What is a cochlear implant ?

A cochlear implant is an electronic device that can restore useful hearing and provide improved communication abilities for persons who have a bilateral (both ears) severe to profound sensorineural hearing loss. Persons who receive little to no benefit from hearing aids are considered for cochlear implant candidacy. There are more than 50,000 children and adults worldwide who utilize cochlear implants.

The field of cochlear implants is well-established. The earliest research on cochlear implantation was conducted over 30 years ago in France. Since that time, the technology of cochlear implants has evolved rapidly from a primitive device using a single electrode to stimulate the ear to devices that transmit sound information via multiple channels or electrodes. The latest advance in cochlear implant technology involves entirely behind-the-ear speech processors.

All modern devices are multi-channel cochlear implant systems. All provide multiple speech perception strategies and features.

How is an implant different from a hearing aid?

Cochlear implants differ from hearing aids in two important ways:

1. Hearing aids and other assistive listening devices simply amplify sounds. A cochlear implant, on the other hand, transforms speech and other sounds into electrical energy that is used to stimulate surviving auditory nerve fibers in the inner ear.

2. Unlike most hearing aids, cochlear implants have both internal (inside the body) and external (worn outside the body) components. A surgical procedure is needed to place the internal processor component of the implant.

How does the cochlear implant work?

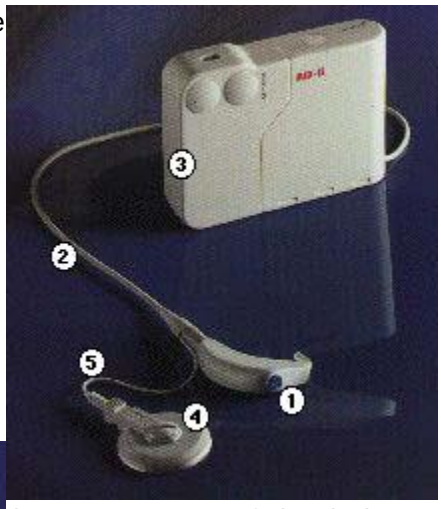
Understanding normal auditory function is essential to understanding how the cochlear implant can restore auditory perception to people with severe to profound hearing loss.
The ear is comprised of three parts:

The outer ear	**The middle ear**	**The inner ear**
Consists of the pinna (visible outer portion) and ear canal	Consists of the eardrum, ossicles (three small bones) and middle ear space	Consists of the snail-shaped cochlea and organs of balance

Sound waves in the environment are collected by the pinna and funneled down the ear canal to the eardrum. These waves strike the eardrum, causing it to vibrate. There are three small bones attached to the eardrum, called the ossicles. As the ear drum vibrates, so do the ossicles. The smallest of these bones is the stapes, which is attached to the snail-shaped cochlea. The motion of the stapes causes the fluid inside the cochlea to move. The movement of this fluid activates thousands of sensory receptors, called hair cells, which line the cochlea. The hair cells are arranged tonotopically, or in pitch order, with high pitch sounds coded in the base of the cochlea and low pitch sounds in the apex. As the hair cells are stimulated, they convert the vibrations into electrical pulses, which are sent along nerve fibers to the brain. The brain interprets these pulses as sounds.

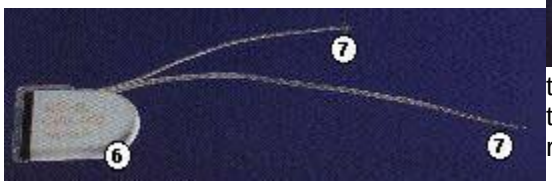
For people who are cochlear implant candidates, the outer ear and the middle ear function normally. However, as the fluid travels in the cochlea, the hair cells are not stimulated and do not generate electrical pulses to be sent to the brain. Therefore, the brain does not perceive the sound. The hair cells may be absent or damaged although typically there are some residual nerve fibers. The cochlear implant attempts to utilize these residual fibers by replacing the function of the hair cells with electrical stimulation.

The cochlear implant is an electronic device that stimulates residual nerve fibers in the inner ear. These electrical pulses are sent to the brain and interpreted as sound. An implant system consists of an external speech processor and headset and an internal, surgically implanted electrode array. All manufacturers currently have ear level processors available for their devices that are much more convenient to the user than the traditional body processor. However, the body processor is useful to illustrate the implant's function and is described below:



1. Sounds in the environment are picked up by a microphone (1) on the headset.

2. The long cable (2) carries the sound signal from the microphone (1) to the speech processor, a powerful miniaturized computer (3).
3. The speech processor (3) filters, analyzes and digitizes the sound signal into coded electrical signals.
4. These coded signals are carried from the speech processor (3) to the transmitting coil (4) via the long (2) and short (5) cables.
5. The transmitting coil (4) sends the signals across the skin to the implanted receiver/stimulator (6) via an FM radio signal.
6. The receiver/stimulator delivers the correct amount of electrical stimulation to the appropriate electrodes (7) on the array to represent the sound signal that was detected.



7. The electrodes (7) along the array stimulate the remaining auditory nerve fibers in the cochlea, which carry the signal on to the brain, where it is interpreted.

Cochlear Implant Surgery
Cochlear implant surgery lasts about three hours and is performed while the patient is under general anesthesia. Some conditions that may affect the cochlea, such as cochlear ossification (bony growth) or cochlear abnormalities may lengthen the time of surgery. Prior to surgery, a small portion of hair is shaved around the ear to be implanted. The surgeon makes a postauricular (behind the ear) incision. A small depression is created in the mastoid bone to hold the receiver/stimulator so that it is flush with the skull. The surgeon drills through the mastoid

bone to the inner ear. The electrode array is then inserted into the cochlea. The receiver/stimulator is secured to the skull, and the incision is closed with stitches. Typically, patients remain in the hospital for one or two nights.

Stitches are removed approximately 10 days after surgery. Patients return to school or work as soon as they feel well enough to do so, usually within a week of surgery. Activation of the implant takes place three to four weeks after implantation, allowing enough time for the incision to heal properly.