14E DESIGN AND THE HUMAN BODY

INTRODUCTION

"I will praise you," said the Psalmist, "for I am fearfully and wonderfully made." (Ps. 139:14) If David could write such a statement three thousand years ago, how much more should we exclaim this today with all that we have learned about the human body. The circulatory system, respiratory system, and nervous system provide amazing examples of intricate design, all pointing to a wise and loving Creator.

CIRCULATORY SYSTEM

The human circulatory system consists of the heart, the arteries, the veins, and the capillaries, designed to deliver oxygen and nutrients to the cells of the body.

In the fascinating classic movie *Red River of Life* [1], Irwin Moon of the Moody Science Institute provides a layman's description of the circulation system:

Respiration with circulation is equivalent to the intake and exhaust of a 30 trillion-cylinder engine (the body has 30 trillion cells which need oxygen and release CO2). Each cell requires oxygen, does work, must be cooled, and gives off an exhaust gas. Instead of a separate supply line for each cylinder, our Creator combined it all into one amazing system.

The body needs at least four gallons of pure oxygen per hour. It cannot be transported in the blood as a gas, or it would result in vapor lock: gas in the bloodstream is deadly. Instead, it combines with the four iron atoms in the complex hemoglobin (Hbg) molecule of the red blood cell to travel from the lungs to the cells (where it is changed back to a gas).

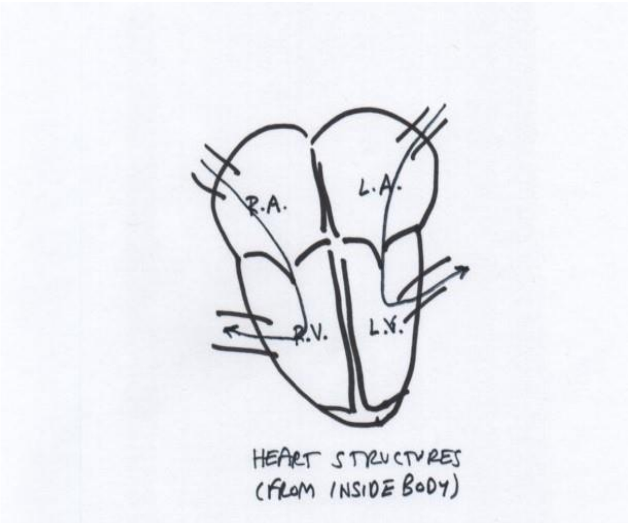
Meanwhile, the exhaust gas, carbon dioxide must be transported from the tissues back to the lungs.

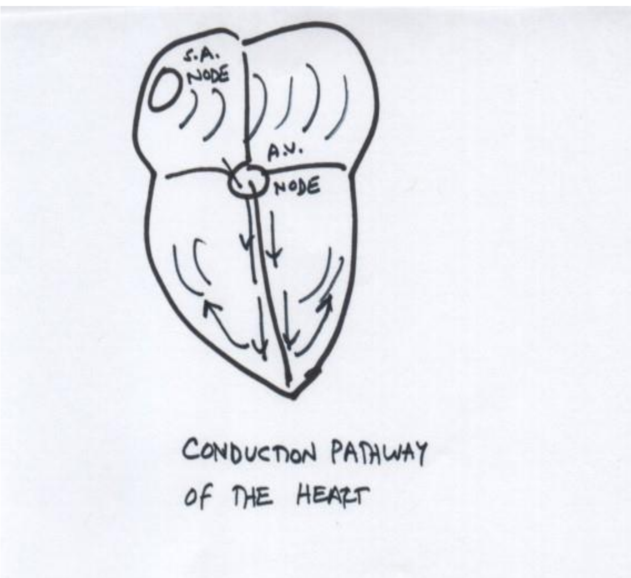
Carbon dioxide must be converted from a gas to a solid to keep from poisoning the blood stream. In one of the fastest reactions in the body, the CO2 is snatched from the tissues of the body by the red blood cells, then hydrated to from carbonic acid. But neither the red cell nor the bloodstream can tolerate this acid. So it must be neutralized instantly.

For this purpose, the blood has been storing up potassium, the fastest acid-binder on the chemist's shelf…After the acid is neutralized the red cells dump it into the blood stream where it combines with the salt in the plasma to form, of all things, ordinary baking soda.

In this safe and harmless form it is carried through the vessels to the lungs. But – our lungs aren't equipped to exhale baking soda. So the red cells go to work again. In a split second they collect the stuff and put it all back together as carbon dioxide, which passes through the capillary walls into the lungs, where we exhale it into the air. It must do all of this quickly enough so that there is time left over for the red cell to pick up another load of oxygen and combine it with Hbg before it reaches the end of a tiny capillary less than 1/50 of an inch in length.[2]

The heart is a four-chambered pump (right atrium, right ventricle, left atrium, left ventricle) which continually pumps blood by the compression of the ventricles. An ionic-electronic signal is generated spontaneously within the right atrium and travels through the heart to the base of the ventricles, creating a contraction as it passes through each structure on its route.





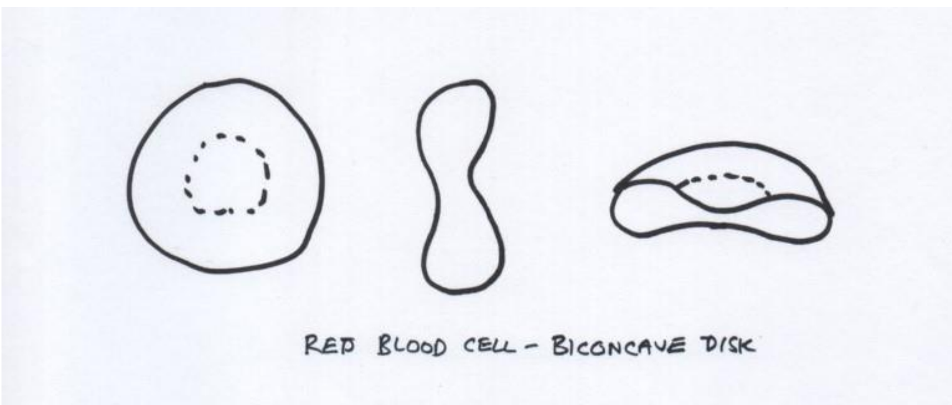
In 1997 Victor Poirier [3] outlined the requirements for a left ventricular assist device (LVAD) that could assist and also copy much of the function of the human heart. Such a device must:

- Produce a flow rate of 10 liters per minute
- Produce a mean arterial pressure of 120 mm Hg
- Produce a beat rate below 120 beats per minute (normal is 70)
- Produce a filling pressure of 20 mm Hg

- Operate continuously (goal was 10 years of operation)
- Cycle 40 million times per year
- Accelerate and decelerate blood from velocities of 0 to 25 liters per minute
- Pump 6 to 11 liters per minute
- Prevent damage to red blood cells and platelets
- Prevent blood clots (thrombi)
- Alter the output consistent with patient's needs (ref)

A healthy human heart is capable of providing all of this for 70 to 90 years or more.

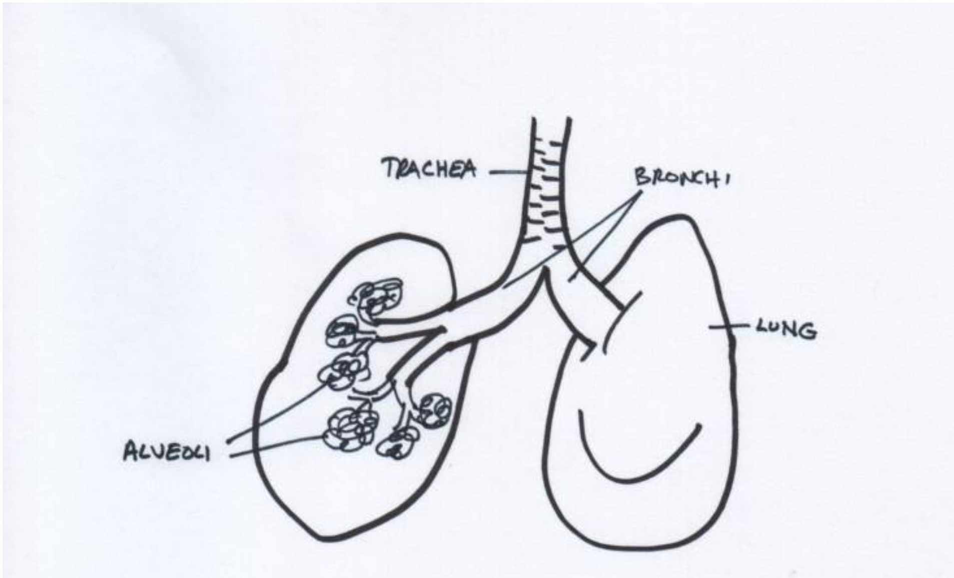
Oxygen is transported through the circulatory system by the body's red blood cells. In *Design Homology* mechanical engineer David Offner examines mathematically the optimal shape for a blood cell: "a surface that defines equal velocity potential for gas diffusion." Derivation of the equation produces a shape (biconcave disk), area, and volume comparable to that of a human erythrocyte (red blood cell). [4]



RESPIRATORY SYSTEM

Coupled with the circulatory system, essential for life, is the respiratory system, consisting of the trachea, lungs, and diaphragm. Julius Comroe described the physiology of the lungs, which make possible oxygen-carbon dioxide gas exchange with every breath: [5]

These two systems [respiration and circulation] cooperate to supply the needs of the tissues. One system supplies air; the other supplies blood. The ultimate purpose is the transfer of gases between air and cells. The respiratory system provides a remarkable mechanism for presenting large volumes of gas to large volumes of blood. It is an air pump, which draws fresh air through air tubes to small air sacs (alveoli of the lungs) that have very thin membranes. The circulatory system is a blood pump, which drives the whole output of the heart through fine, thin-walled vessels (capillaries) surrounding the alveoli...



STRUCTURE OF THE RESPIRATORY SYSTEM

In reality, the respiratory system is a very complex distributing system. It starts as two nasal tubes... and then becomes one, the trachea. The trachea subdivides into two main branches, the right and left bronchi, and each of these divides into two more, and each of these into two more, and so on until there have been 20-30 subdivisions in all. A simple calculation shows that 20 divisions of this type produce about a million terminal tubes. At the end of each are numerous blind pouches, the alveoli; here gas exchange occurs. There are about 300 million of these in the two lungs of man. Their diameter varies from 75 to 300 microns. Some are very close to the center of the lung (the hilum) and some are at the apex or base of the lung, as much as 20-30 c. away from the hilum. To distribute the proper amount of fresh air simultaneously to 300 million alveoli of varying sizes through 1 million tubes of varying lengths and diameters requires a remarkable engineering design. Further, since the air in the conducting tubes does not participate in gas exchange, the internal diameter of the tubes must be small (to minimize the volume of wasted air), but not so small that the respiratory pump must do excessive work against friction in moving air through them.

Another remarkable engineering feat provides a vast and extremely thin surface for the transfer of gases between air and blood. Man at rest requires a transfer of only 200-250 ml of O2 per minute, but during maximal exercise he may need more than 20 times this amount-up to 5,500 ml. The surface area of the membrane available for this transfer is huge-about 70 square meters, or 40 times the surface area of the body; it is less than 0.1 microns thick...

The pump-the right ventricle –drives venous blood into one large tube, the pulmonary trunk. This divides and subdivides until eventually the tubes appear to be alms a lake of blood, which is really blood contained in millions of short, tin-walled capillaries surrounding the alveoli. The surface area of this capillary bed is about 70 square meters, the thickness of each capillary wall is less than 0.1 microns, and the diameter about 7-10 microns. Yet the resistance to flow through *the whole bed is so low that 5-10 L of blood can flow through it each minute with a driving pressure of less than 15 mm Hg.*

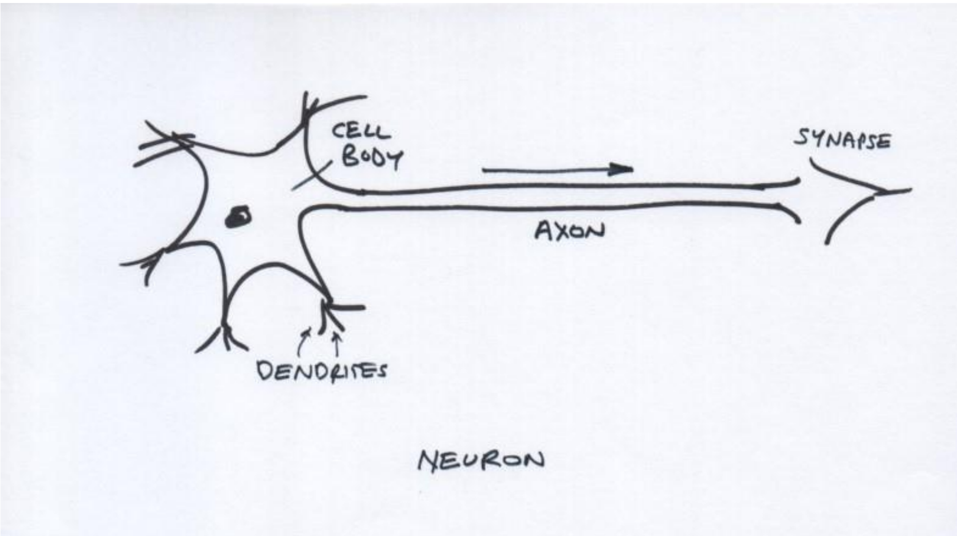
The other physical factor at work throughout the respiration system is that gases naturally move from an area of high pressure to an area of lower pressure, so oxygen enters the lungs, and eventually the cells, while carbon dioxide is released to the outside air.

NERVOUS SYSTEM

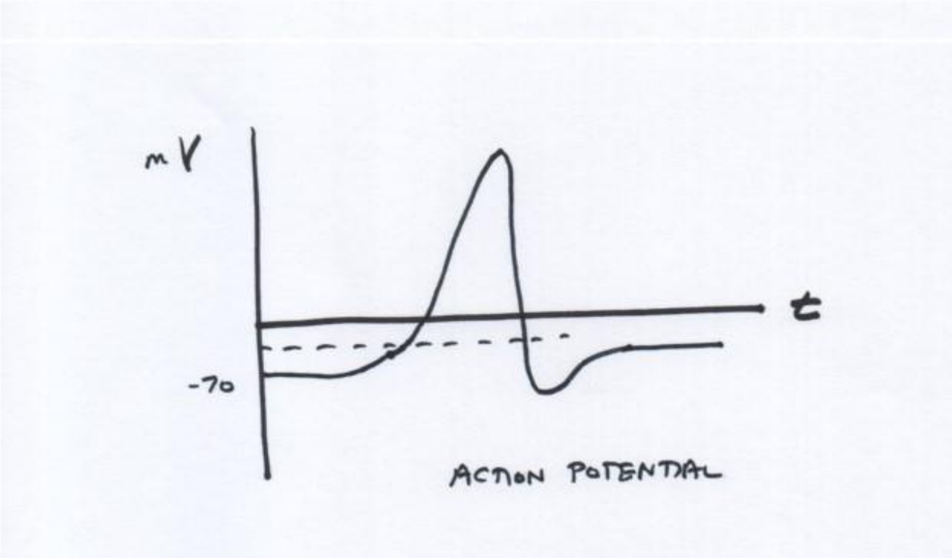
Communication, command, control, and conscious thought are handled by our nervous system, which contains the brain, spinal cord, sense organs, and peripheral nerves.

Neurons

The basic cells of the nervous system are the neurons, which resemble a tree, consisting of a cell body, branching dendrites which receive inputs, a lengthy axon branch, and the terminations of the axon.



A negative voltage of 60 mV exists across the membrane of the cell. Once the cell voltage exceeds a threshold, a large but short duration pulse (about 100 mV) is generated (the action potential).



C.D. Geisler described the propagation of this pulse along the axon: [6]

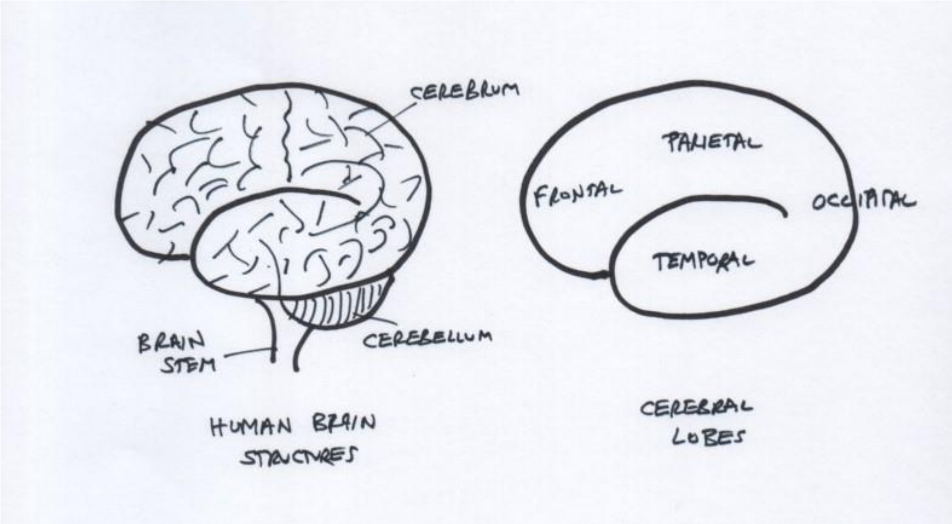
The positive nature of the pulse raises the voltage across the adjacent patch of membrane, causing that voltage to cross its own threshold level. A neuronal pulse is then generated by this second patch of membrane and causes, in turn, the third section of membrane to generate a pulse. The first section is meanwhile resetting itself and is not affected by the pulse on the second section. The process continues on down the axon, each section generating a pulse in the succeeding section. The process is very much like the burning of a firecracker fuse, where the heat of the burning section of the fuse ignites the next section. In both cases, a signal is transmitted from one end to the other, a heat pulse in one case and a voltage pulse in the other. Moreover, in both cases, the length of the signal path does not matter. Once started, the pulse propagates at a constant speed to the end of the line. Unlike the firecracker fuse which burns but once, the axon resets itself in a msec or so and is ready to conduct another pulse...The utility of such a mechanism is clear: pulses can be sent over arbitrarily long distance without any loss of signal.

The neuronal axon terminates in either a region near a muscle or a region near another neuron (synapse), with a chemical transmitter conveying the effect across the gap. The human brain consists of over 100 billion neurons connected through 100 trillion synapses.

Brain

The control system of the body is the brain, an organ slightly larger than a fist, encased inside the skull. The brain contains a number of localized regions, or lobes, each of which provides a major function: temporal (hearing), occipital (vision), frontal (conscious thought).

The average adult brain weighs only about 3 pounds (about 2% of the total body weight). Anatomically, the brain is defined as that part of the nervous system which lies within the cranial cavity of the skull. A rich blood supply sustains its requirements for nutrients and oxygen. A series of membranes cover the surface of the brain, and a fluid, the cerebrospinal fluid (CSF) surrounds the brain and helps to cushion it within the bony skull.



Major brain areas

1. Cerebrum

This region handles all major sensation information. Lobes, or areas, exist for auditory and visual input. Conscious control is likewise handled here. Association with stored experience data is accomplished in the cerebrum. The outer surface (gray matter) of the cerebrum is known as the cerebral cortex, the highest set of integrating centers of the brain.

Four major sections, or lobes, of the cerebral cortex are identified according to location and primary function:

- Frontal – conscious thought, control, decision-making
- Parietal – coordination, motion, sensation
- Occipital – vision, visual processing
- Temporal – hearing, language processing

2. Cerebellum

The cerebellum is responsible for motor coordination. Damage to this region causes difficulty in maintaining posture and position control.

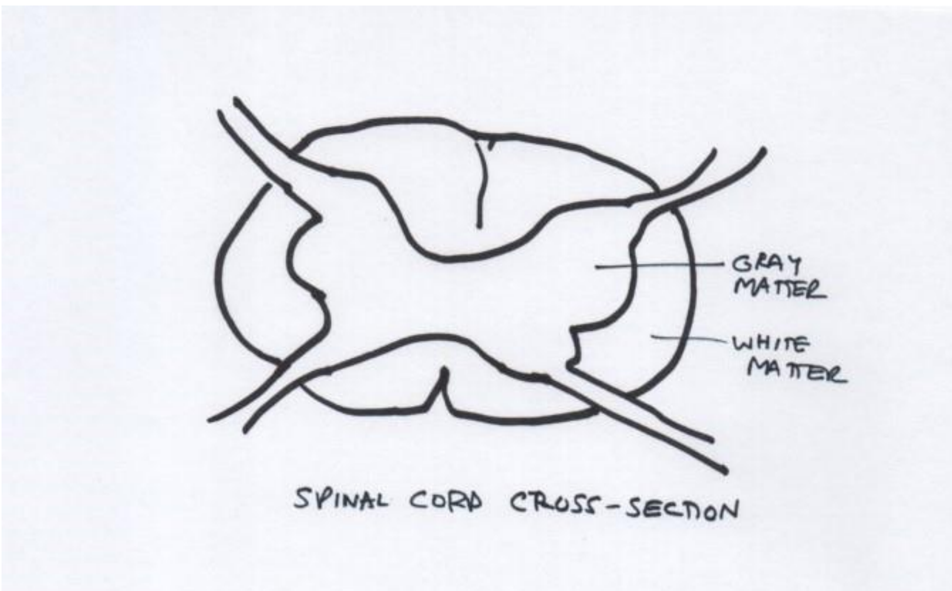
3. Brainstem

The brainstem consists of the remainder of the brain and provides connections between cerebrum, cerebellum, and spinal cord. Nuclei for the specialized cranial nerves exist here as well as centers for breathing control.

Twelve cranial nerves emerge from the brainstem connecting to sensory and motor structures primarily in the head and neck. These are numbered in the order in which they emerge from the brainstem. Primary nerves for smell, vision, and hearing are among these specialized nerves.

Spinal cord

The spinal cord is a tubelike structure that runs from the brainstem to the lower back, encased by bones of the spinal column. The spinal cord delivers control signals from the brain to the lower body and transmits sensory signals from the lower body up to the brain. The butterfly shaped gray matter contains the cell bodies, while the white matter contains the emerging axons. Thirty - one nerve segments emerge from the spinal cord.

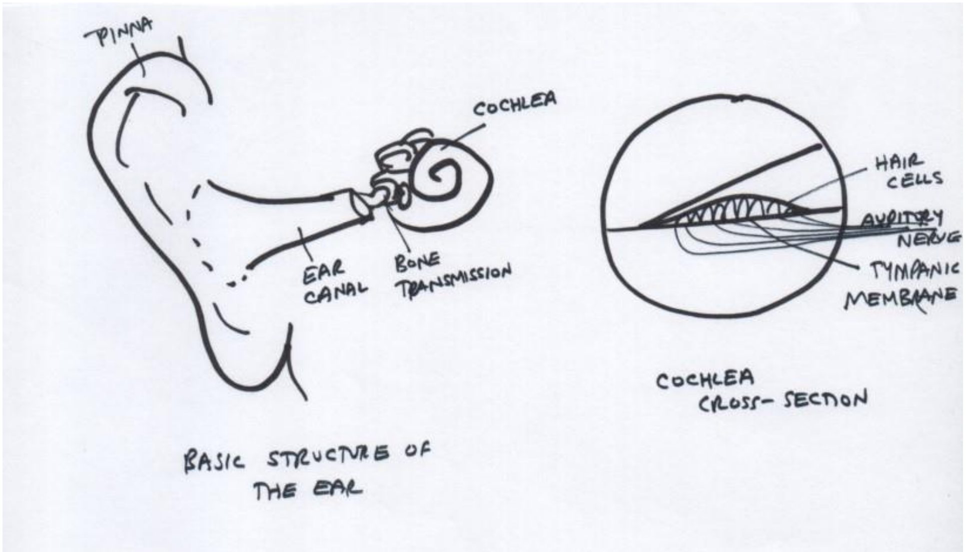


The Ear

Airborne sound waves are channeled to the ear via the pinna, the outer cartilage structure usually referred to as the ear. A short ear canal (external auditory meatus) terminates at the ear drum or tympanic membrane, a fibrous oval and slightly conical structure.

The middle ear is located within the temporal bone and provides a mechanical impedance match between air and the fluid of the inner ear. This is primarily accomplished by a chain of tiny bones – the malleus (hammer), incus (anvil), and stapes (stirrup).

The footplate of the stapes is set into the oval window of the inner ear, such that mechanical vibrations of the tympanic membrane and bony chain give rise to fluid pressure waves within the cochlea.



The inner ear is located within a bony labyrinth of the temporal bone and contains those structures necessary for both vestibular (balance) function and hearing sensation. The bony cochlea is a spiral tube resembling a snail's shell. A series of membranes divides the cochlea into three chambers, each filled with fluid. That chamber known as the cochlear duct or scala media contains the organ of Corti, the sensory end organ for sound stimuli, which rests on the basilar membrane.

The organ of Corti is a complex arrangement of cells, arranged in rows, with supporting structures, in contact with the basilar membrane. The basilar membrane is narrowest at the cochlear base, near the oval window, and widest at the round window. It simultaneously undergoes a decrease in stiffness of approximately one hundredfold along its length.

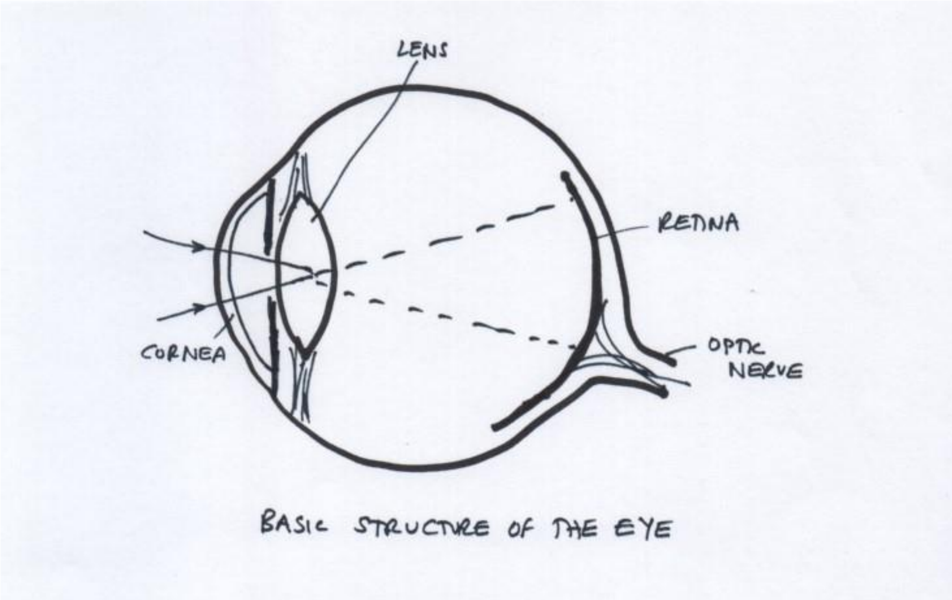
Hair cells, the specific transducers of the auditory system, are located in an inner and an outer grouping, and are innervated by dendritic processes from the eighth cranial nerve. These are the fragile cells that may be damaged by trauma or intense stimulation.

Synaptic connections exist at all levels, many with the reticular system for "attention" or "arousal" responses. Crossovers occur at various levels of the pathway to the brain. Some processing apparently occurs at each level, and the number of fibers carried upward increases in ascending structures. Descending fibers provide feedback paths from all locations.

The auditory cortex is that portion of the cerebral cortex in which the majority of fibers of the central auditory pathway terminate.

The Eye

The eye is capable of recognizing shapes, colors, distances, patterns, and movements. This spherical organ consists of the transparent cornea, an anterior chamber, the muscular iris, a crystalline lens, a rear chamber, and the nerve coating retina.



Biologist George Wald wrote in detail about the comparisons between the eye and a camera: [7]

Today every schoolboy knows that the eye is like a camera. In both instruments a lens projects an inverted image of the surroundings upon a light-sensitive surface: the film in the camera and the retina in the eye. In both the opening of the lens is regulated by an iris. In both the inside of the chamber is lined with a coating of black material which absorbs stray light that would otherwise be reflected back and forth and obscure the image...A camera is focused by moving the lens toward or away from the film, In the eye the distance between the lens and retina is fixed, and focusing is accomplished by changing the thickness [shape] of the lens.

Light images ultimately are projected onto the retina, the innermost coating layer of the eyeball. It is the retina which contains the specialized "rod-and-cone" cells, which convert light energy into the action potentials carried by the optic nerve to the brain.

Light entering the eye is focused by the lens onto the retina lining at the back of the eye, where the sensitive photoreceptors, the rods and the cones, reside. Stimulation of the rods and cones produce nerve impulses in the bipolar cells, which then synapse with the ganglion cells forming the fibers of the optic nerve. The fibers then cross (such that the right eye connects to the left side of the brain and the left eye connects to the right side).

OTHER BODY FUNCTIONS AND DESIGN

Dr. Randy Guliuzza has described a number of additional examples of design in the human body:

Balance and muscle control [8]

Temperature control [9]

Energy for life [10]

The immune system [11]

Bones [12]

CONCLUSIONS

Francis Crick (DNA co-discoverer) once wrote that biologists needed to keep in mind that what they saw was not designed. [13]. Richard Dawkins stated that “Biology is the study of complicated things that give the appearance of having been designed for a purpose.” [14]

These are not scientific statements at all, but rather express the worldview of those scientists. A strong case can be made for the alternative, that a wise and loving Creator specifically designed our body systems to interact with each other and, in many cases, to self-repair.

It is the hand of the Creator that holds all things together by His power (Col. 1:16-17). Therefore, the best scheme that links (or “glues”) all biology together is intelligent design. Nothing makes sense in biology except in the light of evidence. There are dozens of examples of interwoven complexities, or fabric-like designs, in the body for the open-minded biologist. [15]

Our conclusion, then, becomes awe and worship.

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