BODY BY DESIGN STUDY GUIDE

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Introduction

This study guide was designed for use with *Body by Design: Fearfully and Wonderfully Made.* It is hoped that this guide/solutions manual will not only provide clear answers to end-of-chapter questions, but also will encourage and interest students to study further. Humanity is the pinnacle of God's creation. Today, after centuries of study, much is known, but many things are still not understood about the human body. The study of the body is full of thrilling discoveries and realizations for the careful student. Most importantly, this study gives us a deeper awe of our Creator who wove "wisdom in the inward parts."

A key concept in *Body by Design* is that of the interwoven complexity in anatomy. In fact, the "fabrica" concept is "woven" throughout both the text and the questions. Much of the information needed to aid in answering these questions can be found in Table 1.1 on page 10. To answer these questions fully, though, you often may wish to study further in other texts. Indeed, *Body by Design*'s thought-provoking questions are intended to be a springboard into more intensive studies. It is strongly recommended that you invest in a good college-level anatomy and physiology textbook. (See list of recommended reading below.) After reading a chapter in *Body by Design*, read the related chapter(s) in the anatomy and physiology textbook before trying to answer the questions. Also, try to not "look back" while answering the questions. If you can accomplish this, you will be promoting long-term retention, which should be your goal. Skimming the questions before reading the chapter is also a good idea. This helps you pick up the main points in the chapter as you read.

In the study guide, you will notice that, where appropriate, the questions have answers on two different levels. These levels are high school level (HS), and college level (CL), and should give an example of what can reasonably be expected of a junior or senior in high school or a freshman or sophomore in college. Here are some study methods that many have found valuable.

"The notebook" — Any spiral bound notebook will do, preferably one without perforated pages. Write, write, and write while you read. Outline and summarize what you are studying. Number the pages and write on only one side of the pages. Also, leave space between points. This gives you room to add more as you learn, and it makes memorizing your notes much easier. Most find that memorizing the notes out loud is very helpful. However, memorizing the notes verbatim is usually not the best idea. Instead, constantly summarize and review.

"Flash cards" — This method is an old "tried-and-true." It is especially well adapted for the study of anatomy. Many like to put their cards on a metal ring and keep them with them constantly.

"Teach it" — This may seem odd at first, but is really one of the best ways to learn. Choose a limited subject and find a good appreciative wall for an audience. By the time you have explained your subject to the wall a couple times, you will find that you have it memorized and understand it, too.

The best thing you can do for yourself, though, is to read as much as you can about anatomy and physiology and related sciences. There are also several good video series on the human body and pathology. For instance, the TIME LIFE MEDICAL video series with C. Everett Coop, M.D., covers subjects such as diabetes, Alzheimer's disease, and arthritis. The Institute for Creation Research (ICR) and Answers in Genesis (AIG) offer outstanding video series on creation versus evolution.

Here is a list of resources that will help you as you work through *Body by Design.* You will find a longer, different list on page 153 of *Body by Design.* If you live near a university, many of these resources will be readily available. If you are far from a university or a good library, the Internet offers several resources.

Principles of Human Anatomy and Physiology, eighth edition, by G.J. Tortora and S.R. Grabowski, published by John Wiley & Sons. This is an excellent college level textbook

Introduction to the Human Body: The Essentials of Anatomy and Physiology, by G.J. Tortora, published by Harper Collins College Publishers.

Concepts of Human Anatomy and Physiology, fifth edition, by Kent M. Van De Graaff and Stuart Ira Fox, published by Wm. C. Brown Publishers. This is an excellent source with clear in-depth text and excellent pictures and diagrams. This text alone has nearly everything you will need for answering the questions in *Body by Design.*

Wm. C. Brown Publishers also offer a good set of 300 anatomy and physiology flash cards that are useful with any text, and a computerized study guide.

Robbins Pathologic Basis of Disease, fifth or sixth edition, by S.L. Robbins, R. Cotran, and V. Kumar, published by W.B. Saunders Co. This is one of the best pathology texts available. Although it is a medical school level text, it is well-written and very clear, even for undergraduates. I used it quite a bit while preparing the study guide. I recommend, though, that you look for it in a university or medical school library rather than buying it, unless you are seriously planning to attend medical school within a few years.

Netter's Atlas of Human Anatomy, by Frank H. Netter. This is one of the most popular anatomy atlases among medical students. It is available at www.netterart.com.

Grant's Atlas of Anatomy — This is a close runner-up to *Netter's*. It is an outstanding, very detailed work.

Gray's Anatomy, fifteenth edition. This is the classic text on anatomy and is fairly inexpensive.

Hole's Human Anatomy and Physiology, seventh edition, by J. Hole, D. Shier, and R. Lewis, published by Wm. C. Brown Publishers. This text is well-suited for advanced high school or college students.

Hole's Essentials of Human Anatomy and Physiology, seventh edition, by J. Hole, D. Shier, and R. Lewis, published by Wm. C. Brown Publishers. This text is well-suited for middle-level high school or students.

Hole's Human Anatomy and Physiology, seventh edition, by J. Hole, D. Shier, and R. Lewis, published by Wm. C. Brown Publishers. This text is well-suited for upper-level high school students.

ANSWERS TO QUESTIONS

Chapter 1, page 15

1. Design can be recognized in several ways. First, design is evidenced by a structure's perfect suitability for certain tasks. Second, design is revealed in the balanced interplay of several different systems or structures to reach a common goal.

2. The 11 body systems are as follows:
   A. Integumentary system: protects the body from the external environment, and helps maintain homeostasis.
   B. Muscular system: provides movement through contraction or relaxation.
   C. Skeletal system: provides support for the body and protection for vital organs.
   D. Circulatory system: carries nutrients and oxygen to the cells of the body and removes waste.
   E. Respiratory system: provides oxygen to and removes carbon dioxide from the body.
   F. Lymphatic and immune system: protects the body from pathogens. The lymphatic system also returns interstitial fluid to the blood.
   G. Digestive system: works to break down food into components that can be absorbed by the bloodstream.
   H. Excretory system: filters and removes nitrogenous waste from the body.

I. Endocrine system: secretes hormones that regulate and influence different body functions.
J. Nervous system: coordinates the body's internal functions and its response to external stimuli.
K. Reproductive system: provides for the continuation of human race.

The skeletal system is the most widely recognized system of the body. Both the endocrine and the immune systems are less easily recognized.

3. As seen in the text:
a. The relationship of structure to function.
b. Homeostasis
c. Interdependence among body parts.
d. Short-term physiological adaptation.
e. Maintenance of boundaries.
f. Order, organization, and integration.
All of these apply for all body systems.

4. As the systems work together to form a whole, it uncovers a wise plan. Every part is perfectly designed for its role and place. The systems do not interfere with each other, but perfectly complement each other. Through its interwoven, interdependent design, the body reveals Divine wisdom in its inward parts.

5. Vesalius was probably a creationist as revealed by his strong belief in God and in his carefully recorded discoveries of the exquisite design in the human body. Vesalius's bold challenge to the accepted view of his day encouraged later scientists to think critically and to use more scientific methods of study. By using a human cadaver, he proved that there are many differences between humans and animals and one cannot be used to authoritatively describe the other. Thus, he based human anatomy on a far more accurate foundation.

6. Science must be based on facts and careful observations. Thus, like Vesalius, scientists today must be willing to scrutinize all the evidence to discover the truth whether it conflicts with the popular view or not. Nowhere should scientists be more careful in this than in a quick acceptance of the evolutionary theory. Here, they should seek to know both sides, and then, laying aside philosophy, compare the two views with scientific fact.

Chapter 2, page 21

1. The theory of evolution has had a profound influence on the 20th century. For instance, the Holocaust was openly and firmly based on the Darwinian concepts of superior races and the survival of the fittest. Today, evolutionary thinking is the basis for the growing acceptance of abortion and euthanasia. Unfortunately, the belief of evolution has often caused scientists to abandon the scientific method for the sake of evolutionary "proofs." Unless honesty and truth regain their rightful place in science, such frauds and genocides will probably increase in the 21st century.

2. Evolutionists and creationists both agree that changes do occur. However, creationists point out that such changes are limited, cause the loss of information, and cannot change one organism into a different organism. Yet, evolutionists argue that such changes could, over eons of time, result in massive and radical changes.

3. Small variations or loss of information in a closed gene pool constitute microevolution. Microevolution never increases information, but either loses it or presents it in a different combination. In contrast, macroevolution represents huge changes that require vast new information. Macroevolution is the concept that over time, one life form can change into another very different life form.

4. Humans exhibit many variations in such things as height, skin, and eye and hair color. Yet these differences are very small, and humans remain irrevocably human. This is similar to the concept of microevolution — small changes within a kind.

5. In the evolutionary view, man is the product of random, chance processes. Thus, the body should be full of junk relics from earlier stages of evolution. They term such alleged relics "vestigial." Tonsils and wisdom teeth are two examples of such supposed vestigial parts. In contrast, the creation view holds that there is a purposeful design for everything, though it may not be understood yet. This view has proven true with both tonsils and wisdom teeth. Tonsils are important to the immune system, and wisdom teeth are fully functional molars.

6. Though Darwin was very familiar with William Paley's book *Natural Theology,* he rejected it because he rejected God. His writings on evolution were his attempt to rationalize that rejection.

7. One's world view on origins will profoundly influence his values, lifestyle, and actions. If one accepts the evolutionary view that no power higher than chance has brought about life, then man is accountable to no one. In a world ruled by chance, there is no need or place for absolutes such as right and wrong. On the other hand, if one believes in an omniscient, omnipresent, omnipotent Creator, then one realizes that he is accountable to that Creator and must obey His laws.

Chapter 3, page 29

1. A mosaic has thousands of tiny parts which form an intricate, rich pattern. These little pieces are meaningless on their own, yet in the hands of a master craftsman; they can become a complex, beautiful design. Mosaics require careful, thorough planning. When cells are compared to mosaics, this comparison makes a strong argument for intelligent design of the cell.

(HS) 2. The main covering of the cell is two layers of lipids with embedded proteins. These proteins, however, are not stationary and can move in the lipid bilayer, forming complicated and functional mosaics. Hence the term, "fluid mosaic membrane."

(CL) 2. The main covering of the cell is the phospholipid bilayer. Phospholipids have a polar end and a nonpolar end. The polar ends face out while their nonpolar ends face in toward each other. This helps the cell restrict water and mineral movement across the membrane. Proteins embedded in the bilayer membrane selectively transport materials across the membrane, act as receptors, and can move in the bilayer as necessary. Completing the mosaic of the cell membrane are surface glycolipid and glycoprotein carbohydrates.

3. No one thinks that a car came into existence by random chance. One realizes from uniform experience that cars require a designer who has planned carefully in advance, and builders who put that plan into action. If we saw a specialized machine fulfilling its task, we would conclude (even though we had never seen it before) that there was intelligent design behind its construction. The human body is far more specialized and intricate than any machine. Thus, we conclude that the human body is the product of intelligent design.

(HS) 4. Design is seen in DNA in its tight intertwining double helix, its careful base pairing, its stored information, and its outstanding "proofreading" system.

(CL) 4. The vast information stored in the twisting double helix of DNA gives a strong argument for design. Not only can design be seen in the nearly infinite number of base sequences possible, but also in DNA's proofreading system that allows it to be replicated over and over with few mistakes.

(HS) 5. Pseudo-stratified columnar epithelium, simple cuboidal epithelium, simple squamous epithelium,

and simple columnar epithelium. Pseudostratified columnar epithelium has many cilia that enable it to move foreign particles out of the respiratory tract. Simple cuboidal epithelium, with its square shape, is important in secretion. Simple squamous epithelium's flattened shape promotes rapid diffusion in such places as the lungs. Simple columnar epithelium's volume and shape make it very absorptive.

(CL) 5. Pseudostratified ciliated columnar epithelium lines the trachea and the bronchial tubes. With its cilia it functions to force bacteria and dust from the bronchi and trachea. Simple cuboidal epithelium lines tubules and ducts that are actively involved in secretion. Its cube shape enables it to perform this process efficiently. Simple squamous epithelium lines the walls of blood vessels and alveoli in the lungs. Its irregular flattened shape promotes rapid diffusion. Simple columnar epithelium lines the stomach and intestines where it serves as a very absorptive surface.

6. Let us begin with DNA in a multinucleate muscle cell or fiber. This is the molecular level. This DNA is contained in a nucleus of the muscle fiber. The rest of the muscle fiber consists of thousands of myofibrils. This is the cellular level. Each muscle fiber is bound to other muscle fibers to form a muscle bundle. This muscle bundle is then connected by fascia to other muscle bundles to form a complete muscle — for instance the triceps brachii. This muscle, in turn, is part of something much larger: the entire muscular system.

Chapter 4, page 35

(HS) 1. Male: Testes, penis, accessory reproductive glands. Female: Ovaries, uterine tubes, uterus, vagina.

(CL) 1. The primary male reproductive organs are the paired testes. The spermatic ducts, penis, and accessory reproductive glands comprise the secondary male reproductive organs. The female reproductive organs are the paired ovaries, uterine tube, uterus, and vagina. Associated organs, while not technically a part of the reproductive system, include the placenta and umbilical cord. These organs are present only in pregnancy.

2. The overall function of the reproductive system is to ensure the continuation and survival of the human race.

3. The uterine blood supply is a beautifully interwoven component of the reproductive system. The branching vessels of the uterine arteries run over both the uterine tube and ovary before they join together, or anastomose, at the upper portion of the uterus. Its weaving pathway supplies the uterus with plenty of oxygen-rich blood. The complex intertwining of the seminiferous tubules also supply a good example of an interwoven portion of the reproductive system.

4. The growing fetus is surrounded by an amniotic sac derived from ectoderm and mesoderm. This amniotic sac is filled with amniotic fluid that cushions and protects the fetus. The amniotic fluid ensures that a constant pressure and temperature is maintained about the fetus. Surrounding the amniotic sac is the chorion. Because of this protective sac, the fetus is able to develop freely without constriction. The amniotic sac and chorion are a superb protection for the fetus and are strong evidence for intelligent design.

5. Sexually Transmitted Diseases, STDs

6. Recapitulation theory, that human development is a "replay" of macroevolution, was first proposed by Ernst Haeckel. This theory claims that as the fetus develops it reveals different stages of evolution. This faulty theory is based on the vague resemblance of certain fetal structures to animal parts, and Haeckel's fraudulent embryological drawings. It has no basis in fact, and is an example of very poor science. Its modern-day proponent is Dr. Ken Miller.

Chapter 5, page 45

1. This question is best seen in the light of components. The bones of the skeletal system are composed of several types of unique cells. These cells, osteoblasts, osteocytes, and osteoclasts, work together to form the Haversian system of the bone. Osteoblasts form bone, osteoclasts destroy old bone tissue to make room for new, and osteocytes are mature osteoblasts with bone tissue secretions surrounding them.

2. The skeleton provides structure, protects internal organs, and is the center for the production of marrow.

3. Interwoven design is best seen in the structure of compact bone tissue. This bone tissue is a complex arrangement of cylindrical osteons interlaced with thousands of canaliculi that join the osteocytes inside the lacunae in concentric circles. Perforating canals weave through the bone, joining each osteon's central canal. This intricate and beautiful design is a good example of the fabrica concept: the bone is a skillfully woven structure.

(HS) 4. There are several structural differences between male and female pelvic girdles that point to intelligent design. For instance, the female pelvic outlet is wider than the males. The pubic arch in the female is greater than 90 while in the male it is less than this. These and other differences show that the female pelvic girdle is designed for the needs of pregnancy and childbirth.

(CL) 4. The male and female pelves have several differences. First of all, the male pelvis is more massive and has more prominent processes than the female's, which is more delicate. Also, the male pelvic inlet is heart-shaped, while the female's is oval; the male's pelvic outlet is narrow, compared to the female's wider outlet. In the male pelvis, the anterior superior iliac spines are closer together than in the female. In addition, the obturator foramina are oval in the male but are triangular in the female. The male's symphysis pubis is deeper and longer than the female's. The male's acetabula faces laterally, while the female's faces somewhat anteriorly. Finally, the male's pubic arch is less than 90 while the female's is greater than 90 . It is clear that God intelligently designed the female pelvis for the needs of childbirth.

(HS) 5. Arthritis is the most common form of joint degeneration. Its symptoms are pain, stiffening, and swelling at the joints.

(CL) 5. The most common degenerative condition of the joints is arthritis, a common term that covers several inflammatory joint diseases. Prevalent among these is osteoarthritis. Its symptoms include pain, restricted movement of the joints, and deforming calcification at the joints.

(HS) 6. The thumb has a unique joint, the saddle joint, that allows it to have a wide range of motion. Because of this joint, and the thumb's position, the thumb can oppose the other fingers. Without this ability, it would be very difficult to pick things up. The thumb is powerful proof of a wise designer.

(CL) 6. The thumb is one of the amazing wonders of the human body. First, the thumb is joined to the hand by a unique joint found nowhere else in the human body. This joint, the saddle joint, has a surface that is convex in one direction and concave in the other. This gives the thumb a very wide range of motion. Most important of these motions is the thumb's ability to oppose, or move in the opposite direction of, the other fingers and hand. Without this ability, it would be almost impossible to grasp objects and hold them firmly. Also, several muscles in the hand are involved with the intricate manipulation of the thumb. The thumb is powerful proof of a wise designer.

(HS) 7. A suspension bridge's long arches evenly distribute the weight and can withstand shock. In the foot, longitudinal and transverse arches support the body weight by evenly distributing it. These arches protect your feet from the wear and shock of daily use by providing great flexibility and elasticity.

(CL) 7. The foot has two arches, transverse and longitudinal, that give the foot leverage, and spread and support the body's weight. Like a suspension bridge, the arches are somewhat elastic, spreading under weight and springing back into place as soon as the weight is removed. These arches are very important for the foot's protection, because they absorb shock.

Chapter 6, page 53

1. The main components of the muscular system are skeletal muscle, cardiac muscle, and smooth muscle. Skeletal muscles are voluntary muscles, cardiac and smooth are involuntary.

2. The overall function of the muscular system is to provide movement for the body via contraction.

3.(HS). One of the finest examples of interwoven design in the muscular system is that of the sarcoplasmic reticulum and transverse tubules in the muscle fiber. The sarcoplasmic reticulum and transverse tubules are woven around and between the individual myofibrils in a muscle fiber. This interwoven design allows all myofilaments to be rapidly activated to shorten.

3.(CL) One of the finest examples of interwoven design in the muscular system is that of the sarcoplasmic reticulum and transverse tubules in the muscle fiber. A muscle fiber or cell is composed of many column-like myofibrils which in turn are made of thousands of myofilaments. Contraction is caused by the shortening of these filaments. Yet, contraction would not be possible without the interwoven design of the sarcoplasmic reticulum and T.tubules. Sarcoplasmic reticulum is woven tightly around each myofibril. Running alongside of the sarcoplasmic reticulum are the T.tubules that carry the nerve impulse. Thus, when a nerve impulse reaches the muscle fiber, it is transmitted quickly to the reticulum, which in turn releases Ca^{2+}, causing the muscle to contract. What a complex, interwoven design!

4. (HS) The skeletal muscle is composed of several smaller muscle bundles called fasciculi. These fasciculi in turn are formed from many distinct muscle fibers or cells. Muscle fibers contain myofibrils which in turn hold thousands of myofilaments, actin and myosin, which slide together to contract the muscle fiber. This superbly strong design is evidence for creation of the muscles.

4. (CL) The skeletal muscle is covered with a fascia called epimysium. This epimysium extends into the muscle separating it into bundles called fasciculi. Continuous with the epimysium is the perimysium which surrounds each fasciculus. The fasciculi are further subdivided by endomysium into distinct muscle fibers. Skeletal muscle fibers appear striated and have myofibrils that contain thousands of myofilaments arranged in sarcomeres. Thick myofilaments are made of the protein myosin, and the thin of the protein actin. The sliding together of these myofilaments causes contraction of the muscle. Surely, such interdependent complexity reveals a wise Creator.

5. (HS) Muscle fatigue is caused by an accumulation of lactic acid formed in the muscles during overexertion.

5. (CL) Muscle contractions require large amounts of energy in the form of ATP. This ATP is generated normally in a three-stage aerobic cellular respiration. However, during exertion not enough oxygen is present to meet the demand, and the three stages cannot be completed. Instead, the cell resorts to anaerobic respiration to supply the needed ATPs. This form of respiration produces lactic acid as a byproduct. As the lactic acid accumulates, it causes muscle fatigue and pain.

Chapter 7, page 61

1. The digestive organs are these: Oral cavity, pharynx, esophagus, stomach, small intestine, and large intestine. Accessory organs to the digestive system include the tongue, teeth, salivary glands, liver, pancreas, and gallbladder.

2. The overall function of the digestive system is to break down foods through hydrolysis into molecules that can be absorbed easily into the blood or lymph.

3. The small and large intestines are excellent examples of intertwining members of the digestive system. The intertwining of the small intestine allows it to maximize the volume allotted it. This, of course, increases the available surface area needed for absorption of nutrients.

4. The structure of an intestinal villus is far more complex than it first appears. Each villus is formed from a fold in the mucosa. Inside each villus is a lymph vessel called the lacteal. A venule runs up one side of the lacteal and an arteriole runs up the other. The venule and arteriole are woven together by hundreds of capillaries that surround the lacteal. Digested fatty acids cannot enter the blood immediately and are absorbed by the lacteal. Other nutrients absorbed by the villus pass at once into the bloodstream. This complex design requires that all parts be fully functioning at the same time. It is impossible that all these delicate parts could evolve at the same time in the proper place.

5. (HS) Some bacteria are not classified as germs because they do not harm humans. In fact, some bacteria in our intestines provide us with essential vitamins.

5. (CL) Some bacteria are not classified as germs because they are non-pathogenic. Moreover, many of these bacteria are beneficial to humans because they retard the growth of pathogenic bacteria. Also, some bacteria in the intestine help to disassemble certain sugars and cellulose that could not otherwise be digested. Most importantly, certain bacteria are essential for life. Bacteria in the intestines synthesize NAD, a crucial component of cellular respiration.

6. (HS) Dental caries form when sugary food is allowed to accumulate on the tooth, providing a rich feeding ground for bacteria in the mouth. As the bacteria break down the sugar, they form lactic acid, which eventually forms holes in the tooth's enamel.

6. (CL) Dental caries are the result of lactic acid formed as a byproduct when bacteria such as *Streptococcus mutans* break down sugars left on the teeth. The lactic acid gradually breaks through the teeth's enamel. Another bacteria, *Lactobacillus,* speeds up the decay.

Chapter 8, page 67

1. The organs of the excretory system are these: Kidneys, ureters, bladder, and urethra. The functional unit of the kidney is the nephron.

2. The overall function of the excretory system is to filter waste from the blood and then remove it from the body.

3. (HS) The nephron and peritubular capillaries are a good example of intertwining design in the excretory system. The nephrons are twisting tubular structures surrounded by a woven mesh of capillaries.

3. (CL) An intricately intertwined component of the excretory system is the nephron with its associated peritubular capillaries. The Bowman's capsule of the nephron surrounds the glomerulus, a twisted, interwoven ball of capillaries. Filtrate forced through the fenestrate of the capillaries is drawn down the proximal convoluted tubule that leads off the Bowman's capsule. This tubule weaves through an intricate

fabric of peritubular capillaries as it forms the nephron loop and distal convoluted tubule before emptying into the collecting duct.

4. (HS) The kidney clearly shows irreducible complexity. If any component of the kidney's delicate system were missing, the kidney could not function. For example, if the kidney were not highly vascular, not enough water could be reabsorbed, and one would quickly die of enormous water loss. The kidney is truly irreducibly complex.

4. (CL) The kidney clearly shows irreducible complexity. If any component of the kidney's delicate system were missing, the kidney could not function. For example, the glomerular capillaries have very large pores that make these capillaries hundreds of times more permeable than normal. Thus, these pores, or fennestrae, enable the filtrate to pass out of the blood. If these fennestrae were missing, filtration could not take place. If they were larger, blood cells and platelets would escape. Another example of irreducible complexity of the kidney is its vast number of nephrons. If it had fewer, the kidney could not filter the blood fast enough or often enough. Also, if the kidney were not highly vascular, the necessary reabsorption could not occur; and one would die rapidly from enormous water loss.

5. (HS) Urinary tract infections are caused mainly by bacteria (mostly *E.coli)* from fecal matter.

5. (CL) Urinary tract infections are of two main types: cystitis (involving the bladder) and pyelonephritis (involving the kidneys). In 85% of UTIs, the infection is caused by gram-negative bacteria such as *E.coli, Proteus,* and *Enterobacter.* Less frequently, *Staphylococcus* or *Streptococcus fecalis* can produce renal infections.

6. (D) Normally, urine is completely free of glucose, however, in diabetes mellitus, inadequate insulin secretion results in a very high glucose concentration in the blood and thus glucose is in the urine. Also ,the blood glucose level of sample B exceeds healthy blood glucose levels. The normal range for blood glucose is 70–110 mg per 100 ml.

7.(B) Notice that the blood glucose level is very low in sample C's data. Hypoglycemia is caused by overdose or over secretion of insulin.

8. Several of these answers are acceptable, the best being (B) or (A). (E) is a poor answer, since normal urine would contain no glucose either.

9. (C) Diuretics inhibit water from being reabsorbed and therefore increase the volume of the urine.

10. (B) Tube C has the highest hydrogen ion concentration, $[H^+]$, as seen by its low pH. $pH = -\log[H^+]$

Chapter 9, page 77

1. Heart, veins, arteries, capillaries

2. (HS) Sickle cell anemia is an inherited anemia caused by a single mutation. It is characterized by sickled, hardened red blood cells. These sickled cells can be clearly seen by using a light microscope.

2. (CL) Sickle cell anemia is caused by a single genetic mutation on the b chain of hemoglobin. This mutation is the substitution of valine for glutamic acid at the #6 position. The mutation results in sickled, hardened RBCs. Sickle cell anemia is characterized by severe pain attacks, chronic hemolytic anemia, organ and tissue deterioration, susceptibility to severe bacterial infection, and lowered life expectancy. The sickled cells of the disease can be clearly seen through a light microscope. However, hemoglobin electrophoresis and clinical findings are necessary for a definitive diagnosis.

3. (HS) One of the main jobs of the blood is transportation of nutrients, oxygen, and hormones to the cell, and the removal of wastes from the cells. Blood also protects the body by destroying invaders and through clotting to prevent excess blood loss. Blood is made of plasma, red blood cells, platelets, and white blood cells.

3. (CL) The blood functions to transport oxygen and digested nutrients to the cell and to remove metabolic wastes from the cell. The blood also carries hormones and helps stabilize the body's temperature.

Another important function of the blood is protection through phagocytosis of foreign invaders. Blood is made of a liquid part called **plasma** and a cellular part known as **formed elements**. Plasma is a yellowish fluid made of water and solute such as Na^+. Formed elements are the erythrocytes or red blood cells, leukocytes or white blood cells, and platelets which are fragments off of large bone marrow cells.

4. The veins are a complex, interwoven structure of the circulatory system. Veins weave throughout the entire body, reaching all organs and tissues. The veins are woven to the arteries by millions of capillaries. Even the structure of the vein with its three tunics is a beautifully woven design. If it lacked one of these tunics, the vein could not withstand the pressure or perform its job smoothly. The vein's valves keep the blood flowing in the right direction.

5. (HS) It has been proposed that sickle cell anemia is a beneficial trait because it provides the carrier with some protection against malaria. Sickle cell anemia, however, cannot be considered beneficial. It results in obstructed blood vessels, tissue death, severe pain crises, chronic anemia, leg ulcers, bone destruction, gallstones, susceptibility to infection, and shortened life expectancy.

5. (CL) It has been claimed sometimes that the sickle cell trait is beneficial because it offers a slight protection against falciparum malaria. This protection is strongest in the homozygous state of this trait, sickle cell anemia. However, this small protection cannot compensate for the horrors of sickle cell anemia. Normal RBCs are smooth and extremely flexible. Sickled cells are rough and somewhat rigid. This, and their shape, causes them to form "log jams" in small blood vessels, cutting off the blood supply to organs and tissues. Normal RBCs have a life span of 120 days, but sickled RBCs last only 20 days, leading to chronic hemolytic anemia. Other results of SCA include massive leg ulcers, renal lesions, blindness, collapse of the femoral head, extreme susceptibility to bacterial infections, dactylitis, and shortened life expectancy. Beneficial? Hardly.

6. Homeostasis is a dynamic internal constancy that is essential for life. Thousands of feedback mechanisms work to keep an average body temperature, blood glucose level, heart rate, etc. Blood clotting relates to homeostasis because it is the process whereby blood loss is stopped, helping to keep the environment stable. Most homeostasis is maintained by negative feedback mechanisms. For instance, if the body becomes too hot, negative feedback loops work to remove this change in temperature by cooling it. On the other hand, positive feedback increases the change in the body. Blood clotting is an example of positive feedback. As one clotting factor is activated, it causes more and more clotting factors to be activated until the blood clot is produced.

Chapter 10, page 84

1. Nasal cavity, pharynx, larynx, trachea, and lungs (bronchi, bronchioles, and alveoli)

2. The overall function of the respiratory system is gas exchange.

3. One interwoven aspect of the respiratory system is the trachea and bronchial tree. Its many subdividing branches carry oxygen to all parts of the lungs. The arterioles and venules that extend throughout the lungs are woven around these branches and their millions of alveoli to absorb the oxygen.

4. (HS) The alveoli are an interwoven component of the respiratory system. First, the millions of alveoli are woven throughout the lung, reaching all parts. Around each alveoli is an interwoven mesh of capillaries facilitating rapid gas exchange.

4. (CL) The nearly 300 million alveoli in the lungs and their millions of associated venules, arterioles, and capillaries are an excellent example of interwoven complexity. As the bronchial tree enters the lungs, it branches into secondary and tertiary bronchi. These further branch into bronchioles that extend into every part of the lungs. Here, alveoli are clustered into alveolar sacs. Each alveolus is only a single cell layer thick. Between and around each alveolus are arterioles and venules. These vessels are joined to each other by a fabric of capillaries that form a net around each alveolus. This complex interwoven design enables rapid gas exchange.

5. Genesis 2:7 states: "And the LORD God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul." Several things are worth noting. The phrase, "Of the dust of the ground," reminds us that on the atomic level, man is formed from many of the chemical elements that form the ground. When God "breathed into [man] the breath of life," He was not merely giving him oxygen, but directly imparting a living soul to man. For an excellent discussion of this verse, I recommend *The Genesis Record*, by Henry M. Morris.

6. (HS) The simplest explanation is that there are more than a hundred cold-causing viruses. This makes finding a "cure-all" very difficult.

6. (CL) There are more than a hundred known cold-causing viruses today. Scientists believe that this is due to the rhinovirus having an RNA genome that mutates easily, changing its outer protein coat and antigen combination. This makes finding a "cure" for the "cold" very difficult.

7. (C)

8. (D)

Chapter 11, page 95

1. Brain, spinal cord, peripheral nervous system

2. The overall function of the nervous system is receiving, sending, sorting, and translating information via nerve impulses.

3. (HS) Every component of the nervous system reveals interwoven design. One clear example is the nerve cells with their innumerable fabric-like connections to each other. That such complexity could arise merely by random mistakes and chance processes is nothing short of impossible. The speed of an impulse traveling from the farthest end of the peripheral nervous system to the central nervous system is incredible. The complexity of the nervous system and its perfect ability for the task it completes are strong evidences for intelligent design.

3. (CL) It is not difficult to find examples of interwoven complexity in the nervous system. Take the structure and function of a motor nerve of the peripheral system, for example. The nerve is formed from nerve fiber bundles composed of thousands of axons surrounded and supported by neuroglial cells. The axons carry nerve impulses from the fabric of neuron cell bodies and dendrites in the spinal chord. Neuroglial cells called Schwann cells form sheaths of myelin along the axon allowing impulses to be relayed extremely fast. Such a complex, perfectly functioning design could not have come about by chance and is, therefore, strong evidence for a wise designer.

4. (HS) Whether bipolar, unipolar, or multipolar, the neuron is irreducibly complex. For instance, if it lacked its axon, messages could not be transmitted. In some areas, if the axon were not myelinated, the impulse could not be transmitted fast enough.

4. (C.L) Anatomically, the neuron is composed of dendrites, a cell body, and an axon. On further examination, however, the neuron is much more complex. For instance, a complex neurotransmitter ACH released from the presynaptic terminal of the axon carries the nerve impulse across the synaptic cleft. If this neurotransmitter is missing or inhibited by something such as a neurotoxin, no impulse will be able to travel through the neurons and one would die within minutes. Another example of irreducible complexity is the gated proteins that control the action potential. It is clear that the neuron is irreducibly complex and cannot be the product of gradual, small changes.

5. Flexibility refers to a nerve's ability to take over the functions of another nerve, and plasticity refers to the nerves ability to do long-term adjustments.

6. Pain is necessary because it protects us from harming ourselves unintentionally. Without pain, we would, in a sense be helpless — helpless to be a unified whole. When one member of the body was damaged, there would be no rush of the other members to protect it.

7. Integration is the process of joining several parts together to make a unified, working whole. Through the nervous system, unity is brought to the body on the cellular and organ level. For instance, a single neuron synapses with each hair cell in the ear. This neuron, however, can relate the information from a single cell to a vast, integrated network of nerves. Integration is shown on the organ level, too. For instance, nerves integrate the heart with the nervous system, regulating such important things as the cardiac rate.

8. (B)

9. (D)

10. (A)

11. (A)

Chapter 12, page 103

1. (HS) The eye is a sphere composed of three main layers: the sclera which is opaque; the uvea which contains the choroid, ciliary body, and iris; and the retina. At the front of the eye is the lens. Covering the lens is the transparent cornea. Vitreous humor in the eye helps the eye maintain its shape. The eyes function to absorb light rays and translate them into nervous impulses to the brain.

1. (CL) The eye is a sphere composed of three main layers. The outermost layer is the **fibrous tunic**, which is made of a clear cornea and an opaque sclera. The choroid, iris, and ciliary body are collectively known as the **uvea** and comprise the middle layer. The **retina** is the eyeball's innermost layer. Aqueous humor maintains the shape of the cornea, and vitreous humor maintains the eyeball's shape. The basic function of the eye is transduction of light energy into nerve impulses.

2. (HS) The ear has three main sections. These sections are the outer ear that ends at the eardrum, the middle ear (containing three small bones), and the inner ear with its cochlea and canals. The ear detects sound waves and converts them into nerve impulses to send to the brain.

2. (CL) The ear is divided into three basic sections: the outer ear, the middle ear, and the inner ear. The outer ear is made of the auricle and the one-inch long auditory canal. The middle ear is separated from the outer ear by the eardrum. In the middle ear are the three small ear bones: malleus, incus, and stapes. The inner ear begins where the stapes is attached to the oval window. The inner ear is composed of the cochlea

and the semicircular canals. The ear functions to detect sound waves and send the vibrations to sensory fibers that transmit this information to the brain.

3. Here are just a few evidences possible for design in the human eye:

a. The position of the eye in the orbital cavity
b. The protection of the eye by eyelashes and eyelids
c. The amazing lacrimal apparatus
d. The fine-tuned movement of the eyeball through its six extrinsic ocular muscles
e. The iris and its function
f. The three perfectly designed tunics of the eyeball and their function
g. The position of the optic nerve
h. The optimal position of the retina
i. The retinal pigment epithelium

Every part of the incredible human eye is clear evidence for a wise Creator.

4. A transducer converts the input energy of one type to output energy of a different type. Tranduction in the ear is the conversion of sound waves vibrating the eardrum to nervous impulses being sent to the brain.

5. (HS) It is not a flaw in the original design of the eye that causes nearsightedness or farsightedness. Instead, these conditions are the result of deviations from that design resulting in an eyeball that is not the correct shape, or a lens with the wrong shape or thickness.

5. (CL) Nearsightedness and farsightedness are not from a flaw in the design of the eye. Rather, they are deviations from the eye's original design. Nearsightedness (myopia) can be caused by either a too-thick, convex lens or a too-long eyeball. Farsightedness (hyperopia) is the result of a too-flat lens or a too-short eyeball.

6. Otitis media is an infection of the middle ear. Young children have shorter auditory tubes than adults, which puts them at a greater risk for infection. This infection often occurs after swimming, which is understandably popular in the summer.

7. Let us look, for example, on the beautiful relationship of structure to function in the eye. Because the sclera of the eye is opaque, light can only enter through the lens; therefore, the light can be optimally focused on the retina. The iris, with its ability to contract or dilate according to light levels, is another example of this theme. When light energy passes through the eye's lens, it is absorbed by photoreceptors in the retina, breaking down a pigment in the photoreceptors. This starts an electrical nerve impulse in the nerves attached to the photoreceptors.

In his book *In His Image,* Dr. Brand speaks with awe of the eye that he believes was designed and created by God. You will find his discussions of the eye in *In His Image*, on pages 116–119, and in his book *Fearfully and Wonderfully Made,* on pages 22–23.

8. A good example of interdependence in the ear is the three ossicles of the ear and how they transfer the vibration of the eardrum to the inner ear. If any one of these bones were missing, deafness would result. The perfectly designed, interdependent ear could not have been formed in a haphazard, random way and must be the product of intelligent design. These interdependent parts work together in the transduction of sound waves into nerve impulses. Sound waves strike the tympanum, which transmits its vibrations through the ear ossicles to form pressure waves in the cochlea's fluid. Hair cell processes in the cochlea are bent by this wave, triggering sensory neurons to send an impulse to the brain.

A street light is an example of a transducer because it converts electrical energy into light energy.

Chapter 13, page 117

1. The endocrine system is made up of many glands that include the pituitary, thymus, thyroid, parathyroid, adrenal cortex, adrenal medulla, pineal, pancreas, testes, and ovaries.

2. The endocrine system releases hormones that help to regulate and control the body.

3. The endocrine system has an interwoven nature in that it can release hormones to all parts of the body influencing the hormones target cells. It is an interwoven system too in its checks and balances, and permissive and antagonistic effects. These small glands' complex influence is woven throughout the body and reveals wisdom in their plan and function.

4. (HS) In the anterior lobe of the pituitary gland, many interwoven capillaries allow the gland to release its important hormones directly into the bloodstream.

4. (CL) One of the interwoven components of the pituitary gland is the hypophyseal portal system in the infundibulum of the pituitary. Also, in the anterior pituitary, an interwoven mesh of capillaries allows the gland to release its hormones into the bloodstream.

5. (HS) The adrenal cortex secretes aldersterone which regulates the body's mineral and water balance by acting on the kidney. The adrenal cortex also secretes cortisol which helps maintain the body's energy balance. The adrenal medulla secretes the hormones adrenaline and norepinephrine. These hormones enable the body to have the "fight-or-flight" response.

5. (CL) The adrenal cortex secretes three types of steroid hormones known as corticoids. These types are the glucocorticoids, which help in energy balance; the sex steroids, which weakly supplement the gonadal hormones; and the mineralocorticoids, which regulate the mineral/water balance. Aldersterone is the most important mineralocorticoid and acts on the kidney. Cortisol is the most important glucocorticoid and regulates carbohydrate metabolism. The adrenal medulla releases two hormones (catecholamines), epinephrine and norepinephrine. These hormones increase heart, respiratory, and metabolic rate to enable the body for a "fight-or-flight" response.

6. Temperature regulation is controlled by the hypothalamus in the diencephalon of the brain. The hypothalamus is in one role an endocrine gland.

7. Homeostasis is the maintenance of a dynamic constancy in the internal environment of the body. The endocrine system is very important to the maintenance of homeostasis. It releases hormones that balance water, salts, fats, glucose, and many other important substances in the body. The endocrine system also helps maintain energy balance, stimulates growth, and stimulates the production of white blood cells. Thus, it is very important for homeostasis.

8. Humoral theory is the ancient Greek idea that there are four humors or fluids in the body: blood, bile, black bile, and phlegm. If these humors are imbalanced, the body will be unhealthy. Thus, balance was important. This theory, though long proven to be false, was the first attempt to explain something like the idea of homeostasis. Homeostasis, however, is far more complicated. One of the main processes of homeostasis is negative feedback. Negative feedback produces the opposite effect of a change. For example, if a change in temperature has made the body too hot, negative feedback will work to cool the body.

9. Ernest Starling and Sir William Bayliss
There are three main classes of hormones:

a. Steroids — Cholesterol derived, important steroids include cortisol and testosterone.
b. Catecholamines — Related to neurotransmitters, important ones include epinephrine and norepinephrine.
c. Polypeptides — proteins, includes insulin.

10. (HS) Walter Cannon coined the term "homeostasis," Ernest Starling discovered hormones, Claude Bernard developed the idea of chemical balance in the body.

10. (CL) Walter Cannon coined the term "homeostasis." His work was based on Ernest Starling's theory of balance in the body through hormones. Another important contributor to the theory of homeostasis was Claude Bernard who was the first to clearly develop the idea of chemical balance in the body.

11. (HS) Stress lowers the body's resistance to pathogens, increasing the possibility of disease. In contrast, a "merry heart" is like medicine because it strengthens the immune system, lowering the possibility of disease. Though science has just begun to discover the effect laughter can have on our bodies, the Bible spoke of it nearly three thousand years ago.

11. (CL) Hans Selye discovered in 1936 that stress, especially chronic stress, caused the adrenal gland to secrete more glucocorticoids. Glucocorticoids can lower the body's immune system's resistance. Other studies reveal that there are relationships between stress and cancer, and stress and heart disease. On the other hand, several studies have shown that laughter can help our immune system. The Bible is right in saying "a merry heart doeth good like a medicine.

12. The adrenal cortex secretes a very important hormone, cortisol. Cortisol is involved in regulating metabolism. Yet, the adrenal cortex does not control when to release it. This is controlled by the hypothalamus, which directs the pituitary gland to release a hormone, ACTH, to the adrenal cortex stimulating it to release cortisol. What a complex, interdependent pathway! Only a special act by an all-knowing Creator God could have brought all these parts together in one place, fully formed. Truly, there is wisdom in the inward parts.

Chapter 14, page 129

1. The most important organs for the immune system are the lymphoid organs, spleen, thymus, tonsils, and lymph nodes.

2. (HS) The overall function of the immune system is protection.

2. (CL) The overall function of the immune system is protection. The lymphatic system, while very important to the body's defenses, serves two other important functions; namely, it returns interstitial fluid to the blood, and in the small intestine it absorbs fat that cannot immediately enter the blood.

3. (HS) The lymphatic system refers to an actual structure of vessels running throughout the body. The lymphatic system plays an important role in our body's defense. The immune system includes everything that helps in defense — from fevers to killer T cells. Without these defenses, we would quickly die.

3. (CL) The lymphatic system is an anatomical structure of vessels, nodes, capillaries, and organs. The lymphatic has three functions, one of which is immunological defense. On the other hand, the immune system is made up of all organs, structures, and mechanisms that are involved in the body's defense. Without this defense system, our bodies would be quickly overwhelmed by invading pathogens and we would die.

4. (HS) The lymph nodes are woven into a fabric of fibers, capillaries, and vessels. On the inside, lymph nodes also show an interwoven design of small filtering compartments.

4. (CL) The lymph nodes are important in both lymphatic and immune function and present a good example of interwoven design. Lymph nodes are strategically placed all along the lymphatic system. The somewhat oval lymph node is interwoven at one end to several valved, afferent lymphatic vessels, which bring lymph into the node. Inside the node, lymph is filtered through an interwoven maze of trabeculae and cortical sinuses before passing out of the node through efferent lymphatic vessels. The lymph nodes themselves are woven into a fabric of vessels, connective fibers, and capillaries.

5. The lymph node illustrates irreducible complexity both in its inner circulation of lymph through its sinuses and especially in its germinal centers. The germinal center provides for lymphocyte reproduction and for exposure of the lymphocytes to pathogens in the lymph. If any portion of this complex system were missing, immunity would be greatly impaired or lost. The lymph nodes reveal that an all-knowing Creator is behind their structure, function, and placement throughout the body.

6. (HS) Without prompt intervention, an immunodeficiency in the body will lead to death from overwhelming bacterial or viral infections. Because the protective boundary of the immune system is removed, the body is helpless to defend itself against pathogens.

6. (CL) Severe combined immunodeficiency (SCID) is a congenital condition in which the body lacks B and T lymphocytes. Thus, the body does not have the defense boundary it needs and is subject to overwhelming bacterial or viral invasion and death. Acquired immune deficiency syndrome (AIDS) is caused by the human immunodeficiency virus (HIV). HIV destroys helper T lymphocytes. As the immune system's shield is broken, the AIDS patient becomes susceptible to severe infections and cancers such as Karposi's sarcoma. The immune systems protective boundary is essential for life.

Chapter 14, page 129

1. The components of the integumentary system include: epidermis, dermis, and hypodermis. Associated structures include nails, hair, and glands.

2. The overall function of the integumentary system is to provide a protective boundary.

3. One example of interwoven design in the integumentary system is seen in the intertwining blood vessels that supply each hair follicle. Another example is the interwoven elastic fibers in the dermis. Their interwoven design can be seen in fingerprints — the result of the elastic fiber's pull. The fabric of nerves that weave throughout the dermis and hypodermis also displays interwoven complexity.

4. As discussed above, the skin is a very complex organ with many intricate woven structures. Each of these structures play an important role in the skin's duties. For instance, melanocytes in the skin produce melanin that absorbs harmful UV light. If the skin lacked these, it would far more readily succumb to melanoma. Consider also the interlacing blood vessels and capillaries. Not only do they supply the skin cells with necessary nutrients and oxygen, but they are also important in thermoregulation. Clearly, the skin is irreducibly complex.

5. (HS) Acne is caused by the inflammation of sebaceous glands.

5. (CL) Acne occurs when sebum and dead cells become plugged in the pore of a hair follicle. As a result, the sebaceous glands around the follicle become inflamed. Hormonal changes during adolescence aggravate the problem.

6. The figure on page 123 illustrates the progression of a *Salmonella* infection in the GI tract. *Salmonella* bacteria are normally found in eggs, unpasteurized milk and cheese, poultry, and meat. The illustration shows how the bacteria break down the mucosa's boundary and attack the submucosa. Diarrhea, nausea, abdominal cramps, fever, and vomiting are symptoms of *Salmonella* infection.

7. (HS) *E.coli* O157:H7 breaks through the intestinal walls to enter the bloodstream. There it releases a toxin that damages the kidneys. To maintain homeostasis, those who are infected require blood transfusions and sometimes even dialysis. It is a very severe illness.

7. (CL) *E.coli* O157:H7 normally causes hemorrhagic colitis with severe abdominal pain and cramps, and bloody diarrhea. However, about 10 percent of those infected develop hemolytic uremic syndrome (HUS), a serious, life-threatening complication. HUS is the most common cause of kidney failure in children. HUS develops when *E.coli* O157:H7 breaks through the intestinal wall, enters the bloodstream, and releases shiga-like toxin. This toxin damages the kidney, brain, and pancreas. Many patients will have to be put on dialysis and almost all have to receive blood transfusions to maintain homeostasis. Of those who survive HUS, some will permanently require dialysis or will need a kidney transplant.

For more information on *E.coli* and how to avoid it, I can recommend these sites as a beginning: http://www.about-ecoli.com and http://hgic.clemson.edu/factsheets/HGIC3700.htm

Chapter 15, page 139

1. Harvey proved that blood circulates continuously. Also, he insisted on basing his work on careful scientific investigation and not on long-held beliefs. He explained the true function of the heart and predicted the presence of capillaries before they were discovered.

2. Andreas Vesaliuses' *De Humani Corporis* is a masterpiece because of its scientific accuracy both in its text and in its beautiful engravings. It was based entirely on careful human dissection. The book was quite revolutionary in its day because it openly challenged the long-held but false ideas of Galen.

3. Though Galen proved that arteries carried blood and not air, he never understood circulation. Instead he stated that the blood flowed in both directions in each vessel. No one bothered to examine the accuracy of Galen's assertions, and as the years passed, an almost superstitious belief in his inerrancy grew. Today, many accept evolutionary thinking with unquestioning faith. This unsearching belief reflects poor trends in science and will lead to errors.

4. (HS) Joseph Lister's use of antiseptics during surgery dramatically reduced the number of deaths. Ignaz Semmelweis used antiseptics to save the lives of mothers and infants. The work of these men and others led to the acceptance of the germ theory of infection.

4. (CL) Before Lister's work, nearly 50 percent of patients who had any sort of surgery died. These deaths were caused almost entirely by infection transmitted during surgery. Lister's method of antiseptic surgery, therefore, completely revolutionized medicine. Because of his work, deaths in the wards fell between 2 and 3 percent. Ignaz Semmelweis, a Hungarian doctor, also used the germ theory and antiseptics to save thousands of lives in the maternity wards. Because of the careful work of these men and many others, we now understand the origin of infections.

5. (HS) Because of the germ theory, scientists were able to develop a more specific understanding of diseases and the best way to treat them.

5. (CL) The germ theory of disease states that infectious diseases are the result of distinct pathogens. Because of this idea, whole new fields opened in medicine. Scientists began searching for the specific bacteria or virus that caused a disease and then for a way to combat it. As a result, effective medicines were developed.

6. In your essay, you should discuss how real cadavers give students the opportunity to learn through two senses — sight and touch. Also, you will probably want to discuss the practical hands-on experience cadavers offer medical students. Is it too "hallowed" a practice to ever disappear? Also discuss how a real cadaver offers the opportunity for microanatomy.

7. The Human Visible Project is a collection of photos of the human body sliced in 1 mm increments. Columbia University's Vesalius project is attempting to take these photos and form them into clear 3-D images. When this project is complete, it will provide anatomically accurate images for the student to study. This will be very beneficial as anatomical artwork in atlases is influenced by the artist's imagination, even if only slightly. However, the project will be useful for macro, not microanatomy.

8. The Bible teaches that the real human is more than the physical body (Matt. 6:25; 2 Cor. 4:7, 16, 18, and 5:1–8) For a Christian, his body is the temple of the Holy Spirit as long as he lives. Yet, when his body dies, his spirit is released into the presence of his Lord. The body, which will be resurrected, returns to the elemental matter of the earth. This is why dissection is ethical for a Christian. Dissection does not demean the dignity of life. Rather, it deepens our respect for it.

9. (A)

10. (C)

11. The advantages of dissecting a real cadaver are numerous. First of all, when the student dissects a real cadaver, he is using two of his senses, sight and touch, to learn. The use of touch is not possible in a virtual dissection. However, a doctor must have knowledge in his hands as well as in his head. Another advantage of the real cadaver is the exposure to the unique differences between humans. Virtual dissection though, does offer some new advantages to students. A virtual dissection cannot be damaged by a slip of a knife. Also, through virtual imaging, students will be better able to see every structure of the body together and in place.

Chapter 16, page 151

1. No matter what living system you study, you will discover that intelligent design must be behind it. There can be no other sound explanation of the complexity and interdependence of life than that a wise Creator planned and formed it. Evolution cannot underlie biology, because there is no evidence for it, past or present.

2. Here are a few examples:
   a. Changes in fruit flies
   b. Dog varieties
   c. Antigenic variation
   d. Variations in horses
   e. Resistant bacteria
   f. Finch variation
   g. Rhinovirus variations

3. By uniform experience we mean understanding and knowledge that is average, normal, and universal. When we see a complex structure, composed of many interdependent parts, performing a complex task, we infer by uniform experience that there was a designer behind it. Uniform experience helps us to filter out those things that must be the product of intelligent design.

4. Design can be recognized in DNA in several ways. First, design is seen in the ability of its many separate components to work together to store vast amounts of information. Design is seen, too, in its ability to transcribe and replicate that information many times over, with only a few, slight errors normally. Design can be seen in its compact helical structure. When looking for design, put the thing in question through the filter described on page 146 of the text.

5. Disease, decay, and death are products of the curse on creation because of man's rebellion to God. One day, however, God will restore all of creation and destroy death once and for all.

6. We realize that there is "wisdom in the inward parts" when we see the numerous interdependent, complex, perfectly designed structures and mechanisms in the human body. For instance, we see wisdom in the highly complex blood-clotting cascade mechanism. Another example covered in the book is the actually optimal design of our eyes. Truly, the body reveals wisdom far beyond our own!

7. First, ask, "Can this be the product of chance processes?" Then, ask, "Do natural laws explain how this occurred?" If the item in question does not fit either of these, ask, "Does this reveal intelligent design in its structure and function?"

8. Start with simple objects like a pair of scissors or fingernail clippers. You will be surprised at how many there are.

9. Here are just a few examples:
   a. The structure of the ear, its ossicles, membranes, fluid, etc.
   b. The Haversian or osteonic system in bone tissue
   c. The tendons and muscle controlling the hand
   d. Neuromuscular junction (neurotransmitters, sarcoplasmic reticulum, T. tubules, and myofibrils and filaments)
   e. Synovial joints
   f. Nerves
   g. The foot's bones and ligaments

10. What assumptions does the author make? Is his logic sound? What does he base his conclusions on? Scientific journals are also good material, but they are less readable.

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