Biology of Aging II: Immune, Nervous, and Reproductive Systems

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**Lecture Part II: The Nervous System**

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**Objectives**

- Be able to define, distinguish, and describe normal age-related biological changes of the immune, nervous, and reproductive systems
- Be able to discuss the impact of age-related changes on the needs and functioning of older adults
- Understand how normal age-related changes influence the older person's ability to function
- Be able to distinguish normal age-related changes from disease processes
- Be able to distinguish between chronic and acute disorders
- Be able to define and discuss common disorders that come with age of the major body systems.

**Introduction**
Any change in immune function can have a dramatic effect on one’s overall feeling of well being. Aging causes a decline in immune function which leaves every organ - every tissue throughout your body more vulnerable to infectious disease. The teaching method of describing normal aging, followed by a description of age-related disease becomes somewhat arbitrary when talking about the immune system. The ultimate consequence of any age-related decline in immune function is an increase in the incidence and severity of infectious diseases like pneumonia, gastrointestinal disease (i.e. infectious diarrhea), urinary tract infections, skin infections and cancers. The effect of immune aging is so all-encompassing that it has lead some to hypothesize that the aging process is due to immune senescence. An extreme example of the consequence of immune compromise is acquired immune deficiency syndrome or AIDS. Young people in their 20's with AIDS contracted diseases and often died from infections and cancers that were previously only seen with immune senescence in the elderly (i.e. carposis sarcoma - skin cancer, pneumocystic carinii - pneumonia).

To understand aging of the immune system we need to understand how it functions optimally in a young adult. Our bodies have an external lining which serves as a barrier to penetration by bacteria and viruses. The skin is relatively tough and has to be punctured for infections to occur in or below it. The lining of our respiratory tract is covered with mucus which collects foreign particles, including bacteria and viruses, for elimination into the gut. The stomach is an incredibly acidic and highly inhospitable environment for most organisms. If these barriers are penetrated, however, we initially rely upon an aggressive, but nonspecific component of the immune system to attack and eliminate invaders. These cells are a class of white blood cell or leukocyte which do not have the ability to undergo rapid replication, but rather they aggressively attack and digest (phagocytize) foreign agents which have entered the body. This component of our white blood cell defense is always ready to go and it takes a minimum of time before they reach full strength. This property of these nonspecific cells is in contrast the specific immune cells that are also classified as leukocytes, the lymphocytes. These are the cells responsible for the immune reaction, but they take time to mount it. It is the element of time that is crucial when discussing infection and vulnerability in the aged population. The nonspecific leukocytes (i.e. granulocyte, macrophage/monocytes, natural killer cells) and serum proteins known as compliment proteins are first on the scene of an infection and they either eliminate it or try to slow it down until the immune response it fully developed.

All of our white blood cells or leukocytes ultimately originate from a cell division spent by a special class of cell known as a stem cell. White blood cell stem cells and red blood cell stem cells are found within the bone marrow (the stem cells are also referred to as hematopoietic cells). The new precursor-immune cells, recently budded off from the stem cells, undergo specialization into the many different types of white blood cells. This specialization is produced through contact with other cells and hormones of the immune system. The nonspecific phagocytic (digestive) cells include granulocyte, natural killer cells (they target cancer cells) and macrophage cells. If the infection overwhelms these nonspecific cells, the specific component of the immune system (lymphocytes) will be recruited. The lymphocytes include the antibody producing cells known as plasma B-cells and regulatory and killer cells known as T-cells. What sets the lymphocytes apart from the other nonspecific leukocytes is their ability to undergo rapid cell division in response to bacterial or viral invasion. The lymphocytes match and eventually overtake the rate of cell division being performed by bacteria or virus particles. It is this aspect of immune function, cell division by the lymphocytes, which is most affected by the aging process. The white blood cells circulate throughout our bodies in the cardiovascular system and in a parallel duct system of lymphatic vessels and nodes. Collectively, the immune system cells act as our sentries and they are on constant surveillance for microbial attack.
Immune System Aging

Most studies indicate that the nonspecific component of the immune system is relatively unaffected by aging (granulocyte, macrophage/monocytes). Their numbers remain the same and their ability to attack bacteria or virus remains the same. One type of cell that straddles that definition between specific and nonspecific immune cells is the natural killer cells. There is evidence for an age-related decline in their numbers, which is important since these cells primary job is to eliminate cancer cells. There is also evidence of lipid inhibition of these cells which may be important in terms of diet or obesity. The major problem with aging in the immune system, however, appears to reside in the ability of the specific immune system cells (T-cells and B-cells) to undergo rapid cell division. As a result, the immune system has trouble keeping up with the rate of cell division performed by bacteria and virus and the body is much easily over-run. The end result is older people tend to be ill more often and when they do get ill it is much more severe. This is why the elderly are encouraged to receive annual flu vaccinations. The vaccinations produce hundreds of memory cells that help to immediately eradicate the invasion. The reason we need an annual vaccination is because viruses mutate rapidly and the influenza virus changes its outer coat so that memory cells from years gone by cannot recognize it. This is the same reason why we have not developed an AIDS vaccine. The HIV mutates to rapidly for memory cells to work. Why does our specific immune system lose its ability to undergo cell division? To date two clear reasons help to explain the problem. First, as indicated in our general cellular description of aging, all tissues that require cell division are compromised by aging. There is a general slowing the process of cell division with aging, no matter what tissue is examined. Secondly, every human experiences a gradual shrinking of the thymus gland with age. As a result, thymic influences on the production and maturation of all classes of -cells is reduced. The end result of these changes in immune function is an age-related increase in the vulnerability to infectious disease and cancer.

Immune System Age-Related Disease

Symptoms of a disorder of the immune system include severe and numerous infections and increased incidence of cancers. A general lethargy and feeling of malaise may occur. It is important to rule out possible inhibition of the immune system by drugs taken for other disorders (iatrogenic disease). Patients will present with a depressed number of white blood cells (neutropenia) or a complete lack of certain white blood cells (i.e. agranulocytosis). Removal of drugs should result in a return to normal conditions. Nutritional deficiencies can also cause immune compromise. Socioeconomic factors can lend to both vitamin B12 and folate deficiencies. Folate is found in green leafy vegetables and B12 is problematic due to gastric atrophy in aging. Alcoholism can make things worse for both.
Malignancies of the Immune System

In general, there is an increase in the incidence and severity of immune system malignancies in the elderly. The following list provides the most common syndromes.

Acute leukemias (lymphocytic and nonlymphocytic) Cause is varied. Often a consequence of chemotherapy and radiation therapy. Viral infections are also thought to be causative.

Chronic leukemias (lymphocytic or myelocytic)

- Primarily a disease of the elderly
- Genetic risk and possible viral infection as risk factors

Multiple myeloma

- Immature plasma cells found in the bone marrow
- Synthesis of abnormal amounts of antibodies (i.e. IgG, IgA, IgE)
- Increased risk for blacks and people over the age of 50
- Life threatening with risk of renal disease and bone disorders (bone pain is common)

Lymphomas

- Hodgkin’s and non-Hodgkin’s
- Invasion and swelling of lymph nodes
- Fever and weight loss
- Long-term survival with selective chemotherapy
- Immune suppression and/or viral exposure (i.e. Epstein-Barr) are risks.

Websites

Other web sites of interest for aging in the immune system:

- Medicine OnLine
  http://www.meds.com/index.html

- The Leukemia & Lymphoma Society
  http://www.leukemia.org/

- Medical Information: Influenza

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Immune, Nervous, and Reproductive Systems

Part II: The Nervous System

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Lecture Part III: The Reproductive System

Introduction

In describing the nervous system and the aging process, it is easiest to divide up the nervous system into each of its components. We will study the senses, the peripheral nervous system, and the central nervous system (brain and spinal cord). Each of these sections will discuss normal functioning, aging and age-related disease. In the final analysis we will attempt to bring it all together by discussing the interactions that occur between each component (i.e. sensation, central nervous system integration and response generation) to produce behavioral modifications associated with aging.
The Senses

The senses are our environmental detectors. They let us know about light, sound, odors, tastes, heat, pressure to our skin and movement of our bodies. The detection of environmental information is mediated in each of these senses through a specialized type of nervous system cell called a sensory receptor. Sensory receptors behave identically to the basic cell type of the nervous system called the neuron, except each sensory receptor has a developed component of the cell for detecting environmental information. We will describe each of these specialized receptors for each of the senses below. Below we have listed the senses with the environmental information they are specialized to detect.

- **Vision**: light
- **Hearing (audition)**: sound
- **Smell (olfaction)**: odors
- **Taste (gustation)**: tastes
- **Touch (somesthesetics)**: pressure, heat, cold, pain and the movement of our muscles and joints (kinesthesetics)

Vision

Our visual system has evolved to detect light energy that exists within the visual spectrum. The visual spectrum is but a small component of the electromagnetic spectrum that ranges from the lowest frequency radio waves to the incredibly high frequency x-ray and gamma-rays. The frequency of movement of electrons within each atom is emitted as a mass-less particle known as a photon that we see as a colored or white light. When the photon encounters the special pigment protein found in our light receptors or photoreceptors of the eye, the pigment transduces this energy into an electrical impulse which is then sent to the brain.
We have both black and white photoreceptors known as rods and color receptors known as cones. The photo pigment found in rods is rhodopsin and the photo pigment found in cones is iodopsin. Absorption of this energy causes a cascade of events that leads to the activation and discharge of the visual receptor. This message is then sent through many neural links to eventually activate neurons found in the visual cortex located in the back of the head. These cells and all of the other cells are highly active and utilize huge amounts of energy (glucose) and the eye is therefore highly vascularized to enable the rapid supply of fuel to the eye. The visual receptors are located in the back of the eye in a region called the retina. The retina has both rods and cones and there is a special region of the retina called the fovea that has the highest visual acuity and is made-up almost exclusively of cones. The fovea is a specialized component of the macula which also contains a very high percentage of cones. When we focus on something, we are focusing the rays of light onto the fovea. The photoreceptors of the retina connect to a number of other neurons where a series of processing steps occur before the information ever leaves the eye. The image is focused on the fovea by a precise bending or refraction of the light by the most outer covering of the eye, the cornea, and by the lens which is made up of a protein called crystalline. The water bodies between the cornea and the lens (anterior chamber filled with aqueous humor) and the lens and the retina (vitreous humor) also contribute to some of the light refraction. Any change in the shape of the cornea or lens will displace the focus of the image.
Aging and Vision

The age-related changes that occur in the visual system can be divided into the optical component (i.e., the lens and cornea) and the receptive or visual component (i.e., the retina).

Optics

With aging, the cornea becomes thicker and less curved with age making the eye more susceptible to astigmatism (defective curvature which results in inconsistent focusing). The other major change is in the lens. The lens tends to harden and increase in opacity with age. The increase in opacity alters light refraction causing a scattering of light. Opacity may also alter color vision slightly. When opacity becomes severe, the result is a cataract. In cataracts the scattering of light and loss of acuity can be so great as to result in functional blindness. The cataract must be removed for vision to return.

The other major age-related change occurring in the lens is a loss of elasticity. The crystalline proteins in the core of the lens are produced at birth and stay with us for our entire lives. Aging causes opacity and cross-linking of these proteins to decrease their flexibility. This change is due in part to the damaging effects of ultra-violet (UV) radiation. To guard against the UV damage we are encouraged to plastic or glass lenses to help to filter out the UV rays. A loss of flexibility can limit the ability of the lens to round up or accommodate when we try to focus on near objects. We can see images far away, but not near. We become hyperopic or farsighted. All humans experience this change and most will require reading glasses after the age of 55. This age-related loss of accommodation is called presbyopia.

The optical properties of the lens can be changed through

- corrective lenses (eyeglasses),
- contact lenses,
- implanting of a new lens or
- radial keratotomy (reshaping of the cornea).

Reception

Although not part of the sensory system, the size of the pupil (determined by the contraction of the iris) becomes smaller as we get older. The ability of the iris to contract and increase the size of the pupil in dark conditions is most affected. The consequence of this change in pupil function is less light is let into the eye in dark conditions. In addition, there are changes in the functions of rods (i.e. decrease in rhodopsin pigment) that dramatically raises the threshold for detecting light. The end result of these changes is that older people have more trouble adapting to changes in light levels (dark adaptation) and they have less acuity in the dark.

Age-Related Diseases of the Eye

We have already discussed the most common visual disorder of the elderly, cataracts (see above). The second most common disorder is glaucoma. Glaucoma results when the intraocular fluid pressure becomes so great that it disrupts the major nerve leaving the eye with visual information. This is followed by a cutting off of the oxygen and resulting blindness. It is cured by relieving the pressure. The most common treatment is eye drops (Miotics) containing pilocarpine or beta-blockers (i.e. Timolol).
The most devastating eye disease is senile macular degeneration. The macula is responsible for our color vision and it contains the fovea which is critical for focusing images and obtaining the greatest visual acuity. Macular degeneration has a hereditary component and it occurs mostly in women. It is associated with vascular damage and some cases may be treated with laser photocoagulation.

Another disease that commonly results in blindness is diabetes. The vasculature of the eye is highly sensitive to diabetic pathology and the blood vessels of the eye can either become occluded or proliferate to result in blindness.

**Something to Think About**

Click on the **Vision Simulator** and observe the changes that occur in vision with age, as well as the effects of some age-related diseases. Note the problems that the elderly might encounter in life if such changes and diseases are not taken care of.

**Hearing**

Sound moves through the air in waves that result from the compression and collision of adjoining air molecules. Different sounds result from the movement of the air particles at different frequencies. Ultimately the air molecule movement will reach the eardrum (tympanic membrane) of the middle ear causing a compression and movement of the eardrum. The ear drum is attached to the bones of the middle ear (hammer, anvil and stirrup) which religiously follow the frequency and depth of the movement of the ear drum. The stirrup attaches directly to the receptive organ of the ear, the cochlea, at a specialized zone called the oval window. The cochlea is filled with fluid and movement at the oval window sets the fluid into motion in a fashion that is coded for the intensity and frequency of movement experienced by the ear drum. The receptor cells of the cochlea are called hair cells for the hair like projections they send up into the gelatinous fluid filling the cochlea. There are approximately 20,000 hair cells found within the organ of corti positioned in each cochlea and they are arranged in rows of three. The receptors genetically determined to respond to high frequency sounds are located closest to the oval window and the ones designed to detect low frequency sounds are the furthest away from the window. The cochlea looks like a snail shell, with the low frequency receptors all rolled up in the center of the shell. Movement of the fluid in the cochlea causes movement of the hair-like projections which causes the hair cell to discharge (if the movement was at the correct frequency) and send its information out the auditory nerve and into the brain for processing.

**Aging and Hearing**

A loss of hearing associated with aging is referred to as presbycusis. The most common age related change in hearing is a reduced sensitivity or loss of detection of high frequency sounds. This age-related change is due mainly to the damage and loss of hair cells destined to perceive the high frequency sounds. More rarely, changes in the cochlea structure can also cause this type of hearing loss. These changes can impair our ability to localize sounds, especially if our ears are not equally effected. The loss of high frequency
perception also disrupts our ability to perceive and understand speech. This decline is most marked when the person is speaking quickly or with echoes and disruptions as is often encountered in crowded rooms. Hearing loss is determined through an audiogram. Most age related hearing impairment can be treated successfully with hearing aids. Over the last few decades there has been a market improvement in the quality of these devices. Most recently, digital hearing aids have been introduced which are a great improvement over analog devices.

**Vestibular Function**

Our vestibular apparatus (motion detector) which consists of the utricle and saccule (gravity detectors) operate similarly to the cochlea. They are found in the middle ear area and are located in fluid filled chambers. Movement of the fluid causes movement of the hairs projecting up from the hair cells. These hair cells discharge and send information about the direction and speed of our movement as well as the position of our head with respect to gravity. The membranes of the utricle and saccule actually have a number of small rocks called otoliths imbedded in them and they push down upon the underlying receptors to infer information about gravity.

**Vestibular Aging**

Vestibular dysfunction is manifested by a feeling of unsteadiness, disequilibrium and sometimes vertigo and nausea. Like all sensory cells (except taste receptors) loss of vestibular hairs cells is final. With aging there is some loss of hair cells which impairs the message sent to the brain. These cells are also extremely vulnerable to vascular problems and will easily die if the blood supply is cut off. There are some reports of up to a 50% loss of nerve fibers leaving the vestibular organs in individuals over the age of 70. In extreme cases, some individuals will experience vertigo or dizziness with certain head positions. The only treatment is to train the patient to avoid the head positions or rotations.

**Diseases of Aging of the Vestibular Apparatus**

A common disease that occurs in the vestibular system is Meniere's disease. It usually starts with nausea, vomiting and severe loss of balance. Individuals with this condition are sometimes confined to their beds for weeks. This diseases can last for weeks and even months. However, there are medications that can be used to successfully treat this condition.
Smell (Olfaction)

The sense of smell is incredibly important. It is crucial for deriving pleasure from the environment (i.e. spring time, flowers) and an essential component of the pleasure derived from eating. Problems in smell can often result in malnutrition and lead to a lack of interest in eating. The sense of smell also helps protects us from the consumption of spoiled foods and warns us when leaks in household gases exist.

Olfactory receptors located in the olfactory mucosa of our noses have specialized proteins on their exterior that function to detect different air-born molecules (smells). Every receptor is specialized in that it has a different set of protein detectors on it's surface. When one of these proteins grabs on to an odor molecule it causes the olfactory receptor to discharge and send the information to the brain (the olfactory cortex located just above the nose).

Smell and Aging

As we get older we lose sensitivity (we require more odor to detect it) and we also lose our ability to discriminate between odors. As early in life as when we were toddlers we begin to show changes in our olfactory epithelium. We actually lose sensory cells and they are not replaced. At age 25 we have 50,000 olfactory receptors (mitral cells), at age 60 we have 30,000 and by age 90 we are left with 15,000. This loss of sensory cells underlies the decrease in sensitivity associated with age. Environmental exposure to volatile or noxious agents can accelerate the cell loss.
Taste

Much like the sense of smell, we rely upon taste to tell us whether something is good or bad to eat. Taste receptors have specialized proteins on their surface (also called receptors) that detect different molecules that are dissolved in our saliva. Taste receptors are unique cells in the nervous system in that new ones are cycled in about once every eight days. No other sensory system or other component of the nervous system possesses this ability to regenerate. These taste receptor cells collect together in bunches of 40-50 cells to form flask shaped taste buds.

Taste and Aging

Compared to the sense of smell, aging changes in taste are minor due in part to the regenerative ability of the sensory cells. Nearly 50% of taste buds are lost between the ages of 30 to 60 resulting in a decline in taste sensitivity with age. This change can affect the nutritional status of the elderly since a big part of the drive to eat and obtain nutrition is the pleasure that comes from taste.
**Somesthetic Sense**

The sensation of touch, pressure, heat and cold, vibration, pain, and positioning of our limbs and muscles (proprioception) are all produced by receptors located in the skin, joints and muscles. Each modality is detected by specialized sensory cells specific to the environmental stimuli. Generally, all show some sort of decline with age. Some can be accounted for by central - perceptual changes, but much of the functional change can be attributed to loss of skin receptors. Problems with proprioception can also contribute to an increase in unsteadiness and falls. Decreases in the sensitivity to heat and pain can mean that the person will experience more tissue damage before they remove themselves from the harmful stimulus (e.g., burn). This increase in skin damage is then compounded by the slowing in healing rate of the aged skin and the increased vulnerability of the skin to infection with age.

**The Central Nervous System**

Individual cells responsible for mediating communication in the nervous system are called neurons. Compared to other cells found in our bodies, neurons have an incredible complicated architecture. Like all cells, neurons have a central cell body that contains a nucleus and the biochemical machinery for making new proteins. The neuron is unique in that it has a number of very long processes emanating from the cell body, called dendrites, that serve as antennae for receiving inputs from hundreds or even thousands of other nerve cells. Each of the contacts made by other nerve cells onto the receiving nerve cell's dendrites is called a synapse. The neuron receiving all this information will integrate all the signals and, if they are important enough, they will cause the neuron to produce an electrical discharge known as an action potential. The axon acts like an output cable and links the neuron with the next neuron in the circuit to be recruited for the expression of a behavior, thought or physiological response. Axons can be as short as 1/100th of a mm or as long as a meter. For example, when you make the decision to move your foot, a group of neurons in the outer shell of your brain known as the cortex will send an electrical message (action potential) down their axons which travel out of your head and down your spinal cord to make contact (synapse) with a motor neuron located in your spinal cord at the level of about the bottom of your rib cage. This is an incredibly long distance, but the message travels quickly. When you recruit a number of neurons to produce a behavior (for example 20 cells recruited in sequence) the time it takes to produce the behavior is referred to as your reaction time.

For example let's look at what it takes to react to a red light when you are driving. When you see an object in front of you when you are driving or when the signal changes from green to red, the information has to travel from your eye to a series of relays until it reaches the specialized part of the cortex called the visual cortex located at the back your brain. The neurons of the visual cortex then send this to another part of the brain to make sense of the image (associational cortex). The information is integrated and a decision is made about what to do about the image you just saw (i.e. red light). Once that decision is made a cast of neurons send their output signals to the motor neurons designated to control leg and foot movements (again in the cortex) and, if the signal is strong enough, the motor neurons send their message to the second set of motor neurons found in your spinal cord. These cells are then activated and they send their message to the muscles of the foot and leg causing the foot and leg to move and place your foot on the brake.
Aging and the Central Nervous System

It has been demonstrated in almost every animal studied that the speed with which the signal travels down the axon of each neuron is slowed as a function of age (slowing in conduction velocity). It is estimated that the conduction velocity can decrease by as much as 30% over the life span, with reports of 10-40% decreases in conduction velocity. On an individual cell basis it may not seem like much, but when the effect is additive over many hundreds of neurons involved in a circuit it has the behavioral outcome of slowing reaction time. We have already seen that speech spoken rapidly becomes more difficult to understand with age. Part of this problem in understanding rapid speech stems from the slowing in nerve cell conduction velocity. In general, this basic change can contribute to an overall slowing in cognitive processing. To get a feel of the effect now would be a good time to refer to exercise below.

When we look at the overall brain in aged individuals we that there is a steady loss in brain mass that becomes noticeable after the age of 40. Over the life span it is reported that we may lose as much as 10% of our brain mass. This change in not necessarily due to a loss of nerve cells, which appears to moderate, but rather due to a shrinking of nerve cells. Studies have demonstrated that the dendrites of nerve cells in the oldest population tend to be shorter and less complicated. The number of contacts or synapses also appears to decrease. These change indicate that there is less transfer of information between neurons experiencing these regressive changes. If we look inside the cells there is some evidence of neurofibrillary tangles and neuritic plaques in normal aging, but not to the extent seen in Alzheimer's disease. There is also an increase in the number of supportive, non-communicating cells known as glia in the brain of older people. Glial cells are crucial for eliminating waste and performing debridement.

Age-Related Diseases of the Brain

Nerve cells of the brain do not get replaced (regenerate) if they are lost. In the case of small losses, there is enough redundancy in nerve cell function to allow for neighboring nerve cell to take over the duties and compensate for the small loss. If the nerve cell loss is extensive, however, permanent behavioral modifications will occur.

Parkinson's Disease

Parkinson's Disease is caused by an extensive loss of a very small population of neurons located in the midbrain (just above the junction between your neck and head) which use a specific neurotransmitter, dopamine. While these neurons are not numerous, they have a widespread effect on brain function through the many axons they send throughout the brain. The neurons are located in a very specific and small band called the substantia nigra (black substance). The disease is progressive through the gradual loss of these cells. Parkinson's disease occurs in 1 of every 100 people over the age of 60, with approximately 1.5 million Americans presently diagnosed as having Parkinson's disease. It is estimated that 50,000 new patients will be diagnosed each year.

The diagnosis is based upon the behavioral consequences and the responses to drug therapies. The acronym TRAP is used to describe Parkinson behavior standing for - tremor, rigidity, akinesia (slowing of movement), postural instability. Patient also show a shuffling step, a lack of facial expression and
weak voice, and some cognitive - frontal lobe dysfunction which affects personality, consciousness, attention, and abstract thinking. The cause is speculative at this point. Most research suggests an environmental cause, although there is a rare early onset form that is inherited. The suggested environmental causes include head trauma and vascular damage, heavy metal toxicity, excess excitation leading to cell death and free radical damage of cell molecules leading to cell death.

The most common treatment is SINAMET which is a combination of L-dopa and an inhibitor of the enzyme that usually digests dopamine once it has been released. The strategy behind L-dopa therapy is that dopamine neurons use L-dopa to make dopamine, so if you give them more L-dopa they will make more dopamine. Thus despite the loss of dopamine containing and releasing neurons, the remaining dopamine cells will make more and release more dopamine if given L-dopa and their increased release will compensate for the loss of neighboring cells. The problem is the disease is progressive and as more and more cells die the L-dopa therapy becomes less and less effective.

Other strategies involve the blockage of an enzyme that causes oxidation with a drug called Deprenyl or Eldepryl. By reducing free radical production it slows the progression of the disease.

Surgery while it cannot cure the disease, may assist in the treatment of certain symptoms. The brain often works through apposing systems, like ying and yang. With the loss of the substantia nigra, another system in the brain called pallidum becomes overactive. Surgeons have found that pallidectomy (removal of the pallidum) is quite effective in alleviating the rigidity of Parkinson's disease.

### Alzheimer's Disease

Alzheimer's disease is a disease of survivors affecting the oldest old except for the rare familial cases. It was estimated in 1994 that over 4 million Americans had Alzheimer's disease. There is no successful way to prevent or cure this disease, and it is estimated by the year 2020 there will be 15 million individuals with Alzheimer's disease. The prevalence increases with age with 5% over the age of 65, 10% over 75, 33% over 85 afflicted with the disease. The prevalence doubles every 5.1 years after the age of 65. An extremely rare form of Alzheimer's Disease (5% of cases) is inherited as an autosomal dominant gene.

There are several environmental risk factors that may affect the risk of Alzheimer disease. It has been shown that the chronic use of anti-inflammatory drugs (for example for arthritis) reduces the risk for AD by as much as 60% if taken consistently for a period of over 2 years. This include the nonsteroidal anti-inflammatory drugs (NSAIDs) motrin, ibuprofen and aleve. Mental stimulation also appears to reduce the risk for AD with the lowest incidence of AD in those who went to college and professional schools. High risk factors include prior head injury, low levels of education and occupational exposure to glues, pesticides and fertilizers. For women, a large risk factor is lack of estrogen. Estrogen appears to protect the brain from AD and there is evidence that estrogen supplementation therapy (Premarin) reduces the risk of AD by as much as 50%.

Present therapies for AD are limited. First, cognitive retraining is encouraged. The patients need to have their entire lives structured. Drugs that have had limited success include Tacrine and Aricept.
The diagnosis of dementia is made through neurological and psychological testing which detect cognitive impairment. Other conditions that stimulate dementia need to be eliminated before a diagnosis of Alzheimer's Disease can be made. The ultimate diagnosis of senile dementia of the Alzheimer's type is through the postmortem identification of neurofibrillary tangles and neuritic plaques.

The following is a quick list of other causes of dementia that are not of the Alzheimer's type:

1. depression (pseudodementia)
2. chronic anoxia (obstructive pulmonary disease)
3. multi-infarct dementia (from multiple small strokes)
4. Parkinson's disease (many Parkinson's victims have dementia)
5. Huntington's (clarified by family history) disease
6. Pick's disease (a faster progression of the disease)
7. Head trauma (i.e., dementia pugilistica in boxing prizefighters)
8. hydrocephalus: associated with head injury, diagnosed with imaging, high in Men
9. Slow virus disease (Creutzfeld-Jacob)
10. Korsakoff's syndrome (chronic alcoholics)
11. Thyroid disease (both hyperthyroid and hypothyroid) can mimic dementia
12. Vitamin B12 deficiency

Stroke

Lastly, we would like to end with a short discussion of stroke. It is estimated that over 500,000 Americans will suffer a stroke next year. Stroke result when the oxygen supply is cut off to the brain. The most common cause is when small infarcts or occlusions occur and there may no immediate behavioral consequence. If this process continues, however, the summed effect of many small strokes can be devastating (multi-infarct dementia). Large strokes have a more immediate effect. They can cause paralysis, deafness, loss of speech, functional blindness and anything else perceived by or performed by the brain. The reason for the specific loss of select functions with stroke is the regional specialization of the brain. Distinct regions of the cortex are designated for the perception of touch, pain, sound, taste, and light. Other regions are designated for the perception of language, while others are designated for the production of language. We have provided a model of the brain illustrating the regional specialization of function in class exercise A.

The warning signs of a stroke include:

- a sudden weakness, numbness or paralysis of the face, arm or leg
- sudden dimness or loss of vision
- loss of speech, or trouble talking or understanding language
- unexplained dizziness, unsteadiness or sudden falls, with particular concern if the occur with any of the above symptoms.

Websites

http://www.usc.edu/dept/gero/AgeWorks/fall_session/dll/gero500/biology_b_lect/index_a.htm (12 of 13)10/11/07 1:25 AM
Key Points

The Senses

- Age changes in the eye include thickening and loss of curvature of the cornea (astigmatism), opacity and stiffening of the lens (known as presbyopia), decreased pupil size, and decreased ability of iris to contract (resulting in decreased dark adaptation).
- Common diseases of the aging eye include glaucoma, cataracts, and macular degeneration.
- Age-related change in hearing is called presbycusis (a reduced sensitivity or loss of detection of high frequency sounds).
- Vestibular decline results in decreased coordination and balance with age.
- The olfactory cells decline reducing sensitivity in the sense of smell.
- Sensitivity in taste declines with age. However, taste buds are the only nervous cells in the body capable of regenerating. This regeneration makes age-related changes relatively minor.
  The sensation of touch, pressure, heat and cold, vibration, pain, and positioning of our limbs and muscles (proprioception), all show decline with age.

Central Nervous System

- There are six functional components of the nervous system. The first four involve regulation through monitoring, stimulating, communicating, and coordinating all activity. The last two involve the processes of thinking and memory.
- Age changes in the nervous system include slowing in conduction velocity and nerve cell loss (nerve cells do not regenerate).
- Aging diseases of the brain include dementia (Alzheimer’s, vascular, frontal lobe, etc.), Parkinson’s disease, and stroke.
Menopause occurs between ages 45 and 55 in 99% of women, and is marked by the cessation of ovulation. The main feature of menopause is the enormous decrease in the production of estrogen by the ovary. The effect on the female body is dramatic. When estrogen disappears, so do all of its the stimulatory effects. The vagina atrophies and secretions decrease causing women to complain of discomfort during sex. The urinary
bladder and sphincter weaken causing a dramatic increase in the incidence of urinary incontinence. Vaginal and urinary tract infections also increase due to the decrease in acid secretions. Bone mass more rapidly decreases resulting in postmenopausal osteoporosis. To guard against these changes many women are put on estrogen supplementation therapy. The most common drugs are PREMARIN (estrogen) and Provera (progesterone). Each women must be considered individually, however, since a history of female cancers may rule against using estrogens. A history of fibrocytic growths in the breast or malignancies rule out PREMARIN use. There is also an increased risk of breast cancer among women with a family history of this condition.

**Sexuality and Aging in Women**

Your sex drive or libido is the sum of cognitive and psychological drives which direct you to pursue sexual behavior. It is difficult to separate changes in libido from the so called "husband effect", where women over the age of 55 often complain of a decrease in the number of sexual episodes due to their husbands disinterest or impotence. Menopause may contribute to sexual decline related to vaginal dryness and discomfort. Use of over the counter lubricants greatly reduce these problems. Subjects receiving estrogen supplementation therapy to appear to experience a reversal of most of these changes. However, other women comment on an increase in libido and happiness with their sex lives after menopause. This perception may reflect, in part, the loss of risk for pregnancy following intercourse.

**Breast Cancer**

One in every 10 females over the age of 65 contracts breast cancer. The annual death toll associated with breast cancer is 46,000 per year. Risk factors for breast cancer center include: early menarche, late menopause, no children, a history of fibrocytic growths in the breast, and ovarian, uterine, or cervical cancers. Other environmental risks include obesity, a high fat diet and excess alcohol intake. Genetic studies indicate that 5% if all cases are inherited.

The key to the identification and treatment of breast cancer is early detection. Women before the age of 40 should do monthly self examination to detect small lumps which may be a precursor to breast cancer. After the age of 40, annual mammograms are highly encouraged for all women. The mammogram is not reliable for women younger than 40 because their breast tissue is too dense and false negatives may result. If a tumor is identified, a lumpectomy will be performed followed by (if necessary) removal of the lymph nodes. If the cancer is severe, the entire breast will be removed (mastectomy). A recent drug used to fight breast cancer is Tamoxifen. It blocks the action of estrogen on the breast's estrogen receptor, and is useful in early stages. Often in late stages, the cancer takes a new form where it loses estrogen receptors and Tamoxifen becomes ineffective. Thereafter, traditional chemo- and radiation therapy are used.
The Male Reproductive System

Aging of the Male Reproductive System

Men experience an age-related decrease in testicular size and in sperm production. In some men, there is an almost linear decline in testosterone production that becomes noticeable after the age of 40. However, many males experience no decline in testosterone levels. Both the decrease in testosterone and the decrease in sperm production causes an age-related decrease in fertility. The loss of testosterone also results in a decrease in bone and muscle mass in the aging male. The loss of testosterone may also contribute to sexual dysfunction with age in men.

Sexuality in the Aged Male

There are many changes in sexual function with aging. Men experience a gradual decline in orgasmic activity after late adolescence. The rate of achieving an erection is six times slower in men 50-65 than in men 20-30 years of age. There are also decreases in the strength and frequency of contractions during orgasm that reduce the force of your ejaculation. After ejaculating, men experience an age-related increase in the time it takes them to be responsive to another sexual episode (minutes in adolescence to days in old age). It also takes men much longer to achieve an orgasm as they age, which greatly reduces the incidence of premature ejaculation.

While there is still some controversy, part of the age-related decline in male libido and potency can be attributed to the steady decline in testosterone that occurs with age. Other contributing factors include, in terms of libido, an age-related decline in brain arousal chemistry (dopamine and noradrenaline). A final factor worth considering is the many drugs that the elderly often find themselves taking (antihypertensive, antidepressants) which can affect libido.

Age-related Changes in the Male Reproductive System

- In some men, testosterone levels drop by up to 35%.
- The size of the testes decreases.
- There is a decline in the rate of sperm production although the extent varies among individuals.
- Erectile dysfunction (impotence), in which an erection cannot be achieved is experienced by 15% of men by the age of 65 and increases to 50% by age 80.
**Prostate Problems**

Benign prostatic hypertrophy is a disease of advancing age that essentially affects all males to a greater or lesser degree. It is rarely seen before the age of 40, but the incidence increases to 90% of men over the age of 80. Testosterone stimulates growth of the gland as we age. As it grows, the prostate compresses the urethra resulting in symptoms of urinary obstruction. If the bladder is not emptied, it increases the risk of incontinence, bacterial infections and bladder pain from diverticula. The symptoms of urinary obstruction include a hesitancy to void and straining and decreased volume of urine. There will be dribbling and a feeling that there is still urine left in your bladder and an increase in the daily frequency of urinations. The normal prostate is the size of a walnut, but the enlarged prostate can be the size of a lemon. Prostatic enlargement can be detected by a physician performing a rectal examination. The initial diagnosis can be verified by ultrasound imaging and scoping. Treatment can begin early with a drug called Proscar, which inhibits the enzyme for making the active form of testosterone. A side effect, however, is a reduction of sex drive, since it also blocks testosterone action in the brain. If medical treatment is not successful, surgery may be necessary. A simple operation, transurethral resection of the prostate (TURP), can remove enough prostate tissue to provide permanent relief.

**Prostate Cancer**

Much like benign hypertrophy, prostate cancer is rare before the age of 50, but the incidence increases steadily thereafter. It can be asymptomatic or have symptoms similar to benign hypertrophy. Men after the age of 40 are encouraged to have a blood test to measure their prostate serum antigen (PSA). An elevated PSA level suggests the possible presence of cancer and needs to be followed up by sonography of the prostate. Prostatic cancer is a leading cause of cancer death in men age 50 to 65. However, when present in men in the 80's and 90's, it is a very slow growing tumor and unlikely to cause death.

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**Websites**

**Female:**

**Menopause Online**
http://www.menopause-online.com/index.html

**National Action Plan on Breast Cancer**
http://www.4woman.gov/napbc/

**The Truth About Premarin**
http://my.athenet.net/~nrsprntg/stpindex.html

**National Cancer Institution: Tamoxifen Q&A**
http://www.cancer.gov/cancertopics/factsheet/Therapy/tamoxifen
Male:

Prostate Help Association
http://www.personal.u-net.com/~pha/

National Library of Medicine HSTAT: Impotence

Something to Think About

Designing an Age-Awareness Flier

Assume you are the director of a senior services program. How would you design a flier that educates elders about age-associated physiologic changes that utilizes a user-friendly style?

Cyberclass Discussion

After you have completed the readings, lecture and email assignment, please enter the Cyberclass for a discussion.

Please address the following: I would like for you to consider an older person you know who has successfully adapted to declining physical health. How (specifically) has that person been able to do it? What can you (we) learn from this?