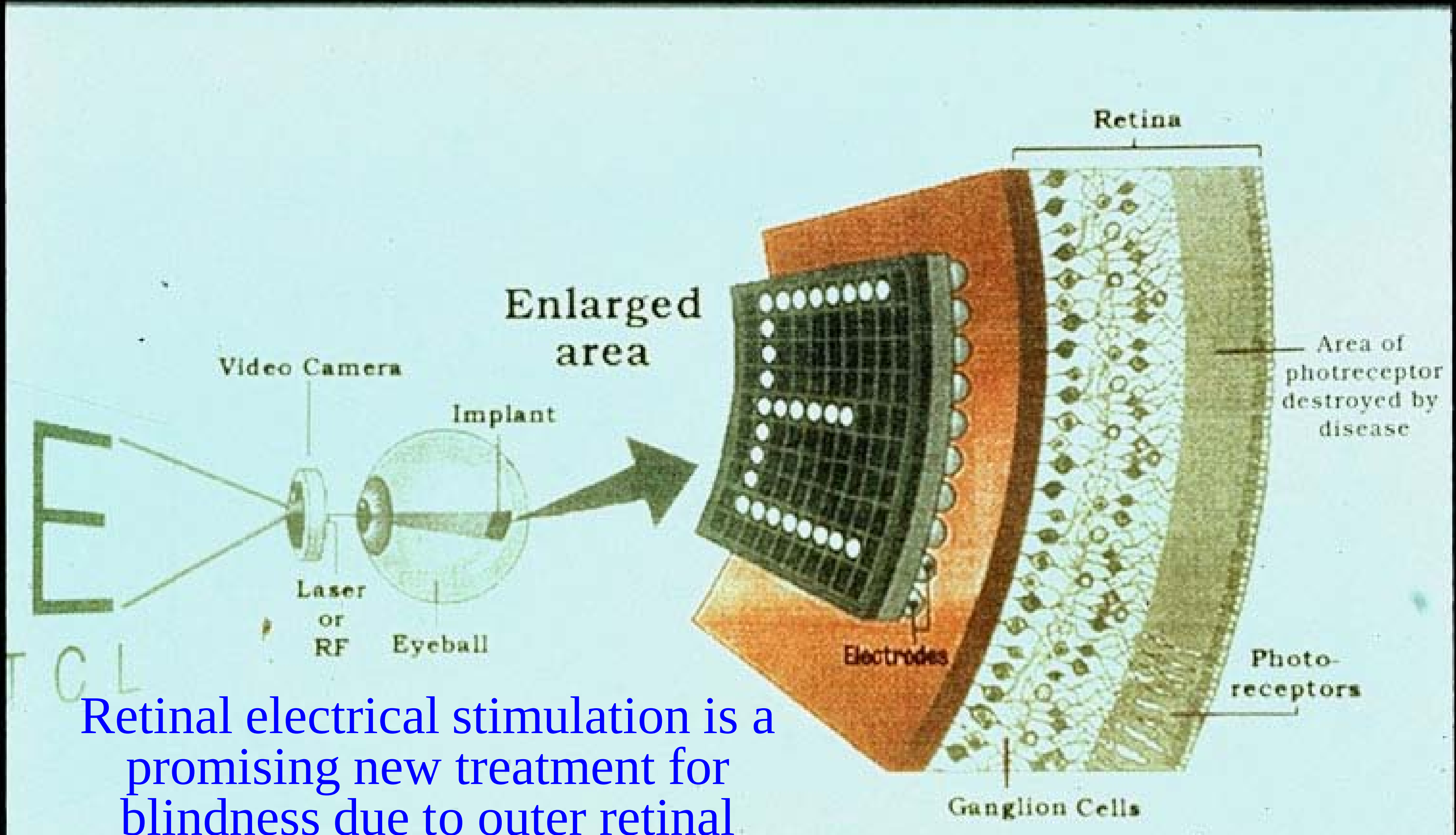
- Drugs to prevent photoreceptor cells from dying
- Stem cells – to grow new photoreceptors or prevent existing photoreceptor cells from dying
- Retinal implants – to bypass dead photoreceptor cells and directly stimulate downstream retinal nerve cells

Cochlear Prosthesis Concept

Cochlear implants have been used to treat deafness for a number of years.

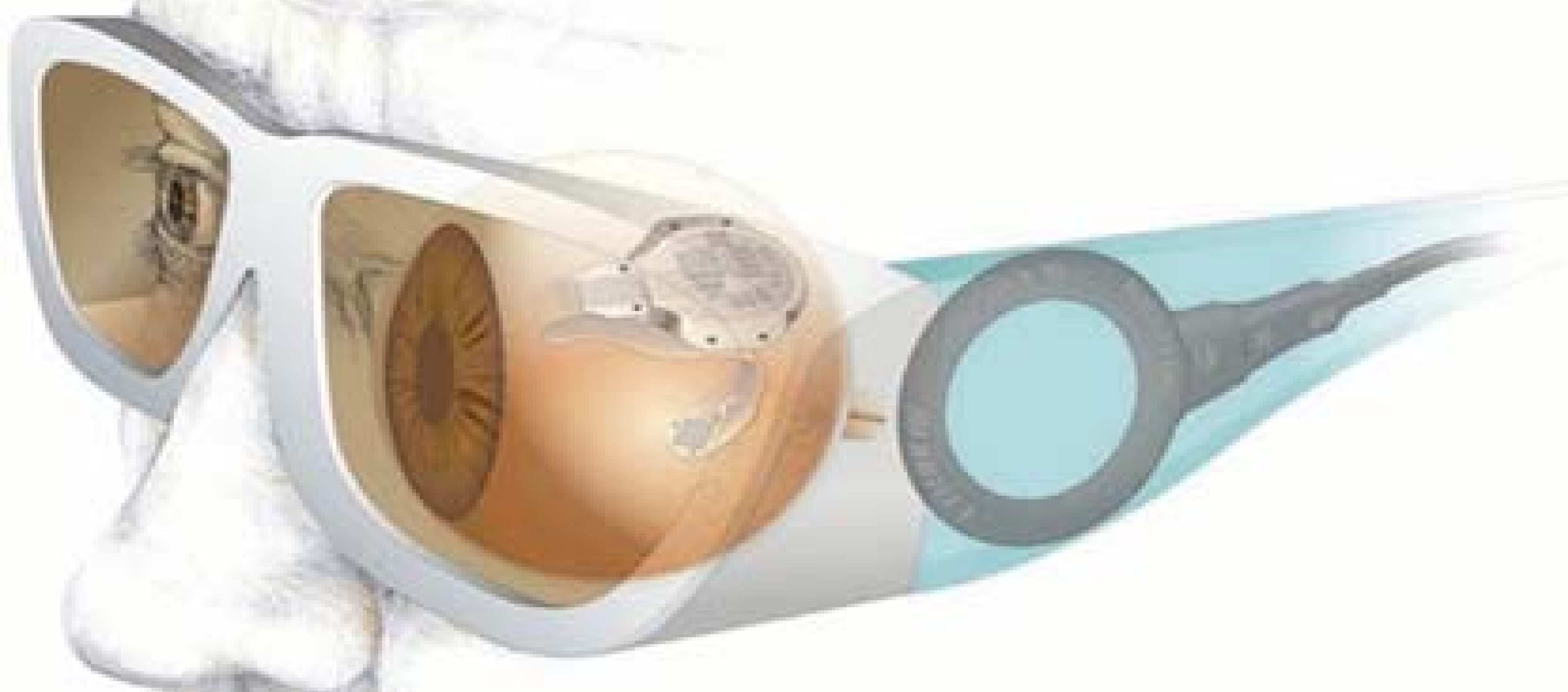


Retinal Prosthesis Concept



Retinal electrical stimulation is a promising new treatment for blindness due to outer retinal degeneration (e.g., retinitis pigmentosa, Usher's syndrome, and age-related macular degeneration).

Retinal implants



- Data from a camera in the lens is converted to an electronic signal and then sent to a receiving antenna in the eye.
- From the receiving unit, the signal travels to the retinal implant where it stimulates retinal cells.
- Activated retinal cells send the image along the optic nerve to the brain.
- Retinal electrical prosthetic devices have been implanted in human subjects where they produce crude images.

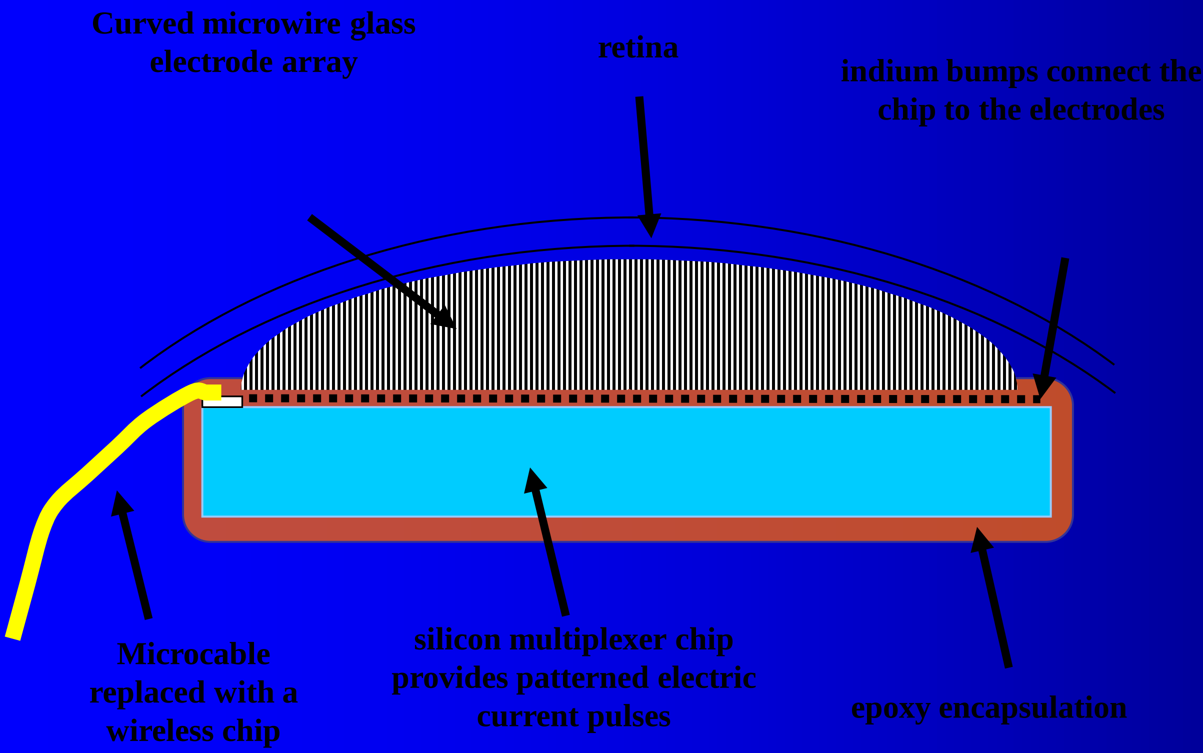
Existing devices with 8x8 arrays produce crude vision, but the resolution is not sufficient for functional or ambulatory vision.

According to psychophysical studies the minimum number of electrodes required for useful vision is 625 (25x25).

An exciting new initiative: UNMC's Intelligent Retina Implant System (IRIS)

- This retinal prosthetic device has two key features that set it apart from existing devices:
- 1) High resolution stimulating electrode array with 3200 individual electrodes (developed by Dr. Lee Johnson, Naval Research Laboratory)
- 2) A learning encoder device that mimics processing of the normal retina circuitry. This device (developed by Dr. Rolf Eckmiller, University of Bonn, Germany) allows the patient to make adjustments that optimize the visual image.
- These features can be used in other visual prostheses projects which are meant to treat all types of blindness including combat trauma

Existing devices with 8x8 arrays produce crude vision, but the resolution is not sufficient for functional or ambulatory vision.
To improve resolution, we plan to use an array with 3200 electrodes (56x56 electrodes).



UNMC’s device will also incorporate a “Learning Retinal Encoder” that allows patients to adjust output from the stimulating electrodes and thus improve visual performance.

- The encoder mimics normal functions of retinal circuitry that help to enhance edge detection.
- The encoder can also compensate for re-wiring or re-mapping that can occur during retinal degeneration.

Goals and timeline

- Stage 1 (Year 1) funded by Earmark:
  - development of a wireless implantation device,
  - Integration of external and internal devices,
  - creating the animal surgical facility in which animal experiments will be performed.
- Stage 2 (Years 2-3) funded by DOD, VA:
  - implantation experiments in normal dogs and a dog model of RP (RCD1 dogs)
- Stage 3 (Year 4) funded by DOD, VA, private donors (?)
  - Phase I human experiments (Year 4) (after IRB and FDA approval)
  - Phase II and III clinical trials will take place during the next five years.

Personnel and Costs for Stage 1

- Stimulator development cost at NRL (Lee Johnson, PhD, Research Associate, Optical Sciences Division, Naval Research Laboratory): $2 M
- UNMC costs of Retinal Encoder development +integration of stimulator (Rolf Eckmiller, PhD, Director, Division of Neural Computation, Department of Computer Science, University of Bonn, Bonn, Germany. Dr. Hesham Ali, Dean of Information Science and Technology, University of Nebraska-Omaha and Dr. Jong-Hoon Youn, Assoc. Professor, Dept. of Computer Sciences, Peter Kiewit Institute(?)): $2 M