

Student Study Guide with Test Questions

G215-B: Anatomy and Physiology - Part II
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Anatomy and Physiology - Part II covers the material in unit 3 (chapters 12-17) offering a look into the nervous, endocrine system control and regulation. Unit 4 (chapters 18-21) explore the fluid transport systems needed to support, protect, and regulate the internal environment of the body.

Again, we would like to encourage you to ask questions about the material in the Natural Health category of The Learning Center, in our Student Discussion Group.

Select the best answer(s) from the text.

Unit 3: Chapter 12

1. The first major function of the nervous system is sensation – receiving information about the environment to gain input about what is happening outside the body (or sometimes, within the body). The nervous system produces a response on the basis of the stimuli perceived by sensory structures. Stimuli that are received by sensory structures are _____. This is called **integration**.
 - A. Divided into those that are only involuntary
 - B. Involved in contraction of glands
 - C. Communicated to the nervous system where that information is processed
 - D. All of the above

NOTE: Page 509. Motor nerves originate in the brain, spinal cord, and autonomic ganglia. Somatic nerves are involved in voluntary and reflex skeletal muscle contraction. The autonomic or involuntary part of the nervous system is separated into two divisions: sympathetic (or somatic) and parasympathetic.

2. Which part of a neuron transmits an electrical signal to a target cell?
 - A. Dendrites
 - B. Soma
 - C. Cell Body
 - D. Axon

3. (True or False) The blood-brain barrier is a physiological barrier that keeps many substances that circulate in the rest of the body from getting into the central nervous system, restricting what can cross from circulating blood into the CNS.
4. Myelin is a lipid-rich sheath that surrounds the axon and by doing so creates a myelin sheath that facilitates the transmission of electrical signals along the axon. Myelin:
 - A. Includes proteins integral to the glial cell membrane
 - B. Is the membrane of the glial cell
 - C. Is rich in lipids (fats)
 - D. All of the above

NOTE: Page 520. Most of the axons in the central nervous system are wrapped in myelin which insulates and protects the axon and helps speed along nerve transmission. The destruction of myelin causes 'demyelinating' diseases which are conditions that result "in damage to the protective covering (myelin sheath) that surrounds nerve fibers in your brain and spinal cord. When the myelin sheath is damaged, nerve impulses slow or even stop, causing neurological problems." Mayo Clinic.org Multiple sclerosis (MS), acute disseminated encephalomyelitis (ADEM), peripheral neuropathy/polyneuropathy, and Guillain-Barre syndrome are all types of demyelinating diseases.

In multiple sclerosis (MS), areas of demyelinated white matter are called plaques. The areas are irregularly distributed throughout the brain and spinal cord. MS has several factors (causes) involved. It appears to be an autoimmune disorder, possibly triggered by a viral infection such as the measles.

Guillain-Barre syndrome (GBS) is a rare disorder in which the body's immune system attacks the nerves. It is the leading cause of acute flaccid paralysis in developed countries characterized by various degrees of weakness and tingling in the extremities, sensory abnormalities and autonomic dysfunction. There is widespread inflammation accompanied by some demyelination of spinal, peripheral, and cranial nerves and spinal ganglia. It is also known as 'acute inflammatory polyneuropathy'.

Prior to onset, about two-thirds of people report symptoms of an upper respiratory infection from a few days to six weeks preceding GBS. "Infection with the bacterium *Campylobacter jejuni* is one of the most common risk factors for GBS. People also can develop GBS after having the flu or other infections (such as cytomegalovirus and Epstein Barr virus). On very rare occasions, they may develop GBS in the days or weeks after getting a vaccination." <https://www.cdc.gov/flu/prevent/guillainbarre.htm> The most noteworthy vaccination being the "flu shot".

5. (True or False) The sodium/potassium pump moves sodium ions (Na⁺) out of a cell and potassium ions (K⁺) into a cell, thus regulating ion concentration on both sides of the cell membrane.

Unit 3: Chapter 13

6. (True or False) There are two types of connections between electrically active cells: chemical synapses and hormonal synapses.
7. (True or False) A neurotransmitter is a chemical signal released from one cell to affect another cell.

NOTE: Page 539. A Prion is a small infectious particle composed of abnormally folded protein. These mis-folded proteins affect the brain structure by acting as a template, inducing proteins with normal folding to convert to the abnormal prion form. Prion diseases belong to the family of protein-misfolding neurodegenerative diseases that also include Alzheimer's, Parkinson's, Huntington's disease, and Amyotrophic Lateral Sclerosis (ALS or Lou Gehrig's disease). All of these diseases are characterized by the misfolding of one or several host proteins which leads to neurotoxicity.

Alzheimer's disease is the most common form of dementia in developed countries. With Parkinson's disease there is a gradual and progressive degeneration of dopamine-releasing neurons in the extrapyramidal system which leads to lack of control and coordination of muscle movement. Huntington's disease has a broad impact on a person's functional abilities and usually results in movement, thinking (cognitive) and psychiatric disorders. ALS, also known as Lou Gehrig's disease, is the most common type of Motor Neuron Disease, affecting both the upper and lower motor neurons (neurons in the brain and spinal cord). It affects the muscles of the arms, legs, mouth, and respiratory system. Additionally, Creutzfeldt-Jakob disease is caused by a 'slow' virus. Transmission is thought to be via a heat-resistant transmissible particle known as a prion protein.

8. The nervous system consists of which of the following parts:
 - A. Somatic
 - B. Autonomic
 - C. Enteric
 - D. All of the above
9. (True or False) In an embryo, both the nervous system and the skin (integumentary system) develop from the ectoderm layer.

TEXT HIGHLIGHTS: Page 555. "Early formation of the nervous system depends on the formation of the neural tube. A groove forms along the dorsal surface of the embryo, which becomes deeper until its edges meet and close off to form the tube. If this fails to happen, especially in the posterior region where the spinal cord forms, a developmental defect called spina bifida occurs. The closing of the neural tube is important for more than just the proper formation of the nervous system. The surrounding tissues are dependent on the correct development of the tube. The connective tissues surrounding the CNS can be involved as well."



The proper development of the neural tube is associated with sufficient Vitamin B12 and folate intake in pregnant women.

“A new study shows that women with vitamin B12 deficiency in early pregnancy were up to five times more likely to have a child with neural tube defects, such as spina bifida, compared to women with high levels of vitamin B12... Neural tube defects refer to a group of birth defects that affect the brain and spinal cord. The defects include spina bifida, which can cause partial paralysis, and anencephaly, a fatal condition in which the brain and skull are severely underdeveloped... Researchers say further studies are needed to confirm these results, but the findings suggest that having vitamin B12 levels above 300 ng/L before becoming pregnant may reduce a child's risk of birth defects.”

<https://www.webmd.com/baby/news/20090302/birth-defects-linked-to-low-vitamin-b12#1>

“Spina bifida (myelomeningocele) is the most common major birth defect among live-born infants. It is now recognized that half of those cases are preventable if folate is given periconceptionally. Epidemiology is discussed, together with an overview of approaches to orthopedic problems from birth to maturity.”

<https://pubmed.ncbi.nlm.nih.gov/8858078/>

“A deficiency of vitamin B12 leads to an indirect, functional folic acid deficiency, as the lack of the former interrupts the cycle of the latter.” <https://www.b12-vitamin.com/folic-acid/>

NOTE: Folate is often bound to amino acids which decrease its bioavailability. Vitamin B12 is necessary to release folate (vitamin B9) from these amino acids. In fact, both of these nutrients rely upon each other.

It is also significant that children with Spina Bifida are from 10 to 73% more likely to have a latex allergy. <https://pubmed.ncbi.nlm.nih.gov/11706433/>

10. The central nervous system (CNS) consists of the brain and the spinal cord. The spinal cord is a single structure, whereas the adult brain is described in terms of four major regions. Which of the following are the four parts of the adult brain?
 - A. The cerebrum, the cerebral cortex, the brain stem, the cerebellum
 - B. The cerebrum, the diencephalon, the brain stem, the cerebellum
 - C. The cerebrum, the diencephalon, the corpus callosum, the cerebellum
 - D. The cerebrum, the prefrontal lobe, the brain stem, the cerebellum

11. The cerebrum is the largest part of the brain. It is divided by a deep cleft, into right and left cerebral hemispheres. Deep within the cerebrum, the white matter of the _____ provides the major pathway for communication between the two hemispheres of the cerebral cortex.
 - A. Corpus callosum
 - B. Cerebral hemisphere
 - C. Basal nuclei
 - D. Limbic cortex

NOTE: Page 559. Proprioception and kinesthesia are often used interchangeably in the general sense of the body's location and movement as it relates to self, however, they have different meanings.

Proprioception is a 'sense' or 'perception', usually at a subconscious level, of the movements and position of the body and especially its limbs, independent of vision; this sense is gained primarily from input from sensory nerve terminals in muscles and tendons (muscle spindles) all throughout the body and the fibrous capsule of joints combined with input from the vestibular apparatus. The vestibular apparatus is the part of the inner ear that provides the sense of balance and spatial orientation for the purpose of coordinating movement with balance.

Put simply, proprioception is knowing where our body is in space without having to look at it. It is our sense of position. For a moment, close your eyes and then touch your nose. That is done by proprioception. In the dark, it is how we know when we are walking, sitting, standing, lying down, standing up or reaching for the lamp. Position, balance, and movement are the keys to proprioception.

Kinesthesia on-the-other-hand is responsible for the refining of learned or repetitive movement. A baby learning how to walk, a pianist practicing the piano, a dancer learning ballet steps and positions, a soccer player learning their footwork with the ball, a mime portraying a character/mood/idea by gestures and bodily movements, etc. A short description of kinesthesia is repetitive movement.

12. The thalamus is a collection of nuclei that relay information between the cerebral cortex and the periphery, spinal cord, or brain stem. It is located inferior and slightly anterior to the thalamus is the hypothalamus, the other major region of the diencephalon. It also is situated immediately above the pituitary gland.

The hypothalamus is a collection of nuclei that are largely involved in regulating _____. The hypothalamus is the "executive region in charge" of the autonomic nervous system and the endocrine system through its regulation of the anterior pituitary gland.

- A. Hormone secretion
- B. The amount of cerebrospinal fluid (CSF) in the brain
- C. Homeostasis
- D. The blood/brain barrier

NOTE: Other functions of the hypothalamus include control of the autonomic nervous system, appetite and satiety, thirst and water balance, body temperature, emotional reactions, sexual behavior and child rearing, sleeping and waking cycles.

NOTE: Page 568. "Parkinson's disease is neurodegenerative, meaning that neurons die that cannot be replaced, so there is no cure for the disorder." The medical definition of "cure" being a pharmaceutical or course of treatment effective to treat a disease or wound.

The body's ability to regenerate itself is immense. Science is just now beginning to learn that, yes, neurons CAN regenerate! The mechanism remains unknown. However, **as there is no current medical "treatment", it is said there is no "cure"**.

A few interesting thoughts...

- **Existence of new neuron repair pathway discovered** ~ "Most of your neurons can't be replaced. Other parts of your body -- such as skin and bone -- can be replaced by the body growing new cells, but when you injure your neurons, you can't just grow new ones; instead, the existing cells have to repair themselves. In the case of axon injury, the neuron is able to repair or sometimes even fully regenerate its axon. But neurons have two sides -- the axon (which sends signals to other cells) and the dendrite (which receives signals from other cells)."
<https://news.psu.edu/story/312002/2014/04/16/research/existence-new-neuron-repair-pathway-discovered>
 - **Scientists Say Neuron Repair is Possible** ~ "Mitochondria are mobile in young cells and as a cell matures, the movement is restricted by a protein called syntaphilin. This protein behaves as a brake or anchor for mitochondria. Headed by researcher Zu-Hang Sheng, the team genetically removed syntaphilin from damaged sciatic nerves that contained non-functioning mitochondria. This allowed mitochondria to regain mobility and resulted in the regrowth of other mitochondria that eventually restored the neurons' ability to repair themselves." <https://futurism.com/scientists-say-neuron-repair-is-possible>
 - **Repairing the Nervous System with Stem Cells** ~ "Although reports dating back as early as the 1960s pointed towards the possibility that new nerve cells are formed in adult mammalian brains, this knowledge was not applied in the context of curing devastating brain diseases until the 1990s. While earlier medical research focused on limiting damage once it had occurred, in recent years researchers have been working hard to find out if the cells that can give rise to new neurons can be coaxed to restore brain function. New neurons in the adult brain arise from slowly-dividing cells that appear to be the remnants of stem cells that existed during fetal brain development. Since some of these adult cells still retain the ability to generate both neurons and glia, they are referred to as adult neural stem cells. These findings are exciting because they suggest that the brain may contain a built-in mechanism to repair itself..."
https://stemcells.nih.gov/info/Regenerative_Medicine/2006chapter3.htm
13. There are multiple routes for blood to get into the CNS, with specializations to protect that blood supply and to maximize the ability of the brain to get an uninterrupted perfusion. Which of these directly affect blood supply to the brain?
- A. The mesenteric artery
 - B. The circle of Willis & external carotid arteries
 - C. The femoral artery

TEXT HIGHLIGHTS: Page 572. "The middle layer of the meninges is the arachnoid, named for the spider-web-like trabeculae between it and the pia mater. The arachnoid

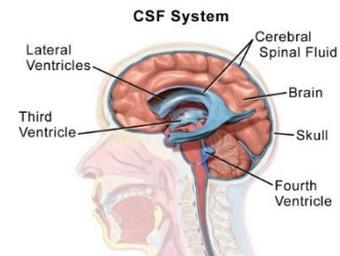
defines a sac-like enclosure around the CNS. The trabeculae are found in the subarachnoid space, which is filled with circulating CSF. The arachnoid emerges into the dural sinuses as the arachnoid granulations, where **the CSF is filtered back into the blood for drainage from the nervous system**. The subarachnoid space is filled with circulating CSF, **which also provides a liquid cushion to the brain and spinal cord**. Similar to clinical blood work, a sample of CSF can be withdrawn to find chemical evidence of neuropathology or metabolic traces of the biochemical functions of nervous tissue.”

NOTE: Page 573. Meningitis refers to inflammation of the subarachnoid space in the brain. While bacterial meningitis is not common, it is very serious. Viral meningitis is the most common form and is usually a relatively mild infection followed by complete recovery.

TEXT HIGHLIGHTS: Page 573. “Cerebrospinal fluid (CSF) circulates throughout and around the CNS. In other tissues, water and small molecules are filtered through capillaries as the major contributor to the interstitial fluid. *In the brain, CSF is produced in special structures to perfuse through the nervous tissue of the CNS and is continuous with the interstitial fluid.* Specifically, CSF **circulates to remove metabolic wastes from the interstitial fluids of nervous tissues and return them to the blood stream**. The ventricles are the open spaces within the brain where CSF circulates. In some of these spaces, *CSF is produced by filtering of the blood that is performed by a specialized membrane known as a choroid plexus.* The CSF circulates through all of the ventricles to eventually emerge into the subarachnoid space where it will be reabsorbed into the blood.

Within the subarachnoid space, the CSF flows around all of the CNS, providing two important functions. As with elsewhere in its circulation, the **CSF picks up metabolic wastes from the nervous tissue and moves it out of the CNS**. It also **acts as a liquid cushion for the brain and spinal cord**. By surrounding the entire system in the subarachnoid space, it provides a thin buffer around the organs within the strong, protective dura mater. The arachnoid granulations are outpocketings of the arachnoid membrane into the dural sinuses so that CSF can be reabsorbed into the blood, along with the metabolic wastes. *From the dural sinuses, blood drains out of the head and neck through the jugular veins, along with the rest of the circulation for blood, to be reoxygenated by the lungs and wastes to be filtered out by the kidneys.*

BLAST FROM THE PAST: Recall the “glymphatic system” from A&P Part I? ...“Researchers recently discovered a series of channels that surround blood vessels within the brains of mice. This system, managed by the brain’s glial cells, was termed the glymphatic system. It moves cerebrospinal fluid, a clear liquid surrounding the brain and spinal cord, quickly and deeply throughout the brain, removing waste.”



CSF, a clear fluid found in the brain and spinal cord, is derived from blood plasma and is therefore, very similar. It is almost free of the proteins and red blood cells found in plasma, and contains nucleic acids (especially cell-free DNA) and a minute amount of white blood cells. There are variations in electrolytes and an increased level of chloride.

In a stunning discovery that overturns decades of textbook teaching, researchers at the University of Virginia School of Medicine have determined that the brain is directly connected to the immune system by vessels previously thought not to exist. That such vessels could have escaped detection when the lymphatic system has been so thoroughly mapped throughout the body is surprising on its own, but the true significance of the discovery lies in the effects it could have on the study and treatment of neurological diseases ranging from autism to Alzheimer's disease to multiple sclerosis.

"Instead of asking, 'How do we study the immune response of the brain?' 'Why do multiple sclerosis patients have the immune attacks?' now we can approach this mechanistically. Because the brain is like every other tissue connected to the peripheral immune system through meningeal lymphatic vessels," said Jonathan Kipnis, PhD, professor in the UVA Department of Neuroscience and director of UVA's Center for Brain Immunology and Glia (BIG). "It changes entirely the way we perceive the neuro-immune interaction. We always perceived it before as something esoteric that can't be studied. But now we can ask mechanistic questions."

"We believe that for every neurological disease that has an immune component to it, these vessels may play a major role," Kipnis said. "Hard to imagine that these vessels would not be involved in a [neurological] disease with an immune component." <https://neurosciencenews.com/lymphatic-system-brain-neurobiology-2080/>

In light of researching the potential involvement of a neurological disease with an immune component... One small, not yet peer-reviewed study from the time period of March through May 2020, was performed on 11 patients with severe COVID-19 that also presented with unexplained neurological symptoms. The research "assessed a large panel of antineuronal and anti-glial autoantibodies using serum and CSF samples from intensive care patients with symptoms including delirium, epileptic seizure, dystonia, and myoclonus."

The researchers reported that "no SARS-CoV-2 was detected in any of the CSF samples" and that "CSF inflammation was indicated in most patients" with "increased CSF levels of neurofilament light chain (a biomarker for axonal damage)." "All patients had anti-neuronal antibodies in their serum or autoantibodies in their CSF that target surface antigens known to be involved in central nervous system disease." <https://www.news-medical.net/news/20200707/Cerebrospinal-fluid-autoantibodies-target-the-brain-in-some-COVID-19-patients.aspx>

NOTE: Page 576. A cerebral infarction is a type of ischemic stroke resulting from a **blockage in the blood vessels** supplying blood to the brain. Stroke caused by cerebral hemorrhage and subarachnoid hemorrhage is when an **artery in the brain bursts**.

14. There are 12 cranial nerves that originate in the brain. The nerves connected to the spinal cord are the spinal nerves. The arrangement of these nerves is much more regular than that of the cranial nerves. There are _____ spinal nerves, named for the level of the spinal cord at which each one emerges.
- A. 28
 - B. 31
 - C. 32
 - D. 41

Unit 3: Chapter 14

15. (True or False) The somatic nervous system is responsible for our unconscious perception of the environment and for our involuntary responses to that perception by means of skeletal muscles. Peripheral sensory neurons receive input from internal stimuli, but the neurons that produce motor responses originate in the central nervous system.
16. Which of the following are “senses” or a “sensory modality” associated with the body?
- A. Taste
 - B. Balance
 - C. Common
 - D. A & B only

NOTE: Page 606. Olfactory receptors (ORs) are not only located in the olfactory sensory neurons of the nose; they are also found in other human tissues. Those which have been tested thus far include the testis, lungs, intestine, skin, heart, and blood. Certain ORs have been found to be expressed in only one tissue, others can be found throughout many different types of tissues throughout the human body. Science is in the early stages of identifying and learning about their function and usefulness in the body.

“Olfactory, or smell, receptors were originally thought to be only in the sensory nerve cells (neurons) of nasal cavity tissues. However, more recent and extensive study suggests that the receptors ‘occur in nearly the entire human body, [and] they appear to be substantially more functionally important than previously suggested,’ researchers from Ruhr-University Bochum in Germany wrote. In addition to the receptors playing a major role in the sense of smell, ‘several essential physiological and pathophysiological processes have been described as targeted by human [olfactory receptors], including path finding, cell growth, [cell death], migration and secretion.” <https://phys.org/news/2018-07-olfactory-cells-body.html>

Multiple studies have revealed that loss of the sense of smell (anosmia) may be an early warning sign of diseases such as Alzheimer's and Parkinson's.

NOTE: Page 606. Ear infections called external otitis are localized inflammation in the auditory canal. The common cause is the bacterium *Staphylococcus aureus*.

17. (True or False) The middle ear is connected to the pharynx through the Eustachian tube, which helps equilibrate air pressure across the tympanic membrane. The tube is normally closed but will pop open when the muscles of the pharynx contract during swallowing or yawning.

NOTE: Page 606-607. The Eustachian tube is a significant source of acute middle ear infections called otitis media. They may occur in older children and adults but are extremely common among children between the ages of 3 months and 3 years. These infections often accompany the common cold; however, a dairy allergy is often the culprit.

Cow's milk allergy is associated with recurrent otitis media during childhood

To determine whether cow's milk allergy (CMA) in infancy is associated with recurrent otitis media (ROM) or other chronic ear infections, we conducted a cohort study by enrolling 56 milk-allergic and 204 control schoolchildren. We also studied the association between ear problems and different atopic manifestations. A higher proportion of children with CMA had had ROM, defined as at least 15 acute otitis media episodes by the age of 10 years (27%, vs 12%, $p = 0.009$), and had undergone adenoidectomy and or tympanostomy compared with the controls (48%, vs 28%, $p = 0.005$). However, this was only true of the children who had developed respiratory atopy. Asthma and/or allergic rhinitis, but not atopic dermatitis, posed a significant risk for ROM, while all the three atopic manifestations enhanced the risk for secretory otitis media. Positive skin prick tests with food, but not with inhaled allergens, tended to be associated with ear problems. In conclusion, we found that **children with CMA in infancy, even when properly treated, had experienced significantly more ROM**, the risk associating with concomitant development of respiratory atopy. <https://pubmed.ncbi.nlm.nih.gov/10728925/>

18. (True or False) The inner ear is responsible for encoding information about equilibrium, the sense of balance. Head position is sensed by the utricle and saccule, whereas head movement is sensed by the semicircular canals. The exact position of the head is interpreted by the brain based on the pattern of hair-cell depolarization.
19. The sense of touch or 'somatosensation' is a group of sensory modalities that are associated with touch, proprioception, and kinesthesia. Which of the following are modalities included in the sense of touch?
- A. Pressure, vibration, and light touch
 - B. Tickle, itch, and temperature
 - C. Pain, proprioception, and kinesthesia
 - D. All of the above

NOTE: Page 614. Conjunctivitis, commonly called ‘pink eye’ occurs due to inflammation of the conjunctiva of the eye. Common causes are irritants or allergens such as pollen, contagious strains of staphylococci streptococci, or the bacteria haemophilus influenzae.



The meibomian glands, also called tarsal glands, are located along the edge of the eyelids. They are especially significant as they keep the eye lubricated and healthy. A bacterial infection called a sty (stye) or hordeolum can block the duct of one of these glands which then leads to a cyst formation that resembles a red, pus-filled, pimple-like bump on the lower or upper eyelid.

20. The eye itself is a hollow sphere composed of three layers of tissue. The outermost layer is the fibrous tunic, which includes the white sclera and clear _____.
- A. Cornea
 - B. Pupil
 - C. Lens
 - D. Retina

NOTE: Page 616. A cataract is a clouding of the lens of the eye which may be age-related or congenital, bilateral or unilateral. They often develop slowly and can affect one or both eyes causing partial or complete vision loss. Cataracts begin due to a buildup of protein deposits in the lens of the eye that clump together to cause clouding.

The aqueous humor provides nutrients including oxygen and glucose to the lens of the eye. Diabetics do not have good control of glucose levels which results in high levels of sugar in the aqueous humor. The lens inside the eye contains an enzyme that converts glucose into sorbitol. This sugar alcohol can affect both cells and protein and likely results in cataracts. People with diabetes are 60 percent more likely to develop cataracts.

21. Cranial nerves convey specific sensory information from the head and neck directly to the brain. For sensations below the neck, the _____ side of the body is connected to the left side of the brain and the _____ side of the body to the right side of the brain.
- A. Left, Right
 - B. Right, left

NOTE: Page 640. Notice the alarming effects of drugs/medications on the elderly woman presented in the interactive link on page 640. The same article can be found here: <https://www.nytimes.com/2002/10/20/magazine/way-we-live-now-10-20-02-diagnosis-rapid-weight-loss-garbled-speech-body-moving.html?n=Top%2fFeatures%2fMagazine%2fColumns%2fDiagnosis>. Ruling out the side-effects of drugs first could have helped this woman much sooner which is an important lesson for natural health professionals. It is common for clients to suffer from the side-effects of pharmaceuticals and also drug interactions that occur between multiple pharmaceuticals (called polypharmacy). Seventy percent of Americans take prescriptions. Of these 17 percent are prescribed antibiotics and 13 percent, opioids for pain.

“Those aged 65 to 69 take an average of 15 prescriptions per year, while those from 80 to 84 take an average of 18, according to the American Association of Consultant Pharmacists. It’s a practice that begins early. AARP found that, on average, 45-year-olds take four different prescription drugs — every day...

The economic impact of medication-related problems is estimated at \$177.4 billion per year, rivaling that of Alzheimer’s disease, cancer, diabetes and heart disease. Plus adverse effects brought on by the combination of multiple drugs are thought to be responsible for nearly a third of all hospital admissions. Each year 32,000 seniors suffer hip fractures caused by medication-related problems. It’s simple: They are overmedicated, feel dizzy when they stand up, and fall. Or worse, get behind the wheel of a car...

The Journal of General Internal Medicine found that U.S. doctors routinely prescribe potentially harmful drugs to older patients even when equally effective, less powerful drugs are available. Truth is, even some of the most commonly prescribed drugs can be problematic for elderly patients because they linger in their systems longer, causing higher rates of complications.” https://www.huffpost.com/entry/elderly-taking-too-many-pills_b_7079060

Unit 3: Chapter 15

22. (True or False) The autonomic nervous system is often associated with the “fight-or-flight response,” which refers to the preparation of the body to either run away from a threat or to stand and fight in the face of that threat. The autonomic nervous system does not differentiate between threats whether real or imagined, physical or emotional and will “automatically” react in a similar way to each perceived threat stimulus.
23. In the sympathetic nervous system, neurotransmitters (signaling molecules) are released at synapses, whereas hormones are released into the bloodstream. Which of the following are sympathetic nervous system neurotransmitter(s)?
- A. Norepinephrine
 - B. Nicotine
 - C. Acetylcholine
 - D. A & C only
24. (True or False) When particularly strong visceral sensations rise to the level of conscious perception, the sensations are often felt in unexpected places. For example, strong visceral sensations of the heart will be felt as pain in the left shoulder and left arm. This irregular pattern of projection of conscious perception of visceral sensations is called myofascial pain.

25. A person stands up quickly and feels dizzy momentarily (called orthostatic hypotension). This may occur because:
- A. Blood is not getting to the brain so it is briefly deprived of oxygen
 - B. The cardiovascular system has to adjust to the new challenge of keeping blood pumping up into the head while gravity is pulling blood down into the legs
 - C. Blood volume is too low due to dehydration or certain medications
 - D. Of disorders ranging from diabetes to multiple system atrophy that cause autonomic failure
 - E. All of the above

NOTE: Page 681. Glaucoma is a group of conditions in which intraocular pressure rises due to impaired drainage of aqueous fluid. Persistently raised intraocular pressure may damage the optic nerve leading from impaired vision to complete loss of sight.

Unit 3: Chapter 16

NOTE: Page 695. The article, Multiple Sclerosis Rates Up 50% by Miranda Hitti appears on the WebMd website and states “The review from the National Institute of Neurological Disorders and Stroke says almost one in 1,000 people in the U.S. have MS. However, the National Multiple Sclerosis Society says that figure could still be low”.

“These findings are consistent with the hypothesis that immunization with the recombinant hepatitis B vaccine is associated with an increased risk of MS, and challenge the idea that the relation between hepatitis B vaccination and risk of MS is well understood”. *Neurology*. 2004 Sep 14;63(5):838-42. Recombinant hepatitis B vaccine and the risk of multiple sclerosis: a prospective study. Hernán MA, Jick SS, Olek MJ, Jick H.

“Multiple sclerosis (MS), a chronic inflammatory autoimmune disease of the central nervous system (CNS) commonly diagnosed in adults, is being recognized increasingly in children. An estimated 1.7%-5.6% of all patients with MS have clinical symptoms before reaching the age of 18 years”. *Autoimmune Dis*. 2013;2013:673947. Pediatric multiple sclerosis: current concepts and consensus definitions. Pena JA1, Lotze TE.

“Acute disseminated encephalomyelitis (ADEM) is characterized by a brief but widespread attack of inflammation in the brain and spinal cord that damages myelin – the protective covering of nerve fibers. ADEM often follows viral or bacterial infections, or less often, vaccination for measles, mumps, or rubella. The symptoms of ADEM appear rapidly, beginning with encephalitis-like symptoms such as fever, fatigue, headache, nausea and vomiting, and in the most severe cases, seizures and coma. ADEM typically damages white matter (brain tissue that takes its name from the white color of myelin), leading to neurological symptoms such as visual loss (due to inflammation of the optic nerve) in one or both eyes, weakness even to the point of paralysis, and difficulty coordinating voluntary muscle movements (such as those used in walking). ADEM is sometimes misdiagnosed as a severe first attack of multiple sclerosis (MS), since the symptoms and the appearance of the white matter injury on brain imaging may be similar.

However, ADEM has several features which differentiate it from MS. First, unlike MS patients, persons with ADEM will have rapid onset of fever, a history of recent infection or immunization, and some degree of impairment of consciousness, perhaps even coma; these features are not

typically seen in MS. Children are more likely than adults to have ADEM, whereas MS is a rare diagnosis in children. In addition, ADEM usually consists of a single episode or attack of widespread myelin damage, while MS features many attacks over the course of time. National Institute of Health: Neurological Disorders and Stroke, NINDS Acute Disseminated Encephalomyelitis Information Page, March 21, 2016

26. Orientation is the patient's awareness of his or her immediate circumstances. It consists of an awareness of:
- A. Place (the person knows where they are and why)
 - B. Personal Identity (who they are and being able to communicate that information)
 - C. Time (as in date and what is occurring around the person)
 - D. All of the above
27. Which of the following are the sensory nerves for smell, sight, balance, and hearing:
- A. Trigeminal, facial, and glossopharyngeal nerves
 - B. Oculomotor, trochlear, and abducens nerves
 - C. Olfactory, optic, and vestibulocochlear
 - D. A & B only

Unit 3: Chapter 17

28. (True or False) The nervous system uses two types of intercellular communication—electrical and chemical signaling. The endocrine system also uses both electrical and chemical signaling to communicate.
29. The endocrine system consists of cells, tissues, and organs that secrete hormones as a primary or secondary function. The endocrine gland is the major player in this system. The primary function of these ductless glands is to secrete their hormones directly into the surrounding fluid. The _____ and the blood vessels then transport the hormones throughout the body.
- A. Cerebrospinal fluid
 - B. Intracellular fluid
 - C. Synovial fluid
 - D. Interstitial fluid

TEXT HIGHLIGHTS: Page 734. "The endocrine system consists of cells, tissues, and organs that secrete hormones as a primary or secondary function. The endocrine gland is the major player in this system. **The primary function of these ductless glands is to secrete their hormones directly into the surrounding fluid.** The interstitial fluid and the blood vessels then transport the hormones throughout the body. The endocrine system includes the **pituitary, thyroid, parathyroid, adrenal, and pineal glands.** Some of these glands have both endocrine and non-endocrine functions. For example, the pancreas contains cells that function in digestion as well as cells that secrete the hormones insulin and glucagon, which regulate blood glucose levels. The **hypothalamus, thymus, heart, kidneys, stomach, small intestine, liver, skin, female ovaries, and male testes are other**

organs that contain cells with endocrine function. Moreover, adipose tissue has long been known to produce hormones, and recent research has revealed that even bone tissue has endocrine functions.”

Adipose tissue hormones ~

“It is now widely accepted that white adipose tissue (WAT) secretes a number of peptide hormones, including leptin, several cytokines, adiponectin and acylation-stimulating protein (ASP), angiotensinogen, plasminogen activator inhibitor-1 (PAI-1), adiponectin, resistin etc., and also produces steroid hormones. This newly discovered secretory function has shifted our view of WAT, which is no longer considered only an energy storage tissue but a **major endocrine organ**, at the heart of a complex network influencing energy homeostasis, glucose and lipid metabolism, vascular homeostasis, immune response and even reproduction. Virtually all known **adipose secreted proteins are dysregulated when the WAT mass is markedly altered**, either increased in the obese state or decreased in lipodystrophy. This strongly implicates adipose-secreted products in the etiopathology and/or complications of both obesity and cachexia.” <https://pubmed.ncbi.nlm.nih.gov/12508947/>

(Etiopathology is the determination or study of the cause of a pathology. Cachexia is a wasting disorder that causes extreme weight loss and muscle wasting, and can include loss of body fat.)

NOTE: Page 735. The endocrine system consists of glands widely separated from each other with no physical connections. They are commonly called ductless glands because hormones diffuse directly into the bloodstream.

TEXT HIGHLIGHTS: Page 735. “Although a given hormone may travel **throughout the body in the bloodstream, it will affect the activity only of its target cells**; that is, **cells with receptors for that particular hormone**. Once the hormone binds to the receptor, a chain of events is initiated that leads to the target cell’s response. Hormones play a critical role in the regulation of physiological processes because of the target cell responses they regulate. These responses contribute to human reproduction, growth and development of body tissues, metabolism, fluid, and electrolyte balance, sleep, and many other body functions.”

NOTE: Page 735. When a hormone arrives at its target cell, it binds to a specific receptor where it acts as a switch influencing chemical or metabolic reactions within the cell.

30. Which of the following is NOT an endocrine gland?

- | | |
|----------------|-------------------|
| A. Pituitary | E. Salivary |
| B. Thyroid | F. Pineal |
| C. Parathyroid | G. Pancreas |
| D. Adrenal | H. Testes/Ovaries |

31. (True or False) The hormones of the human body can be divided into two major groups on the basis of their chemical structure. Hormones derived from amino acids include amines, peptides, and proteins. Those derived from lipids include steroids.
32. (True or False) An endocrine gland may also secrete a hormone in response to the presence of another hormone produced by a different endocrine gland. Such indirect hormonal stimuli often involve the hypothalamus which produces releasing and inhibiting hormones that control the secretion of a variety of pituitary hormones.
33. (True or False) The anterior pituitary gland manufactures and secretes hormones. The posterior pituitary gland does not produce hormones, rather it stores and secretes hormones produced by the hypothalamus. Growth hormone (GH) is the most abundant hormone synthesized by the anterior pituitary. The production of GH declines as one ages.
34. The activity of the thyroid gland is regulated by thyroid-stimulating hormone (TSH), also called thyrotropin. TSH is released from the _____ pituitary in response to thyrotropin-releasing hormone (TRH) from the hypothalamus. As discussed shortly, it triggers the secretion of thyroid hormones by the thyroid gland. In a classic negative feedback loop, elevated levels of thyroid hormones in the bloodstream then trigger a drop in production of TRH and subsequently TSH.
- A. Superior
 - B. Posterior
 - C. Anterior
 - D. Inferior

NOTE: Page 748-749. TSH stimulates growth and activity of the thyroid gland. The Thyroid gland secretes the hormones T4 (thyroxine) and T3 (tri-iodothyronine).

NOTE: Page 749. Simply said, **cortisol** is a steroid hormone secreted by the anterior pituitary. It is released when the hypothalamus releases CRH (**cort**icotrophin releasing hormone).

NOTE: Page 752. Iodine is essential for the formation of the thyroid hormones, T4 and T3, so numbered as these molecules (T4, T3) contain four and three atoms of the element iodine respectively.

35. (True or False) The release of T3 and T4 from the thyroid gland is regulated by thyroid-stimulating hormone (TSH).

NOTE: Page 753. The pituitary releases thyroid stimulating hormone (TSH) when thyroxine levels are low. If TSH levels are high it is usually because the thyroid is not responding to the request to produce hormones and the pituitary continues to send more TSH because it wants the thyroid to produce hormones. This is why high TSH levels are related to hypothyroid function.

Thyroid hormones, T3 and T4, are often referred to as metabolic hormones because their levels influence the body's basal metabolic rate, the amount of energy used by the body at rest. When T3 and T4 bind to intracellular receptors located on the mitochondria, they cause an increase in nutrient breakdown and the use of oxygen to produce Adenosine Triphosphate (ATP) which provides energy to the cell.

36. Adequate levels of thyroid hormones are also required for:

- A. Protein synthesis
- B. Fetal and childhood tissue development
- C. Growth
- D. All of the above

NOTE: Page 755. There are three main categories of thyroid dysfunction:

- Abnormal secretion of thyroid hormones T3 and T4 which lead to hyperthyroidism or hypothyroidism
- Goiter, which is the enlargement of the thyroid gland
- Tumors

In Grave's disease an antibody mimics the effects of TSH and causes increased levels of T3 and T4, goiter, and exophthalmos (protrusion of the eyeballs) in many cases. Both Hyper- and Hypo- thyroidism may have some symptoms in common.

Autoimmune thyroiditis is the most common cause of acquired hypothyroidism which is Hashimoto's disease. Goiter which is an enlargement of the thyroid gland without signs of hyperthyroidism, is sometimes present. It is caused by a relative lack of T3 and T4 and the low levels stimulate the secretion of TSH resulting in an enlargement (hyperplasia) of the thyroid gland. Persistent iodine deficiency is the main cause.

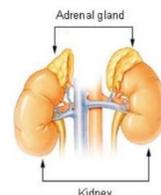
NOTE: Page 758. Hypocalcemia causes tetany (muscle twitching, cramping, spasms, or convulsions) as low blood calcium levels increase the excitability of peripheral nerves. As is written in your text, hypocalcemia or "low blood calcium levels" may be caused by parathyroid hormone deficiency, called hypoparathyroidism, which may develop following injury or surgery involving the thyroid gland."

37. During the menstrual cycle, luteinizing hormone (LH) triggers ovulation in women, as well as the production of estrogens and progesterone by the ovaries. LH stimulates production of _____ by the male testes.

- A. Testosterone
- B. Dihydroepiandrosterone
- C. Androstenedione
- D. Aldosterone

TEXT HIGHLIGHTS: Page 761. "As noted earlier, the adrenal cortex releases glucocorticoids in response to long-term stress such as severe illness."

NOTE: Pages 761-763. The two adrenal glands are situated on the upper pole of each kidney. Adrenal hormones are essential for life, the regulation of metabolism, and responses to stress.



The adrenal cortex produces three groups of steroid hormones called glucocorticoids from cholesterol; cortisol, corticosterone, and cortisone. Cortisol (hydrocortisone) is the main glucocorticoid. The “iod” ending in glucocorticoid indicates that it is a ster“oid”. These steroid hormones are produced by the adrenal cortex and are known for their anti-inflammatory and immunosuppressive actions.

Steroid hormones, (even natural ones) may have side-effects when needed for long periods of time; increased appetite, weight gain, increased blood glucose levels, fragile thin skin that heals slowly, acne, irregular menses and facial hair in women are a few.

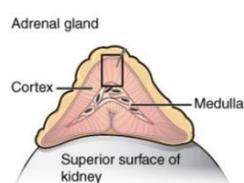
We can see how these would be beneficial to the body under the long-term stress of illness. But for those with chronically stressful lifestyles, these side effects would quickly be unwanted. Synthetic glucocorticoids, made by pharmaceutical companies cause these and more unwanted and harmful side-effects. Because of this they are generally prescribed for short-term use.

Stress & Body Shape: Stress-Induced Cortisol Secretion Is Consistently Greater Among Women with Central Fat ~

“Central fat distribution is related to greater psychological vulnerability to stress and cortisol reactivity. This may be especially true among lean women, who did not habituate to repeated stress. The current cross-sectional findings support the hypothesis that stress induced cortisol secretion may contribute to central fat and demonstrate a link between psychological stress and risk for disease.

<https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.7416&rep=rep1&type=pdf>

The adrenal cortex also secretes sex hormones. They are mainly androgens (male sex hormones) and the amounts produced are insignificant compared with those secreted by the testes and ovaries in late puberty and adulthood.



The adrenal medulla is found in the center of the adrenal cortex. The hormones epinephrine (adrenaline) and norepinephrine (noradrenaline) that are involved in stimulating the fight-or-flight response are secreted from here. Adrenaline has a greater effect on the heart and metabolic processes whereas noradrenaline has more influence on blood vessel diameter.

Cushing’s syndrome is the result of the hypersecretion of cortisol. Addison’s disease is due to the hyposecretion of glucocorticoid and mineralocorticoid hormones.

38. (True or False) The functions of the pineal gland are well-understood by science. One of its primary functions is to produce and secrete the amine hormone melatonin, which is derived from serotonin.

NOTE: Page 765. The pancreas is an organ that plays an essential role in converting the food we eat into fuel for the body's cells. The pancreas has two main functions: an exocrine function that helps in digestion and an endocrine function that regulates blood sugar. The endocrine component of the pancreas consists of islet cells that create and

release important hormones directly into the bloodstream. Two of the main pancreatic hormones are insulin and glucagon. Maintaining proper blood sugar levels is crucial to the functioning of key organs including the brain, liver and kidneys.

The endocrine component of the pancreas: The cells that make up the pancreatic islets (islets of Langerhans) are found in clusters irregularly distributed throughout the substance of the pancreas. Pancreatic hormones are secreted directly into the blood stream. Glucagon increases and insulin decreases blood glucose levels.

39. (True or False) The ovaries produce estrogens, which include estradiol, estriol and estrone.

TEXT HIGHLIGHTS: Page 769. “**Dysfunction of insulin production and secretion**, as well as the target cells’ responsiveness to insulin, can lead to a condition called diabetes mellitus.”

NOTE: Page 769. People who are diabetics are highly susceptible to infection, especially by bacteria and fungi, possibly because phagocyte activity is depressed by insufficient intracellular glucose. Insulin resistance is the result of changes in the cell membranes that block the insulin-assisted movement of glucose into the cells.

Peripheral neuropathy is a group of diseases of peripheral nerves NOT associated with inflammation. They are classified as polyneuropathy and mononeuropathy.

“If you’re used to thinking of insulin solely as a ‘blood sugar hormone,’ hang on to your hat. Insulin has many other roles, almost to the point that lowering blood sugar is one of the least impressive things it does. If you follow what you think is a healthy diet yet still experience bothersome symptoms or serious issues your doctor has been unable to explain—joint pain, acne, infertility, hypertension, erectile dysfunction, migraines, skin tags—chronically high insulin might be the culprit.

...Several conditions often considered idiopathic—meaning, no one knows what causes them—can be directly tied to chronic hyperinsulinemia. One of these is essential hypertension. Insulin inhibits renal sodium excretion: as the kidneys retain more sodium, more water is retained as well, increasing the blood volume and raising blood pressure. Hyperinsulinemia also impairs healthy blood vessel function, making the vessels less pliant and accommodating, which also contributes to higher blood pressure. As if that weren’t enough, insulin also has effects on the sympathetic nervous system that may raise blood pressure. For most people, salt consumption has little to no effect on blood pressure, and dietary sodium is not a contributor to hypertension.

Another condition that fits this description—misattribution to a wrongly demonized dietary factor—is gout. Animal protein in general, and red meat, in particular, typically take the blame for gout, with alcohol—beer, especially—a close second. Gout occurs when a compound called uric acid builds up in the body and precipitates into crystals that lodge in the joints. The big toe is most commonly affected, but gout attacks can affect other joints. Uric acid comes from the breakdown of purines, which are concentrated in animal proteins but are also found

in plant foods. Uric acid isn't a problem in a healthy body that excretes it properly. It's only problematic when it accumulates and solidifies, and the primary driver of this is high insulin. Just as with sodium, hyperinsulinemia inhibits excretion of uric acid. The answer isn't to reduce dietary purines (which would mean cutting back on some of the most nutrient-dense foods available); the answer is to reduce insulin levels.

Simply stated, health providers fail to identify chronic hyperinsulinemia as the primary driving factor in many chronic noncommunicable diseases because insulin testing isn't performed anywhere near as often as it should be. A great deal of morbidity and early mortality could be prevented if people were made aware that their seemingly inexplicable issues actually have a very clear explanation, and it's something fairly easy to correct." <https://www.westonaprice.org/health-topics/modern-diseases/the-hidden-problem-of-chronic-hyperinsulinemia/>

NOTE: Page 770. Serotonin (5-hydroxytryptamine, 5-HT) is present in platelets, in the brain, and in the intestinal wall.

"Serotonin (5-HT) is most commonly thought of as a neurotransmitter in the central nervous system. However, the predominant site of serotonin synthesis, storage, and release is the enterochromaffin cells (EC) of the intestinal mucosa. Within the intestinal mucosa, serotonin released from EC cells activates neural reflexes associated with intestinal secretion, motility, and sensation. Because of the importance of serotonin in normal gut function and sensation, a number of studies have investigated potential changes in mucosal serotonin signaling in pathologic conditions. Despite the inconsistencies in the current literature, changes in serotonin signaling have now been demonstrated in inflammatory bowel disease, irritable bowel syndrome, postinfectious irritable bowel syndrome, and idiopathic constipation." - Dis Colon Rectum. 2007 Mar;50(3):376-88. Serotonin and its role in colonic function and in gastrointestinal disorders. Costedio MM1, Hyman N, Mawe GM.

40. Organs with secondary endocrine functions (that secrete hormones) include:
- A. Heart, GI tract, Kidneys
 - B. Skeleton, Adipose tissue, Skin
 - C. Thymus, Liver
 - D. All of the above
41. (True or False) Menopause is a sign of an aging endocrine system in the female body. Ovarian function declines by decreasing in both size and weight and becoming progressively less sensitive to gonadotropins which gradually cause a decrease in estrogen and progesterone levels and the resulting inability to reproduce.
42. (True or False) Andropause (or viropause) is when testosterone levels decrease in the aging male.

Unit 4: Chapter 18

NOTE: Page 784. Blood is a fluid connective tissue. It circulates constantly around the body, allowing constant communication between tissues distant from each other. Blood is composed of a clear, straw-colored, watery fluid called plasma in which several different types of blood cells are suspended.

The constituents of plasma are water and dissolved and suspended substances, including: plasma proteins, inorganic salts*, nutrients, waste materials, hormones, and gases. Plasma viscosity (thickness) is due to plasma proteins, mainly albumin and fibrinogen. Plasma proteins, with the exception of immunoglobulins, are formed in the liver.

*An inorganic salt is an essential nutrient. They are mostly in the combination form when in food, and often dissociated into inorganic salt ions within the body fluid. There are also a small amount of inorganic salts in the body fluid combined with protein, especially trace elements. As far as their inorganic salt composition is concerned, body fluids are essentially dilute saltwater solutions. Think about whenever a person is admitted to a hospital. One of the first things they are given is a bag of fluids called IV saline. Saline is a saltwater solution intended to rehydrate the body.

43. The cellular elements found in blood can be referred to as the “formed elements” or blood cells. They include:
- A. Red blood cells (RBCs) which are also called “erythrocytes”
 - B. White blood cells (WBCs) which are also called “leukocytes”
 - C. Platelets (cell fragments) which are also called “thrombocytes”
 - D. All of the above
44. Which of the following are NOT function(s) of blood?
- A. To deliver oxygen and nutrients and remove wastes from cells
 - B. To carry neurological impulses both to and from the heart muscle
 - C. Defense, distribution of heat, and maintenance of homeostasis
 - D. All of the above

NOTE: Page 793. Red blood cells (erythrocytes) are the most abundant type of blood cell. Their main function is in the transport of gases, mainly of oxygen. Because they have no nucleus, they can’t divide (replicate) so they need to be continually replaced by new cells from the red bone marrow.

45. Each iron ion in the heme can bind to one oxygen molecule; therefore, each hemoglobin molecule can transport four oxygen molecules. An individual erythrocyte can contain about _____ hemoglobin molecules, and therefore can bind to and transport more than 1 billion oxygen molecules.
- A. 100 million
 - B. 200 million
 - C. 300 million
 - D. 400 million

46. (True or False) Heme iron, from animal foods such as meat, poultry, and fish, is absorbed more efficiently than non-heme iron from plant foods.
47. The two vitamins that are required for red blood cell synthesis are B12 and folate (folic acid). Which three trace minerals are required to produce hemoglobin?
- A. Copper, iron, and zinc
 - B. Manganese, iron, chromium
 - C. Magnesium, zinc, chloride
 - D. Iron, copper, fluoride

NOTE: Page 795. The life span of erythrocytes, red blood cells, is about 120 days before being broken down (hemolysis) in the spleen, bone marrow, and liver. The iron released during breakdown is reused to make new blood cells. The breakdown also results in the formation of biliverdin which is further reduced to the yellow pigment bilirubin and transported to the liver. In the liver, bilirubin is changed from a fat-soluble to a water-soluble form and is excreted as part of bile.

48. (True or False) There are more than 400 types of anemia and more than 3.5 million Americans suffer from this condition. Anemia can be caused by which of the following?
- A. Blood loss
 - B. Faulty or decreased RBC production
 - C. Excessive destruction of RBCs
 - D. All of the above

NOTE: Page 797-798. Anemia is the inability of the blood to carry enough oxygen to meet the body's needs. Iron deficiency anemia can result from deficient intake of iron or the proper type of iron for a person's needs, or poor absorption from the alimentary tract. Iron absorption also depends on a sufficiently acidic environment in the stomach.

Pernicious anemia is the most common form of vitamin B12 deficiency. It is an autoimmune disease that destroys intrinsic factor and parietal cells in the stomach. B12 deficiency anemia, regardless of cause, leads to irreversible neurological damage.

Aplastic anemia is the result of bone marrow failure. Because the bone marrow also produces leukocytes and platelets, leukopenia (low white cell count) and thrombocytopenia (low platelet count) are also likely.

Leukocytes (white blood cells) have the important functions of defense and immunity. Rising white cell numbers in the blood stream usually indicate a physiological problem such as infection, trauma or malignancy. They are divided into two categories: granulocytes and agranulocytes. Granulocytes include the neutrophils, eosinophils and basophils. Neutrophils are small, fast and active scavengers that protect the body from bacterial invasion and remove dead cells and debris from damaged tissues.

NOTE: Page 801. Eosinophils help with the elimination of parasites. They are also involved in both the production of and lowering of tissue inflammation. (They adjust to

meet the needs of the body.) Basophils are closely associated with allergic reactions but it is the mast cells that result in the rapid onset of allergy symptoms.

NOTE: Page 802. Leukocytes (white blood cells) known as agranulocytes include the monocytes and lymphocytes. Monocytes are the largest and develop into macrophages in the tissues. A macrophage protects the body by “engulfing” indigestible material like dust and bacteria. Macrophages also make and release various active chemicals called cytokines.

TEXT HIGHLIGHTS: Page 799. Gotta love these leukocytes! “Once they have exited the capillaries, some leukocytes will take up **fixed positions** in lymphatic tissue, bone marrow, the spleen, the thymus, or other organs. Others will **move about** through the tissue spaces very much like amoebas, continuously extending their plasma membranes, sometimes wandering freely, and sometimes moving toward the direction in which they are drawn by chemical signals. **This attracting of leukocytes occurs because of** positive chemotaxis (literally “**movement in response to chemicals**”), a phenomenon in which **injured or infected cells and nearby leukocytes emit the equivalent of a chemical “911” call**, attracting more leukocytes to the site. In clinical medicine, the differential counts of the types and percentages of leukocytes present are often key indicators in making a diagnosis and selecting a treatment.

NOTE: Page 802. Lymphocytes are white blood cells that fight infections (viruses, bacteria, and toxins) thereby strengthening the immune system. They develop from stem cells in the red bone marrow and from precursors in lymphoid tissue. There are two distinct types of lymphocytes: T lymphocytes and B lymphocytes. T lymphocytes develop in the thymus gland and B lymphocytes develop in the bone marrow and lymph nodes.

Leukemia (acute): A malignant proliferation of white blood cell precursors by the bone marrow. The proliferation of immature leukemic blast cells crowds out other blood cells formed in the bone marrow. This can cause anemia, low white cell count, and a low platelet count. Because the leukocytes are immature when released, immunity is reduced and the risk of infection is high.

NOTE: Page 803. The third and last type of blood cells are called thrombocytes or “platelets”. Technically they are not an actual cell, but a fragment of the cytoplasm of a large type of stem cell called megakaryocyte. Platelets carry substances that promote blood clotting. About 1/3 of the platelets are stored in the spleen. In an emergency they are released as needed to control excessive bleeding.

Thrombosis is the formation of a blood clot (thrombus) inside a blood vessel, which interrupts blood supply to the tissues.

49. Which of the following steps are involved in hemostasis (commonly called blood clotting)?
- A. Vascular spasm which constricts the flow of blood
 - B. Platelet plug formation to temporarily seal small openings in the vessel
 - C. Coagulation to enable vessel wall repair after blood leakage stops
 - D. All of the above

NOTE: Page 807. Vitamin K is required by the liver for the synthesis of many clotting factors and therefore deficiency leads to abnormal clotting. Vitamin K is fat-soluble and bile salts are required in the colon for its absorption.

NOTE: Page 809. Deep vein thrombosis (DVT) carries a significant risk of death (often from pulmonary embolism if a clot fragment travels to the lungs).

Embolism is the blocking of a blood vessel by any mass of material (an embolus) traveling in the blood. This is usually a thrombus or a fragment of a thrombus but there are other embolic materials.

50. (True or False) Antigens are substances that the body does not recognize as belonging to the “self” and that therefore trigger a defensive response from the leukocytes of the immune system.

Unit 4: Chapter 19

NOTE: The next three chapters cover the heart, blood vessels and lymphatic systems. Cardio (heart), vascular (blood vessels) System: The pumping action of the heart provides constant circulation of the blood through blood vessels. The blood vessels provide both pulmonary circulation and the systemic circulation of blood. The lymphatic system is connected, both structurally and functionally to the cardiovascular system.

“Oxygen-poor blood is pumped to the lungs from the heart (arterial circulation). Oxygen-rich blood moves from the lungs to the heart through the pulmonary veins (venous circulation). Pulmonary circulation also includes capillary circulation. Oxygen you breathe in from the air passes through your lungs into your blood through the many capillaries in the lungs. Oxygen-rich blood moves through your pulmonary veins to the left side of your heart and out of the aorta to the rest of your body.” <https://www.nhlbi.nih.gov/health-topics/how-heart-works>

51. (True or False) The systemic circuit transports blood to and from the lungs, where it picks up oxygen and delivers nitrogen dioxide for exhalation. The pulmonary circuit transports oxygenated blood to virtually all of the tissues of the body and returns relatively deoxygenated blood and carbon dioxide to the heart to be sent back to the pulmonary circulation.

NOTE: Page 827. The right side of the heart pumps blood to the lungs (the pulmonary circulation) where gas exchange occurs (the blood collects oxygen from the air sacs and excess carbon dioxide diffuses into the air sacs for exhalation). Carbon dioxide is one the waste products of cell metabolism. It diffuses into the blood and the blood transports it to the lungs for excretion.

The left-side of the heart pumps blood into the systemic circulation, which supplies the rest of the body. Here, tissue wastes are passed into the blood (and lymph) for excretion, and body cells extract nutrients and oxygen.

TEXT HIGHLIGHTS: Page 829. The pericardial membrane that surrounds the heart consists of three layers and the pericardial cavity. The heart wall also consists of three layers. **The pericardial membrane and the heart wall share the epicardium.**

NOTE: Page 829. Pericarditis is the swelling and irritation (inflammation) of the pericardium, Sharp chest pain occurs when the irritated layers of the pericardium rub against each other. It is often a viral or suspected viral infection but the symptoms can closely resemble a heart attack - always have a medical doctor rule out heart attack!

52. The wall of the heart is composed of three layers of unequal thickness. Select the best answer.

- A. Pericardium, mesocardium, and endocardium
- B. Epicardium, myocardium, and endocardium
- C. Epithelium, mesothelium, and endothelium
- D. All of the above

NOTE: Page 844. Infarction is a term given to tissue death because of interrupted blood supply.

The following excerpt is a succinct explanation of how the heart's electrical system.

“Your heart's electrical system controls all the events that occur when your heart pumps blood. Your heart's electrical system is made up of three main parts:

- The sinoatrial (SA) node, located in the right atrium of your heart
- The atrioventricular (AV) node, located on the interatrial septum close to the tricuspid valve
- The His-Purkinje system (bundle of His), located along the walls of your heart's ventricles

A heartbeat is a complex series of events. These events take place inside and around your heart. A heartbeat is a single cycle in which your heart's chambers relax and contract to pump blood. This cycle includes the opening and closing of the inlet and outlet valves of the right and left ventricles of your heart.

Each heartbeat has two basic parts: diastole and systole. During diastole, the atria and ventricles of your heart relax and begin to fill with blood. At the end of diastole, your heart's atria contract (atrial systole) and pump blood into the ventricles. The atria then begin to relax. Your heart's ventricles then contract (ventricular systole), pumping blood out of your heart.

Each beat of your heart is set in motion by an electrical signal from within your heart muscle. In a normal, healthy heart, each beat begins with a signal from the SA node. This is why the SA node sometimes is called your heart's natural pacemaker. Your pulse, or heart rate, is the number of signals the SA node produces per minute. The signal is generated as the vena cavae fill your heart's right atrium with blood from other parts of your body. The signal spreads across the cells of your heart's right and left atria.

This signal causes the atria to contract. This action pushes blood through the open valves from the atria into both ventricles. The signal arrives at the AV node near the ventricles. It slows for an instant to allow your heart's right and left ventricles to fill with blood. The signal is released and moves along a pathway called the bundle of His, which is located in the walls of your heart's ventricles.

From the bundle of His, the signal fibers divide into left and right bundle branches through the Purkinje fibers. These fibers connect directly to the cells in the walls of your heart's left and right ventricles. The signal spreads across the cells of your ventricle walls, and both ventricles contract. However, this doesn't happen at exactly the same moment.

The left ventricle contracts an instant before the right ventricle. This pushes blood through the pulmonary valve (for the right ventricle) to your lungs, and through the aortic valve (for the left ventricle) to the rest of your body. As the signal passes, the walls of the ventricles relax and await the next signal.

This process continues over and over as the atria refill with blood and more electrical signals come from the SA node.” <https://www.nhlbi.nih.gov/health-topics/how-heart-works>

NOTE: Page 848. The heart possesses the property of autorhythmicity, which means it generates its own electrical impulses and beats independently of nervous or hormonal control. However, it is supplied with both sympathetic and parasympathetic nerve fibers which increase and decrease respectively the intrinsic heart rate. In addition, the heart responds to a number of circulating hormones, including adrenaline (epinephrine) and thyroxine.

NOTE: Page 857. Tetany is caused by hypocalcemia. Low blood calcium levels increase excitability of peripheral nerves.

53. Which of the following is the world's most widely consumed psychoactive drug?
- A. Alcohol
 - B. Amphetamines
 - C. Caffeine
 - D. Opioids
54. The human heart is the first functional organ to develop. It begins beating and pumping blood around day _____.
- A. 63-64
 - B. 28-29
 - C. 44-45
 - D. 21-22

Unit 4: Chapter 20

NOTE: Arteries are blood vessels responsible for carrying oxygen-rich blood away from the heart to the body (except of the pulmonary artery and the umbilical artery). Veins are blood vessels that carry blood low in oxygen from the body back to the heart for reoxygenation (with the exception of pulmonary veins and the umbilical vein).

55. Arteries and arterioles have thicker walls than veins and venules because they are closer to the _____ and receive blood that is surging at a far greater pressure. Arterioles are the smallest arteries and they branch out and become smaller until they are the minute capillaries.

- A. Heart
- B. Lungs
- C. Kidneys
- D. Brain

56. A vein is a blood vessel that conducts blood toward the heart. Because they are low-pressure vessels, larger veins are commonly equipped with _____ that promote the unidirectional flow of blood toward the heart and prevent backflow toward the capillaries caused by the inherent low blood pressure in veins as well as the pull of gravity.

- A. Gates
- B. Valves
- C. Flaps
- D. Switches

NOTE: Page 895. Veins return the depleted blood to the heart under low pressure. When cut, the veins collapse while the thicker walled arteries remain open. When an artery is cut blood spurts at high pressure while a slower, steady flow of blood escapes from a vein. The veins also branch out - the smallest veins are called venules. At any one time, two-thirds of the body's blood is in the venous system.

57. (True or False) Any blood that accumulates in a vein will decrease the pressure within it, which can then be reflected back into the smaller veins, venules, and eventually even the arteries. Increased pressure will promote the flow of fluids out of the capillaries and into the interstitial fluid. The presence of excess tissue fluid around the cells leads to a condition called varicose veins.

NOTE: Page 897. Excess fluid accumulates to result in the swelling of Edema. It can occur in superficial tissues or deeper organs. There are four main causes: Increased venous blood pressure, decreased plasma osmotic pressure because plasma protein levels fall, impaired lymphatic drainage and increased small-vessel permeability.

TEXT HIGHLIGHTS: Page 900. "When systemic arterial blood pressure is measured, it is recorded as a ratio of two numbers (e.g., 120/80 is a normal adult blood pressure), expressed as **systolic pressure over diastolic pressure**. The systolic pressure is the higher value (typically around 120 mm Hg) and **reflects the arterial pressure resulting from the ejection of blood during ventricular contraction, or systole**. The diastolic pressure is the lower value (usually about 80 mm Hg) and **represents the arterial pressure of blood during ventricular relaxation, or diastole**."

NOTE: Page 904. Constriction and dilation of the arterioles are the main determinants of peripheral resistance. Vasoconstriction causes blood pressure to rise and vasodilation causes it to fall. **Blood Pressure = Cardiac Output x Peripheral Resistance**

NOTE: Page 907. Patches or 'plaques' of atheroma also known as atherosclerosis or 'hardening of the arteries' are like small fatty lumps that develop within the inside lining of blood vessels (arteries). Over time patches of atheroma can become larger and thicker restricting and reducing blood flow through the artery. Sometimes a patch of atheroma may develop a tiny crack or rupture on the inside surface of the blood vessel triggering a blood clot (thrombosis) to form over the atheroma. This may completely block the blood flow. While atherosclerosis (the presence of plaques) is considered to be a disease of older people because that is when the clinical signs appear, plaques actually start to form in childhood in developed countries.

The negative effects of hydrogenated trans fats and what to do about them

"Partially hydrogenated vegetable oils have been in the American diet since 1900. More than 50 years ago they were found to contain trans fatty acids that were different from natural fatty acids in plant oils and in animal fat. There was growing evidence that the consumption of trans fats have negative health effects, including increasing plasma lipid levels. In 2003, the Food and Drug Administration (FDA) ruled that the amount of trans fat in a food item must be stated on the label after January 1, 2006; food items could be labeled 0% trans if they contain less than 0.5g/serving. Since the initial ruling, it is now known that the fatty acids in partially hydrogenated vegetable oil are 14 cis and trans isomers of octadecenoic and octadecadienoic acids that are formed during hydrogenation. They cause inflammation and calcification of arterial cells: known risk factors for coronary heart disease (CHD). They inhibit cyclooxygenase, an enzyme required for the conversion of arachidonic acid to prostacyclin, necessary for the regulation of blood flow. There have been several reformulations of hydrogenated fat containing varying amounts of trans fatty acids and linoleic acid, an essential fatty acid that is converted to arachidonic acid. Epidemiological data suggest that when trans-fat percentages go up and linoleic acid percentages go down, death rates rise; when trans goes down, death rates go down. In spite of the harmful effects of trans fats, the FDA allows it in the food supply as long as the amount in a food item is declared on the label. Trans fat should be banned from the food supply." <https://pubmed.ncbi.nlm.nih.gov/19345947/>

58. (True or False) The catecholamines epinephrine and norepinephrine are released by the adrenal medulla, and enhance and extend the body's sympathetic or "fight-or-flight" response. They increase heart rate and force of contraction, while temporarily constricting blood vessels to organs not essential for flight-or-flight responses and redirecting blood flow to the liver, muscles and heart.
59. (True or False) The average weight of the heart for the nonathlete is about 300 g, whereas in an athlete it will increase to 500 g. This increase in size generally makes the heart weaker and less efficient at pumping blood, decreasing both stroke volume and cardiac output.

NOTE: Page 920. Aneurysms are abnormal local dilations of arteries, which vary considerably in size. If an aneurysm ruptures, hemorrhage follows, the consequences of which depend on the site and extent of the bleed.

60. Chronically elevated blood pressure is known clinically as hypertension.

Hypertension does NOT lead to:

- A. An aneurism
- B. Heart failure
- C. Chronic kidney disease
- D. Heat stroke
- E. Peripheral arterial disease

NOTE: Page 922. Shock (circulatory failure) occurs when the metabolic needs of cells are not being met because of inadequate blood flow. Septic shock or “blood poisoning” is caused by severe infections in which bacterial toxins are released into the circulation and trigger a massive inflammatory and immune response. Neurogenic shock may occur with sudden acute pain, severe emotional experiences, spinal anesthesia and spinal cord damage.

61. The liver receives its dual blood supply from which of the following? (page 957)

- A. From normal systemic circulation via the hepatic artery
- B. From the hepatic portal vein
- C. From the aorta
- D. Both A & B

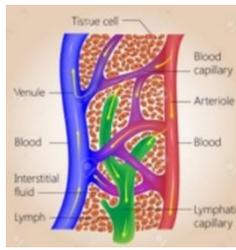
Unit 4: Chapter 21

The main functions of the lymphatic system:

- Collecting and transporting tissue fluids from the intercellular spaces in all the tissues of the body, back to the bloodstream
- Playing an important role in returning plasma proteins to the bloodstream
- Transporting digested fats once absorbed from the villi in the small intestine to the bloodstream via the lacteals and lymph vessels
- Manufacturing new lymphocytes in the lymph nodes
- Creating antibodies in the lymph nodes which assists the body with building up an effective immunity to infectious diseases
- Filtering out micro-organisms (such as bacteria) and foreign substances such as toxins, etc. Lymph nodes are vitally important in the body’s defense mechanism.
- Transporting large molecular compounds (such as enzymes and hormones) from their manufactured sites to the bloodstream

The lymph nodes are small glands that often occur in clusters. The human body contains about 700 of them. They act as filters that sieve off the harmful (and unused) substances brought by the lymphatic channels. A lymph node contains two regions: the cortex and the medulla. The cortex contains lymphocytes, predominantly B lymphocytes

which mature completely within the bone marrow and some T lymphocytes that exit the bone marrow immature to attain maturity within the thymus.



NOTE: Page 977. Every tissue/organ/system is made up of billions of cells. Every cell in the body is surrounded by a fluid called interstitial fluid. Where there is a cell, there is a blood supply (capillaries deliver oxygen, nutrients...) and lymph vessels (remove unused materials delivered by the capillaries and waste products that the cell has exported into the interstitial fluid). Every individual cell (kidney cells, skin cells, heart cells...) needs nourishment and has waste products.

The adult body contains 5 to 6 liters of blood which consists of two parts - a fluid called plasma and blood cells suspended in the plasma. Lymph on-the-other-hand is a clear watery fluid identical in composition to interstitial fluid and similar in composition to plasma but lacking plasma proteins.

“Lymph” is contained within lymphatic vessels, whereas “interstitial fluid” is found in the extracellular matrix between cells. Cells are bathed in this interstitial or tissue fluid and absorb oxygen and nutrients from the interstitial fluid that surrounds them, which has itself absorbed these substances from the circulating blood.

Interstitial fluid becomes lymph when it returns or is taken up by lymphatic capillaries. Interstitial fluid and lymph are similar at first (in the capillaries and small collecting vessels), but lymph later changes composition along its course, especially as it passes through lymph nodes. In each lymph node some properties are removed from the lymph and many lymphocytes are added to it, increasing its benefit to the immune system.

Not all the water and cell waste products return to the blood capillaries. Of the 24 liters or so of fluid that moves out of the blood across capillary walls every day, only about 21 liters return to the bloodstream (through the vein system). Extra tissue fluid and some cell waste materials enter the lymph (or lymphatic) capillaries.

62. The lymphatic vessels begin as open-ended _____, which feed into larger and larger lymphatic vessels, and eventually empty into the bloodstream by a series of ducts. Along the way, the lymph travels through the lymph nodes, which are commonly found near the groin, armpits, neck, chest and abdomen.
- A. Capillaries
 - B. Venules
 - C. Veins
 - D. Arterioles

The lymphatic system also supplies dietary fats and fat-soluble materials such as vitamins A, D, E and K to the body. These nutrients are absorbed into the central lacteals (lymphatic vessels) of the villi located in the small intestine.

NOTE: Page 978. There is no ‘pump’, like the heart, involved in the onward movement of lymph, but the muscle layer in the wall of the large lymph vessels has an intrinsic ability to contract rhythmically. In addition, lymph vessels are compressed by activity in

adjacent structures, such as contraction of muscles and the regular pulsation of large arteries. To state it simply: exercise (muscle contraction) and heart rate (exercise again) are key in moving lymph throughout the body.

63. (True or False) The lymphatic system relies on endothelial flaps and collagen filaments for the ability to move lymphatic fluid. The larger lymphatic arteries contain a series of endothelial flaps (two-way valves) which close to prevent “backflow” and to create stagnation in the liver.

NOTE: Page 979. Lymph vessels become larger as they join together, eventually forming two large ducts just below the diaphragm, the thoracic duct (on the left side of the body) and the right lymphatic duct.

64. The immune system is a collection of barriers, cells and soluble proteins that interact and communicate with each other in extraordinarily complex ways. Which of the following temporal phases show the correct order of timing?

- A. Barrier defenses, innate immune response, adaptive immune response
- B. Innate immune response, barrier defenses, adaptive immune response
- C. Adaptive immune response, innate immune response, barrier defenses
- D. None of the above

65. (True or False) A natural killer cell (NK) is a circulating blood cell that contains cytotoxic (cell-killing) granules in its extensive cytoplasm. It shares this mechanism with the cytotoxic T cells of the adaptive immune response. NK cells are among the body’s first lines of defense against viruses and certain types of cancer.

NOTE: Page 985. Lymph is filtered as it passes through the lymph nodes. Particulate matter may include bacteria, dead and live phagocytes containing ingested microbes, cells from malignant tumors, worn-out and damaged tissue cells and inhaled particles.

66. (True or False) The major routes into the lymph node are via afferent blood vessels. Cells and lymph fluid that leave the lymph node may do so by another set of vessels known as the efferent blood vessels.

67. (True or False) The spleen is a major secondary lymphoid organ, sometimes called the “filter of the blood” because of its extensive vascularization and the presence of macrophages and dendritic cells that remove microbes and other materials from the blood, including dying red blood cells. The spleen also functions as the location of immune responses to blood-borne pathogens.

NOTE: Page 986. Unlike lymph nodes, the spleen has no afferent lymphatics entering it, so it is not exposed to diseases spread by lymph.

NOTE: Page 988. When T lymphocytes and B lymphocytes come into contact with an antigen, they can then recognize it. Once they arrive at a lymph node, they rapidly multiply a large number of identical cells (or clones) with the same antigen receptor as the original.

NOTE: Page 989. Mucosa-associated lymphoid tissue (MALT) is found in the gastrointestinal, respiratory and genitourinary tracts, all systems of the body exposed to the external environment.

68. Which of the following is NOT considered a barrier defense?
- A. Skin (keratinized epithelium, sweat & sebaceous glands, low pH, washing)
 - B. Mouth (the lysozymes in saliva)
 - C. Brain (common sense to avoid disease-causing pathogens)
 - D. Stomach (very low pH)
 - E. Mucosal surfaces (epithelial cells & mucosal tissues prevent growth of pathogens)
69. (True or False) A macrophage is an irregularly shaped phagocyte that is amoeboid in nature and is the most versatile of the phagocytes in the body. They are called different names, depending on the tissue: Kupffer cells in the liver, histiocytes in connective tissue, and alveolar macrophages in the lungs. They engulf, then digest cellular debris and pathogens.
70. The hallmark of the innate immune response is inflammation. Inflammation does not only have to be initiated caused by infection, it can be also be caused by tissue injury. Characteristic indicator(s) of inflammation are which of the following?
- A. Heat
 - B. Redness
 - C. Pain
 - D. Swelling
 - E. Loss of Function
 - F. All of the above
71. Antibodies were the first component of the adaptive immune response to be characterized by scientists working on the immune system. The cause of the agglutination is an antibody molecule, also called an _____.
- A. Immunoglobulin
 - B. Antigen
 - C. Antibody
 - D. None of the above

TEXT HIGHLIGHTS: Page 1012. “Antibacterial wipes, soaps, gels, and even toys with antibacterial substances embedded in their plastic are ubiquitous in our society. Still, **these products do not rid the skin and gastrointestinal tract of bacteria, and it would be harmful to our health if they did. We need these nonpathogenic bacteria on and within our bodies to keep the pathogenic ones from growing.** The urge to keep children perfectly clean is thus probably misguided. Children will get sick anyway, and **the later benefits of immunological memory far outweigh the minor discomforts of most childhood diseases.** In fact, getting diseases such as chickenpox or measles later in life is much harder on the adult and are associated with symptoms significantly worse than those seen in the childhood illnesses.”

NOTE: Page 1012. Herpes zoster viruses cause chickenpox mainly in children and shingles in adults. Periodic exposure to the wild virus throughout life (parenthood, grandparenthood, etc.) is protective against outbreaks of shingles in adults keeping the immune system strong.

72. The primary mechanisms against viruses are NK (natural killer) cells, interferons, and cytotoxic T cells. Antibodies are effective against viruses mostly during protection, where an immune individual can neutralize them based on a previous exposure.

TEXT HIGHLIGHTS: Page 1022. **How Stress Affects the Immune Response: The Connections between the Immune, Nervous, and Endocrine Systems of the Body**

“The physical connections between these systems have been known for centuries: All primary and secondary organs are connected to sympathetic nerves. What is more complex, though, is the *interaction of neurotransmitters, hormones, cytokines, and other soluble signaling molecules, and the mechanism of “crosstalk” between the systems...*

Chronic stress, unlike short-term stress, **may inhibit immune responses even in otherwise healthy adults. The suppression of both innate and adaptive immune responses is clearly associated with increases in some diseases**, as seen when individuals lose a spouse or have other long-term stresses, such as taking care of a spouse with a fatal disease or dementia.”

It is important to take note of the ways chronic stress can negatively affect the body:

Effects of Stress on Body Systems	
System	Stress-related illness
Integumentary system	Acne, skin rashes, irritation
Nervous system	Headaches, depression, anxiety, irritability, loss of appetite, lack of motivation, reduced mental performance
Muscular and skeletal systems	Muscle and joint pain, neck and shoulder pain
Circulatory system	Increased heart rate, hypertension, increased probability of heart attacks
Digestive system	Indigestion, heartburn, stomach pain, nausea, diarrhea, constipation, weight gain or loss
Immune system	Depressed ability to fight infections
Male reproductive system	Lowered sperm production, impotence, reduced sexual desire
Female reproductive system	Irregular menstrual cycle, reduced sexual desire

~ END of PART II ~