

Chapter 12

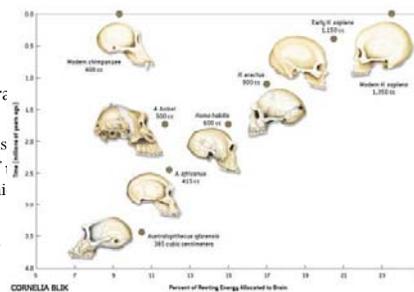
The Nervous System

Biology 3201

12.1

The Structure of the Nervous System

- Humans have the most complex nervous System of all organisms on earth
 - This is the result of millions of years of evolution.
- The evolution of the more complex vertebrate brain exhibits a number of trends
 1. The ratio of the brain to body mass increases
 2. There is a progressive increase in the size of the area of the brain, called the **cerebrum**, which is involved in higher mental abilities.
- Over the past two million years, the human brain has doubled in size.



Structure of the Nervous System

- The human nervous system is very important in helping to maintain the homeostasis (balance) of the human body.
- The human nervous system is a high speed communication system to and from the entire body.
- A series of sensory receptors work with the nervous system to provide information about changes in both the internal and external environments.
- The human nervous system is a complex of interconnected systems in which larger systems are comprised of smaller subsystems each of which have specific structures with specific functions.

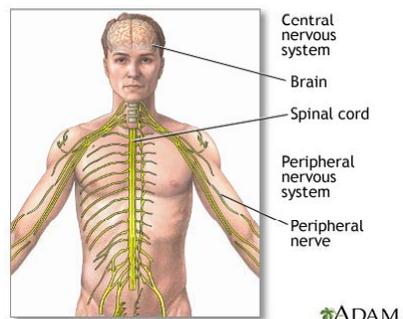
Two Major Components

- Central Nervous System (CNS)
 - Made up of the **brain** and **spinal cord**
- Peripheral Nervous System (PNS)
 - The PNS is made up of all the **nerves** that lead into and out of the CNS.
- See Fig. 12.2 , Page. 392

Central Nervous System

- The CNS, brain and spinal cord, receives sensory information and initiates (begins) motor control.
- This system is extremely important and therefore must be well protected. Protection is provided in a variety of ways
 - Bone provides protection in the form of a skull around the brain and vertebrae around the spinal cord.
 - Protective membranes called **meninges** surround the brain and spinal cord.
 - Cerebrospinal fluid fills the spaces between the meninges membranes to create a cushion to further protect the brain and spinal cord.

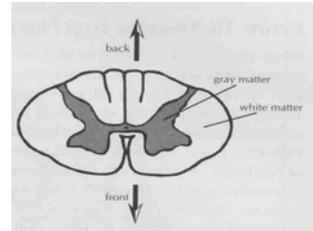
CNS



- The spinal cord extends through the vertebrae, up through the bottom of the skull, and into the base of the brain.
- The spinal cord allows the brain to communicate with the PNS.
- A cross section of the spinal cord shows that it contains a central canal which is filled with cerebrospinal fluid, and two tissues called **grey matter** and **white mater**.
- See Fig. 12.4, P. 393

Grey Matter

- The grey matter is made of neural tissue which contains three types of nerve cells or neurons:
 1. Sensory neurons
 2. Motor neurons
 3. Interneurons
- Grey matter is located in the center of the spinal cord in the shape of the letter H.
- The white matter of the spinal cord surrounds the grey matter. It contains bundles of interneurons called **tracts**

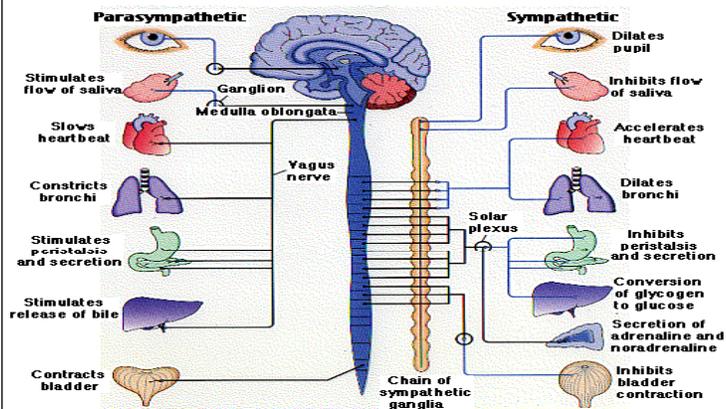


See Fig.12.4 on page 393

Peripheral Nervous System

- Made up entirely of nerves
- The PNS is made up of two subsystems:
 1. Autonomic Nervous System
 2. Somatic Nervous System
- The autonomic nervous system is not consciously controlled and is often called an involuntary system. It is made up of two subsystems:
 1. Sympathetic Nervous System
 2. Parasympathetic Nervous System
- The sympathetic and parasympathetic systems control a number of organs within the body.

Sympathetic vs. Parasympathetic



See Also:

Page 394

Figure 12.5

Fight-or-Flight

- The sympathetic nervous system sets off what is known as a “fight - or - flight” reaction.
 - This prepares the body to deal with an immediate threat.
 - Stimulation of the sympathetic nervous system causes a number of things to occur in the body:
 1. Heart rate increases
 2. Breathing rate increases
 3. Blood sugar is released from the liver to provide energy which will be needed to deal with the threat.

Parasympathetic N.S.

- The parasympathetic nervous system has an opposite effect to that of the sympathetic nervous system. When a threat has passed, the body needs to return to its normal state of rest.
- The parasympathetic system does this by reversing the effects of the
 - Heart rate decreases (slows down).
 - Breathing rate decreases (slows down).
 - A message is sent to the liver to stop releasing blood sugar since less energy is needed by the body

Somatic Nervous System

- Made up of **sensory nerves** and **motor nerves**.
- Sensory nerves carry impulses (messages) from the body's sense organs to the central nervous system.
- Motor nerves carry messages from the central nervous system to the muscles.
- To some degree, the somatic nervous system is under conscious control.
- Another function of the somatic nervous system is a reaction called a **reflex**

Receptors, Effectors and Neurons

5 skin receptors

1. Pain
2. Heat
3. Cold
4. Pressure
5. Touch

4 special sensory organs

1. Nose
2. Eyes
3. Ears
4. Tongue (taste)



- **Receptors**

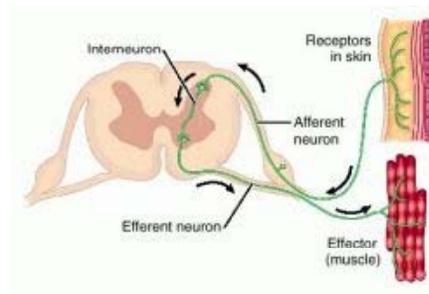
- Take in stimuli (pain, smell etc.) from the environment and relay it to the CNS for processing.

- **Effectors**

- The muscles and glands of the body, which respond to nerve impulses sent to them from the CNS via the PNS.

Reflex Response

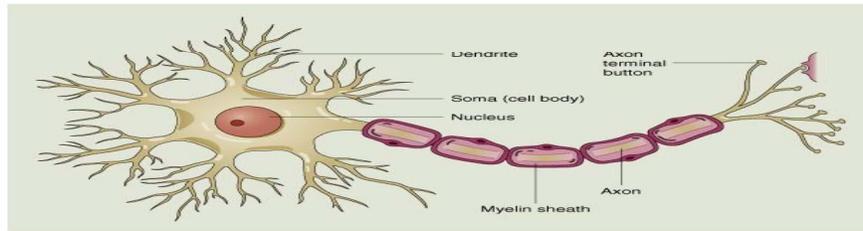
- The **neuron** or nerve cell is the structural and functional unit of the nervous system.
- Both the CNS and the PNS are made up of neurons.
- 90% of the body's neurons are found in the CNS.
- Neurons held together by connective tissue are called **nerves**.
- The nerve pathway which leads from a stimulus to a reflex action is called a **reflex arc**.



Page 396, Figure 12.7

Lab # 1 - Reflex Response pg 396 - 397

The Neuron



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- A typical nerve cell or neuron consists of three parts

1. The cell body
2. Dendrites
3. Axon

See Fig. 12.6, P. 395

Parts of a Neuron

- Cell Body
 - the largest part of a neuron.
 - It has a centrally located nucleus which contains a nucleolus. It also contains cytoplasm as well as organelles such as mitochondria, lysosomes, Golgi bodies, and endoplasmic reticulum
- Dendrites
 - receive signals from other neurons.
 - The number of dendrites which a neuron has can range from 1 to 1000s depending on the function of the neuron
- Axon
 - long cylindrical extension of the cell body.
 - Can range from 1mm to 1m in length.
- When a neuron receives a stimulus the axon transmits impulses along the length of the neuron. At the end of the axon there are specialized structures which release chemicals that stimulate other neurons or muscle cells.

Types of Neurons

- There are three types of neurons:
- Sensory neuron
 - Carries information from a sensory receptor to the CNS.
- Motor neuron
 - Carries information from the CNS to an effector such as a muscle or gland.
- Interneuron
 - Receives information from sensory neurons and sends it to motor neurons.
- See Fig. 12.7, P. 396

The Brain & Homeostasis

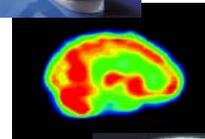
- Today, scientists have a lot of information about what happens in the different parts of the brain; however they are still trying to understand how the brain functions.
- We know that the brain coordinates homeostasis inside the human body. It does this by processing information which it receives from the senses.
- The brain makes up only 2% of the body's weight, but can contain up to 15 percent of the body's blood supply, and uses 20 percent of the body's oxygen and glucose supply.
- The brain is made up of 100 billion neurons.
- Early knowledge of how the brain functions came from studying the brains of people who have some brain disease or brain injury.

The Brain & Technology

- Innovations in technology have resulted in many ways of probing the structure and function of the brain. These include:
 - The electroencephalograph (EEG) which was invented in 1924 by Dr. Hans Berger. This device measures the electrical activity of the brain and produces a printout (See Fig. 12.8, P.398). This device allows doctors to diagnose disorders such as epilepsy, locate brain tumors, and diagnose sleep disorders.
 - Another method is direct electrical stimulation of the brain during surgery. This has been used to map the functions of the various areas of the brain. In the 1950s, Dr. Wilder Penfield, a Canadian neurosurgeon was a pioneer in this field of brain mapping
 - Advances in scanning technology allow researchers to observe changes in activity in specific areas of the brain. Scans such as computerized tomography (CAT scan), positron emission tomography (PET scan), and magnetic resonance imaging (MRI scan) increase our knowledge of both healthy and diseased brains.

CAT, PET, and MRI Scans

- **CAT scans** take a series of cross-sectional X-rays to create a computer generated three dimensional images of the brain and other body structures.
- **PET scans** are used to identify which areas of the brain are most active when a subject is performing certain tasks.
- **MRI scans** use a combination of large magnets, radio frequencies, and computers to produce images of the brain and other body structures.



Parts of the Brain

- See page 399, figure 12.11
- The **medulla oblongata** is located at the base of the brain where it attaches to the spinal cord. It has a number of major functions:
 - It has a cardiac center which controls a person's heart rate and the force of the heart's contractions.
 - It has a vasomotor center which is able to adjust a person's blood pressure by controlling the diameter of blood vessels.
 - It has a respiratory center which controls the rate and depth of a person's breathing.
 - It has a reflex center which controls vomiting, coughing, hiccupping, and swallowing.
- Any damage to the medulla oblongata is usually fatal.

Cerebellum & Thalamus

- **Cerebellum**
 - Located towards the back of the brain, controls muscle co-ordination. This structure contains 50 percent of the brain's neurons. By controlling our muscle coordination, the cerebellum helps us maintain our balance.
- **Thalamus**
 - Known as a sensory relay center. It receives the sensations of touch, pain, heat and cold as well as information from the muscles. Mild sensations are sent to the cerebrum, the conscious part of the brain. Strong sensations are sent to the hypothalamus

Hypothalamus & Cerebrum

- **Hypothalamus**
 - Main control center for the autonomic nervous system.
 - Helps the body respond to threats (stress) by sending impulses to various internal organs via the sympathetic nervous system. After the threat is passed, it helps the body to restore to its normal resting state or homeostasis.
- **Cerebrum**
 - Largest part of the brain. It has a number of functions:
 - All of the information from our senses is sorted and interpreted in the cerebrum.
 - Controls voluntary muscles that control movement and speech
 - Memories are stored in this area.
 - Decisions are made here

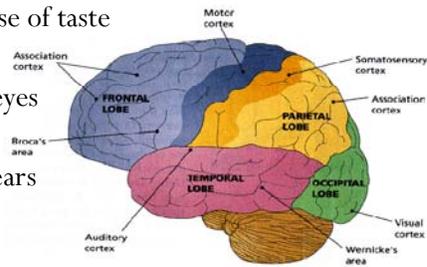
More on the Cerebrum

- The cerebrum is divided into two halves:
 - **Right and left hemispheres.**
 - Each hemisphere is covered by a thin layer called the **cerebral cortex**. This cortex contains over one billion cells and it is this layer which enables us to experience sensation, voluntary movement and our conscious thought processes. The surface of the cortex is made of grey matter.
- The two hemispheres are joined by a layer of white matter called the **corpus callosum** which transfers impulses from one hemisphere to the other.
- The cerebrum is also divided into four lobes.

See Fig. 12.12, P. 400

The Four Lobes

- Frontal Lobe
 - Involved in muscle control and reasoning. It allows you to think critically
- Parietal Lobe
 - receives sensory information from our skin and skeletal muscles.
 - It is also associated with our sense of taste
- Occipital Lobe
 - Receives information from the eyes
- Temporal Lobe
 - Receives information from the ears



12.2

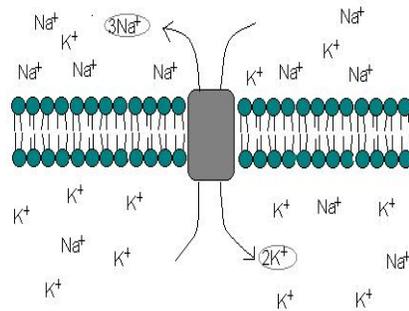
How The Neuron Works

- Resting potential – Neuron at “rest”
- Not carrying an impulse
- Neuron surface is polarized
 - Outside is overall positively charged, while inside is overall negatively charged
- Outside of neuron membrane is positively charged
 - Caused by higher concentrations of positive ions than negative ions outside in the tissue fluid .

Diagram of neuron in resting potential

+++++ lots of Na^+ , less K^+ ++++++ **OUTSIDETHE AXON**
 -----+-----+----- **INSIDETHE AXON**
 -----+-----+-----

- Some Na^+ ions and K^+ ions are present inside, but the overall charge is negative
- Membrane of neuron has gated channels to move Na^+ and K^+ ions.
- The larger negatively charged ions in the cell (proteins, amino acids, etc.) cannot diffuse out.
- The Na^+ and K^+ ions outside are attracted to the negative ions inside the cell and start to diffuse in.



- Resting potential (-70 mV) is maintained by special gated channels in the neuron's membrane called sodium - potassium (Na^+ / K^+) pumps
- For every 3 Na^+ ions they pump out of the cell, in exchange they pull 2 K^+ ions back into the cell. (a 3 out, 2 in ratio).
- This maintains more positive ions outside the cell than inside, maintaining the resting potential polarization
- see fig C in Fig 12.13, p. 403

Action Potential

- Action potential is when a neuron's membrane has been stimulated to carry an impulse. The membrane depolarizes (polarity reverses)
- Stimulation causes a wave of depolarization to travel along the neuron, from the dendrites, through the cell body to terminal brushes.
- When the neuron receives an impulse the membrane becomes highly permeable to sodium.
- The gated K^+ channels close and the gates of the Na^+ channels open $\rightarrow Na^+$ ions move into the axon, making the interior more positive than the outside of the neuron.
- This causes a **depolarization** in this area of the neuron, causing the polarity to be reversed area of the axon.
- The sodium rushes in displacing the potassium For a very short time the polarity of the affected region changes and becomes positive on the inside and negative on the outside
- This action sets off a chain reaction where the membrane next to the affect one becomes permeable In this fashion the impulse is transferred the length of the neuron.

Action Potential in Action

- [Maintenance of membrane potential](#)
- [Action Potential](#)
- [Action Potential Chain Reaction](#)
- [Action Potential of a Myelinated Neuron](#)

Animations linked to jump drive – biology3201\notes\animations

Refractory Period

- The brief time between the triggering of an impulse and the time it takes to restore the neuron back to resting potential, so that it can carry another impulse.



- A neuron cannot transmit two impulses at once, it must first be reset before it can be triggered

Repolarization of the Neuron

- Areas are depolarized only for a split second
- As the impulse passes, gated sodium ion channels close, stopping the influx of sodium ions.
- Gated potassium ion channels open, letting potassium ions leave the cell. This repolarizes the cell to resting potential.
- The gated potassium ion channels close and the resting potential is maintained by the Na^+ / K^+ pumps, restoring this area of the axon back to resting potential.

A Few More Points About A. P.

- Power of the nervous system
 - Oxygen and glucose are used by the mitochondria of the neuron to produce energy - rich molecules called ATP which are used to fuel the active transport of Na^+ and K^+ .
- Wave of Polarization
 - By using a wave impulse can move along the entire length of a neuron and the strength of the signal does not decrease.
 - Thus, a stimulus such as stubbing your toe gets to the brain at the same strength as a bump in the head.
- Threshold
 - The level of stimulation a neuron needs for an action potential to occur. (e.g. a particle of dust landing on your skin is below threshold, you don't feel it but a fly landing on your skin is above threshold, you feel it)

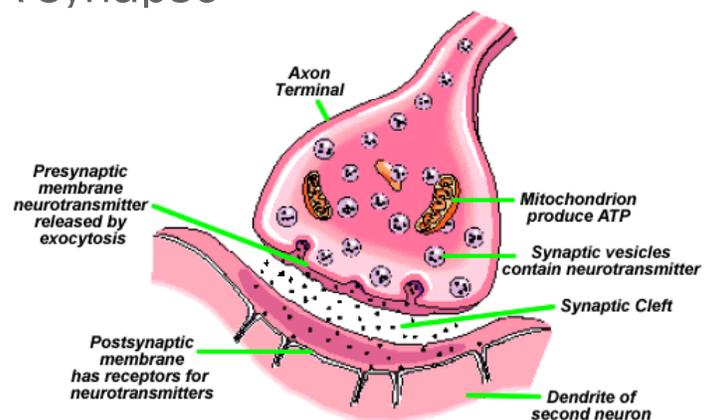
All-or-None Principle

- Axons are governed by this principle.
- Neurons do not send mild or strong impulses. If an axon is stimulated above the threshold level, the axon will trigger an impulse along the entire length of the neuron.
- The strength of the impulse is the same along the entire neuron. Also, the strength of an impulse is not made greater by the strength of the stimulus. The neuron fires at the same strength all the time.
- So what causes the sensation from a mild poke to be different from a hard jab?
 - Pain receptors are buried at different levels of the skin. The harder the jab, the more receptors fire off, increasing the sensation of pain

The Synapse

- The gap between the axon terminal of one neuron and the dendrite of another neuron or an effector muscle
- **Pre-synaptic neuron**
 - The neuron that carries the wave of depolarization (impulse) **towards** the synapse.
- **Post-synaptic neuron**
 - The neuron that **receives** the stimulus from across the synapse.
- **Synaptic vesicles**
 - Specialized vacuoles found in the pre-synaptic neuron's axon terminal membrane.

A synapse



The Synaptic Response

- When the axon terminals of the pre-synaptic neuron receive an impulse, special calcium ion gates in the membrane open.
- This triggers the release of **neurotransmitter** molecules from synaptic vesicles in the membrane.
- The neurotransmitters diffuse into the synapse area, binding with special sites on the postsynaptic neuron's dendrites call **receptor sites**.
- Neurotransmitters are either **excitatory** or **inhibitory**.
 - **Excitatory neurotransmitter**
 - The impulse will be passed on, starting up in the post-synaptic neuron and continuing through this neuron.
 - **Inhibitory neurotransmitter**
 - Blocks the transmission from going into the next neuron.

Neurotransmitters and their Effects

1. **Acetylcholine**
 - can have excitatory or inhibitory effects, depending on the muscle on which it acts. Stimulates skeletal muscle but inhibits heart muscle.
 - is the primary neurotransmitter of the somatic and parasympathetic nervous system.
2. **Noradrenalin**
 - The primary neurotransmitter of the sympathetic nervous system
3. **Glutamate**
 - Neurotransmitter of the cerebral cortex; accounts for 75% of all excitatory transmissions in the brain.

Neurotransmitters and their Effects

1. GABA (Gamma Aminobutyric Acid)

- Most common inhibitory neurotransmitter in the brain.

2. Dopamine

- works in the brain to elevate your mood (**happy happy!!!**) and works out in the body to help control skeletal muscles.

3. Serotonin

- Involved in alertness, sleepiness, thermoregulation (body temp) and regulating your “mood”.

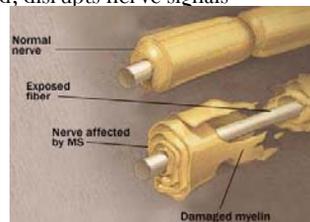
Disorders of the Nervous System

Multiple Sclerosis (or MS)

- Progressive disorder (gets worse over time)
- Affects nerves in the brain and spinal column
- myelin sheath around nerves become damaged; disrupts nerve signals

Symptoms

- blurred or double vision
- slurred speech
- loss of muscle coordination
- weakness
- tingling or numbness in arms or legs
- seizures
- Autoimmune disorder - own immune system mistakenly attacks the myelin sheaths
- No cure but there is some drugs that suppress the immune system



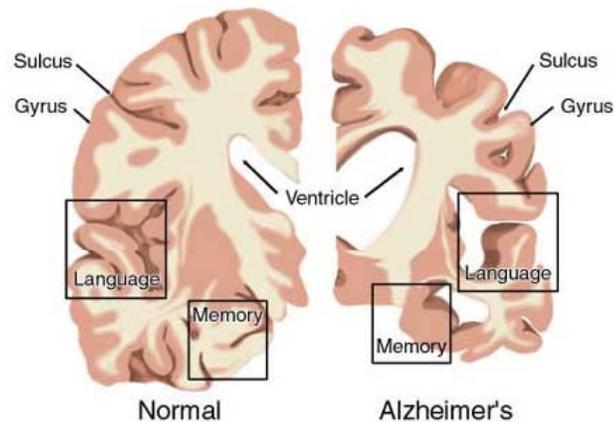
Disorders... 2 of 8

Alzheimer's Disease

- Progressive form of dementia - an impairment of the brain's intellectual functions
- Brain deteriorates, causing memory loss, confusion and impaired judgement.
- Caused by deposits of a protein called amyloid in the brain that disrupts communication between brain cells
- Levels of acetylcholine drop, further breaking down brain cell communication.
- Patients start out not being able to remember things, have difficulty learning.
- Eventually old memories are lost - cannot recognize people they know.
- Have personality changes - irritable, anxious, aggressiveness
- No means of preventing it; no real treatment, but certain drugs can be used to increase the brain's production of acetylcholine but this only works for less than a year.
- Mental function declines until death

Normal Brain vs. Alzheimer's Brain

Brain Cross-Sections



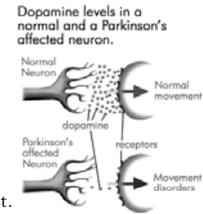
Disorders... 3 of 8

Parkinson's Disease

- Progressive, chronic movement disorder
- Caused by gradual death of neurons that produce dopamine, a neurotransmitter in the Brain that acts to carry messages between areas of the brain controlling body movements.

Symptoms:

- Begins with slight tremors and stiffness in limbs on one side of the body.
 - Tremor eventually spreads to both sides of the body
 - Limbs become rigid
 - Body movements slow down; have an abnormal gait (walk)
- By the time 1st symptoms appear, 70 - 80% of cells producing dopamine are lost.
- No cure at present.
- Treatments are drugs that boost the production of dopamine or mimic the effect of dopamine on brain cells. The drugs used have bad side effects like mental impairment so their use is limited.
- There are some surgical treatments; used in patients that do not respond to drugs. Lesions develop in the areas of the brain affected or electrodes are implanted- very experimental treatments.
- New innovative treatment is the transplanting of fetal brain tissue into the affected areas.



Disorders... 4 of 8

Meningitis

- Caused by a **viral or bacterial infection** of the meninges protecting the brain and spinal cord.
- Viral meningitis is less serious but bacterial meningitis can be fatal if not treated

Symptoms:

- Headache
 - fever and stiff neck
 - sensitivity to light
 - Drowsiness
- Diagnosed by lumbar puncture (spinal tap). A needle is inserted into the spine and cerebrospinal fluid is drawn out for analysis.
- Vaccines are available for some bacterial meningitis but not for the viral types.
- Survivors of bacterial meningitis may suffer long-term effects like hearing loss.

Disorders... 5 of 8

Huntington's Disease

- Fatal progressive disorder; there is no cure and no way of slowing it down. Usually die within 15 years of its diagnosis.
- Inherited genetically
- Nerve cells in certain parts of the brain degenerate

Symptoms:

- jerky, twitching movements
- progressive decrease in mental and emotional abilities; memory loss and personality changes
- loss of major muscle control
- Each child of a parent with Huntington's has a 50% chance of inheriting the disease. This often happens because the symptoms often do not appear until the person is in their 40's, long after they have started their families.
- Genetic screening is available to see if a person has Huntington's.

Disorders... 6 of 8

Amyotrophic lateral sclerosis (ALS)

aka Lou Gherig's disease

- Is a progressive, neuromuscular disease that weakens and eventually destroys motor neurons. Loss of skeletal muscle control and coordination (eg. muscle weakness, trouble walking, talking, swallowing, etc.) eventual paralysis of all muscles, voluntary and involuntary
- Loss of diaphragm function eventually leads to death
- The cause of ALS is not completely understood. Researchers and physicians suspect viruses, neurotoxins.

Disorders... 7 of 8

Tourette's syndrome

- The most well-known tic disorder
- Tics are usually very rapid, short-lived, stereotypical repeated movements that commonly involve the motor system or the voice.
- Two types of tics:
 1. **Motor tics** often involve the eyelids, eyebrows, or other facial muscles, as well as the upper limbs.
 2. **Vocal tics** may involve grunting, throat clearing, coughing, or cursing.
- Usually begins in childhood or adolescence and is much more common in males.

Tourette's syndrome...

- The disease sometimes improves but other times worsens
- Attention deficit hyperactivity disorder (ADHD) and obsessive-compulsive disorder are often seen in persons with Tourette's
- Individuals with tic disorders often describe a strong urge to perform a particular tic and may feel pressure building up inside of them, if the action is not performed
- Cause associated with high levels of dopamine in the brain.
- Treatment of most tic disorders employs the use of medications that decrease the amount of dopamine in the brain.

Disorders... 8 of 8

Epilepsy

- Is a chronic neurological condition characterized by recurrent seizures
- Caused by abnormal cerebral nerve cell activity
- Improper concentration of salts within the brain cells and over activity of certain neurotransmitters can disrupt orderly nerve cell transmission and trigger seizure activity.

Treating Stroke and Spinal Cord Injury

- A stroke is caused by a loss of blood (oxygen and nutrients) to brain tissue. Effects were studied in Biology 2201 (p. 326). The degree of damage and the areas of the brain affected are diagnosed by CAT or MRI. Severe spinal cord injury results in paralysis of muscles below the break point. Diagnosis can be done by CAT and MRI.
- Treatments of stroke currently involve rehabilitation
 - physical therapy, mental exercises and other processes to try to force other parts of the brain to take over the functions lost, such as speech, motor coordination, etc.
- New and radical treatment involves the transplanting of stem cells into the injured area.
 - Stem cells are cells that have not yet specialized. They take on the characteristics of the cells around them, replacing the damaged brain cells.
 - This is called **cell - based therapy**. There is great hope for this technique. Stem cell therapy could also be used one day to repair damaged spinal tissue.

STSE: Drugs & Homeostasis

Assignment

[Drugs hand-out](#)

- Read the STSE article
- Answer the following questions
 - Understanding concepts: 1, 2, 3, 4
 - Extensions: 1
- Due date: 1 week from today
- Section review assignment

12.3 The Sense Organs The Human Eye

- Humans receive a lot of information through their eyes.
- Our eyes are important and therefore are protected by a number of things:
 - Eyelashes
 - Eyelids
 - Eyebrows
 - Ridges of bone in the skull



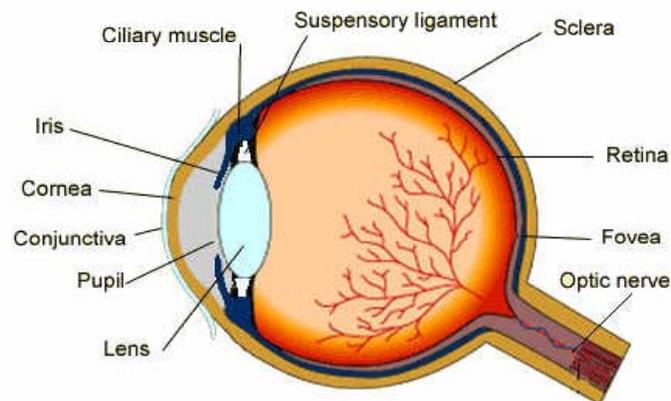
Structure of the Eye

See page 410 – fig 12.19

- **Lens** - The clear, flexible tissue that adjusts as you look at objects close or far away.
- **Iris** - The muscle that adjusts the pupil to regulate the amount of light that enters the eye.
- **Retina** - The inner layer of the eye. It has two types of photoreceptors, rods and cones.
- **Cornea** - The clear part of the sclera at the front of the eye.
- **Choroid layer** - The middle layer of the eye that absorbs light and prevents internal reflection. The layer forms the iris at the front of the eye.
- **Fovea** - An area located directly behind the center of the lens. Cones are concentrated here.
- **Rods** - Photo receptors in the eye. They are more sensitive to light than cones but are unable to distinguish color (see only in black and white)
- **Cones** - Color receptors in the eye; less sensitive to light than rods but see in color.
- **Pupil** - The opening in the middle of the iris of the eye. The size of the pupil can be adjusted to control the amount of light entering the eye.
- **Blind spot** - Part of the retina, where axons of ganglion cells leave to form the optic nerve. This part of the retina forms no image on it.

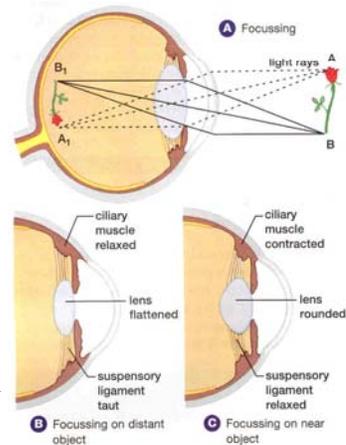
Diagram: The Eye

- See figure 12.19 in your book for the full diagram, this figure is not as completely labeled.



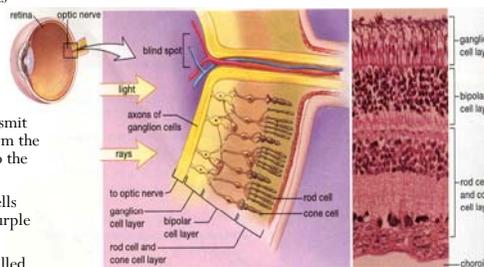
How The Eye Works

- Light entering the eye first passes through the cornea.
- Next, the light passes through the pupil. The pupil will dilate or open if there is not enough light entering the eye. On the other hand, the pupil will constrict or close if there is too much light. (NEGATIVE FEEDBACK LOOP)
- Next, the light passes through the lens. The shape of the lens can change depending on your distance from an object. When you look at something far away the lens flattens and when you look at something close the lens becomes more rounded. This adjustment of the lens is called **accommodation**.



How The Eye Works....

- Next, the light is focused on the retina. The retina has three layers ;
 1. The ganglion cell layer
 2. The bipolar cell layer
 3. The rod and cone cell layer
- The bipolar cells join with the rods and cones to transmit impulses to the ganglion cells. The ganglion cells form the **optic nerve**. The optic nerve carries the impulse to the brain to be interpreted.
- The retina contains approximately 150 million rod cells and 6 billion cone cells. Both rods and cones use a purple pigment called **rhodopsin** to perform their job.
- The cones are concentrated in an area of the retina called the **fovea centralis**. Rods are located all over the retina.



Disorders of the Eye 1

Myopia or near-sightedness

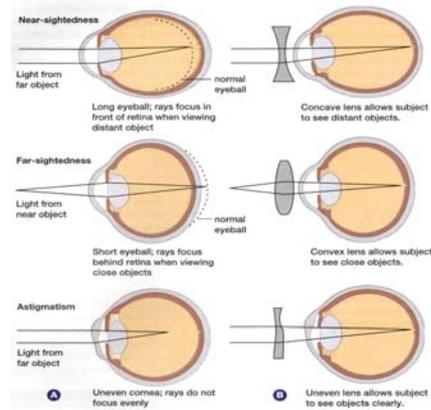
- Person has trouble seeing objects which are far away. It is caused by the eyeball being too long or the ciliary muscles being too strong and causing the lens to become distorted.

Hyperopia or far-sightedness

- Person has difficulty in seeing objects which are close. It is caused by the eyeball being too short or the ciliary muscles being too weak and therefore unable to focus the lens properly. Thus, images of nearby objects cannot be focused on the retina.

Astigmatism

- An abnormality in the shape of the cornea or lens which results in an uneven focus. The image is focused in front of the retina and cannot be seen correctly. Corrective lenses are used to focus the image onto the retina so that it can be seen correctly.



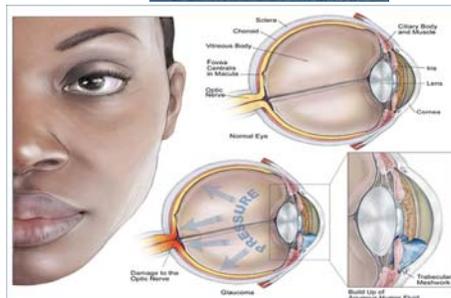
Disorders of the Eye 2

Cataracts

- Cloudy or opaque areas on the lens which increase over time and can eventually cause blindness.
- They are common in older people and can result from too much exposure to sunlight.
- They can be treated surgically by replacing the damaged lens with an artificial lens.

Glaucoma

- Caused by too much aqueous humour building up between the lens and the cornea.
- Normally, excess aqueous humour is drained from this area, however, if the drainage ducts become blocked the extra fluid creates pressure that destroys the nerve fibers that control peripheral vision.
- The damage cannot be repaired, but can be curbed by drug treatment or surgery



Treatment Options

- Laser surgery can be performed to correct disorders such as myopia, hyperopia, and astigmatism.
- There are two main types of laser surgery:
 1. Photorefractive keratectomy (PRK) surgery
 - Performed with anesthetic eye drops. A laser beam reshapes the cornea by cutting microscopic amounts of tissue from the outer surface of the cornea. The procedure takes only a few minutes and recovery is quick.
 2. Laser in situ keratomileusis (LASIK) surgery
 - Performed for people who are near-sighted. First a knife is used to cut a flap of corneal tissue, then a laser is used to remove the tissue underneath the flap and then the flap is replaced.
- If the cornea is seriously impaired by disease, a corneal transplant can be performed. Here a diseased cornea is removed and replaced by a healthy donor cornea. Recovery is long and vision improves over 6 to 12 months



The Human Ear

- The human ear contains mechanoreceptors. These structures are able to translate the movement of air into nerve impulses which are interpreted by the brain.

The ear has three sections

1. The outer ear
 2. The middle ear
 3. The inner ear
- The outer ear is made up of two parts: the **pinna** and the **auditory canal**. The pinna catches the sound and sends it down the auditory canal which contains tiny hairs and sweat glands. The auditory canal carries the sound to the **eardrum or tympanic membrane**.
 - The middle ear begins at the **tympanic membrane**. It ends at two small openings called the **round window** and **oval window**. There are three small bones between the eardrum and the oval window, these are the **malleus** (hammer), **incus** (anvil), and **stapes** (stirrup). These three bones are collectively called the **ossicles**. Connected to the middle ear is a tube called the **auditory tube** or **eustachian tube**. This tube is used to equalize air pressure within the ear

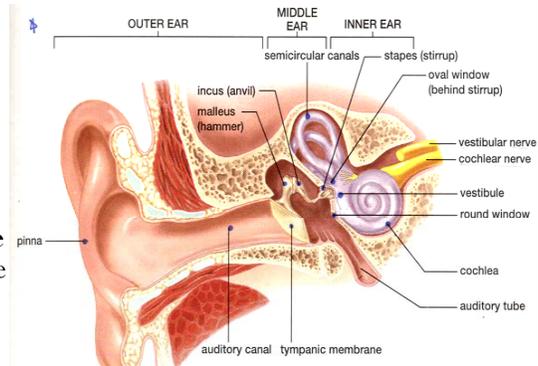


The Human Ear...

- The inner ear is made up of three sections:

1. Cochlea
2. Vestibule
3. Semicircular canals

1. The **cochlea** plays a role in hearing. The **vestibule** and **semicircular canals** are involved in balance and equilibrium.



How the Ear Works 1

1. Sound waves are caught by the pinna and enter the auditory canal.
2. At the end of the auditory canal, the sound waves cause the tympanic membrane (eardrum) to vibrate.
3. Vibration of the eardrum causes the three ear bones (ossicles) to vibrate.
 - The malleus strikes the incus and the incus causes the stapes to move.
 - Movement of the stapes causes the oval window to vibrate and this vibration passes to the cochlea and passes through the cochlear fluid.

How the Ear Works 2

4. The cochlea contains three canals:
 - vestibular canal, cochlear canal, and tympanic canal.
5. The lower wall of the cochlea is made up of a basilar membrane.
 - This membrane has many tiny hair cells. These hair cells combine to form a spiral organ called the organ of Corti.
6. These hairs join with the cochlear nerve which connects with the auditory nerve.
7. The auditory nerve sends the impulse to the brain to be interpreted.

Disorders of the Auditory System

- Any disorder will generally result in deafness
- There are two main types of deafness
 1. Nerve Deafness
 - Caused by damage to the hair cells in the cochlea. It is an uneven deafness in which you can hear some frequencies better than others. It is irreversible
 2. Conduction Deafness
 - Caused by damage to the outer or middle ear. It affects the transmission of sound waves to the outer ear. People who have this type of deafness are not totally deaf.
 - This type of deafness can be improved by using a hearing aid.

3 Types of Hearing Aids



Conventional hearing aid

- has a microphone to receive the sound, an amplifier to increase the volume of the sound, and a receiver which transmits the sound to the inner ear.

Programmable hearing aid

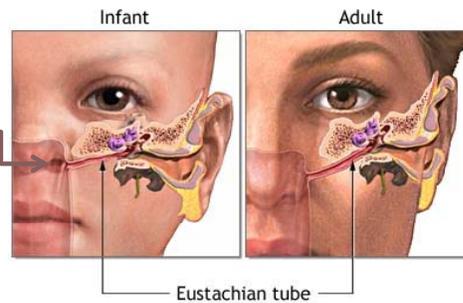
- Has an analog circuit which is programmed by a health care professional. It also has automatic volume control.

Digital hearing aid

- Processes sound digitally. The digital hearing aid can change the pitch and frequency of a sound wave to meet an individual's needs.

Middle Ear Infection

- Problem faced by many children with regards to hearing is fluid build-up behind the eardrum.
- This causes chronic middle ear infections.
- This is caused by an improperly angled eustachian tube which prevents proper fluid drainage.
- It can be corrected by tympanostomy or tube surgery
 - a procedure in which plastic tubes are placed in a slit in the eardrum.
 - The tube allows for the fluid to drain and this relieves pressure on the eardrum.
 - As the eardrum heals, the tube is usually pushed out of the ear. This takes about 6 months to 2 years.



ADAM.

Chapter 12 - Complete

- Section Review Question
 - Page 416 – 1, 2, 4, 6, 7, 8, 9, 10, 11, 15

- Eye and Ear Test
 - Date: TBA