Answers to Questions from Cells and Tissues

Note to parent:

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Part 1:

1. Anatomy means to cut to pieces or cut apart.

2. Gross anatomy is what may be seen with the unaided eye when dissecting a body. Regional anatomy is the anatomy of a region of the body as seen during dissection. Systemic anatomy is studying an entire system throughout the body such as the skeletal system or the muscular system.

3. The word histology is derived from a Greek word for fabric or web and recognizes the fact that many tissues look woven under the microscope.

4. A compound microscope uses one objective at a time and is used to examine slides where light is transmitted through the slide. A stereo microscope uses two objective lenses at the same time (as well as two eye pieces) and is designed to look at small objects in three dimensions.

5. Ultrastructural anatomy is the study of cells and parts of cells at very high magnification by means of an electron microscope.

6. Robert Hooke named the little box-like chambers in bottle cork "cells" because they reminded him of the cells (little rooms) in a monastery that monks lived in. The little box-like cells of cork are indeed plant cells.

7. Plant cells differ from animal cells in that plants have a strong cell wall enclosing the cell, whereas animal cells have a thin and flexible cell membrane enclosing the cell. Plants also engage in photosynthesis

8. Nobody has ever actually counted the number of cells in the adult human body but it is estimated that there are 50 to 100 trillion cells in the body.

9. There are four primary tissues.

10. A dime is approximately one millimeter thick.

11. The most common unit of length for light microscopy is the micrometer or, as it is often called, the micron. There are a thousand microns is one millimeter and thus a micron is about 1/1000 the thickness of a dime.

12. The most common units of measurement in the electron microscope is the nanometer or the angstrom. There are 10 angstrom in one nanometer and there are a thousand nanometers in a millimeter.

13. Optical resolution is a measurement of how small an object can be seen in for example in a microscope. Technically it is the closest distance that two points can be and still be distinguished as two points rather than blurring into one.

14. The resolution of the human eye is about .2 millimeters.

15. The maximum resolution of a compound microscope is about .2 microns while the resolution of a transmission microscope can be an angstrom or less.

16. Human red blood cells measure about 6 microns in diameter.

17. The banding period of a skeletal muscle cells is about 2 microns.

18. Most sections for the light microscope are cut 2-6 microns.

19. Fixation of tissue cross links and coagulates proteins making them more solid so that they can be sectioned.

20. Tissues for study in the light microscope are typically embedded in paraffin or plastic. This allows them to be thinly sectioned to make slides for use in the microscope.

21. The instrument used for sectioning tissue for study on the microscope is called a microtome.

22. Biological sections for study under the light microscope are stained with dyes to make their components visible. Unstained sections generally lack both color and contrast.

23. The nucleus of the cell is a membrane bound structure which contains the genetic material of the cell (DNA). The Nucleolus is a non-membrane bound structure within the cell which makes and contains the ribosomal RNA.

24. Ribosomes are organelles within the cell that function to assemble amino acids into proteins as determined by the messenger RNA.

25. Cells that contain large amounts of rough endoplasmic reticulum are engaged in making large amounts of proteins for export outside of the cell. Cells that contain large amounts of free ribosomes are making proteins that will mostly remain within the cell.

26. The Golgi apparatus processes and packages macromolecules, such as proteins and lipids in the cell and facilitates their secretion outside the cell.

27. Mitochondria are membrane bound organelles that generate energy in the form of ATP (adenosine triphosphate) for the use of the cell.

28. Lysosomes are small membrane bound vesicles in the cell that contain acid hydrolase that break down waste material and other cell debris.

29. Centrioles are organelles of the cell that produce the mitotic spindle fibers involved in the movement of chromosomes during cell division and also play a role in producing cilia and flagella.

30. HeLa cells are cervical cancer cells that have been grown in culture for many years. HeLa cells are unusual in that they have continued to divide without usual limit and have been used to study cell function and disease.

31. Electrons are passed through the image in a transmission electron microscope (much like light passes through a section in a compound microscope). Electrons are scanned over the surface of the specimen in a scanning electron microscope producing a 3 D image.

32. The advantage of using a scanning electron microscope (SEM) over an optical stereo microscope is that the SEM has much greater depth of focus.

33. The four primary tissues are epithelia, connective tissue, muscle and nerve.

34. An epithelium is a sheet of one or more layers of cells with little or no extracellular tissue and no blood vessels penetrate within it.

35. A simple squamous epithelium is a single layer of flattened cells. Stratified squamous epithelium has many layers of cells with the lower layers being columnar or cuboidal and the superficial layers are squamous.

36. An epithelium can function as protection (epidermis of skin), absorption (simple columnar lining the intestine), secretion (simple cuboidal in pancreas), transport (kidney tubule), filtering (simple squamous of the lung or kidney glomerulus), and sensory (olfactory mucosa).

37. Blood vessels are lined with simple squamous epithelium (called an endothelium). This allows nutrients and gases to diffuse through.

38. An epithelium can be arranged as a sheet (epidermis of skin), a tube (sweat gland) and as a ball (thyroid or pancreas glands).

39. The cells of a simple epithelium appear essentially hexagonal when viewed from the surface.

40. Goblet cells are goblet shaped mucous producing cells and are numerous in the large intestine.

41. Microvilli are tiny finger like processes that may be found on the luminal surface of certain epithelial cells where they serve to increase surface area and aid absorption (e.g. Columnar epithelial cells of the small intestine). Cilia are also a specialization of the lumen surface of some epithelial cells, but they are highly motile and much longer than microvilli (e.g. the cells lining the trachea and oviduct).

42. Cilia beat in a metachronal pattern (like dong the wave and a ball game). Only this pattern can move substance along the surface of the epithelium (e.g. move a fertilized egg down the oviduct to the uterus.

43. Epithelia are classified according to the number of layers of cells they contain and the shape of the cells. If the cells are arranged in a single layer, the epithelium is called simple; if the cells are arranged in two or more layers, the epithelium is called stratified. If the cells have a flattened shape, the epithelium is called squamous; if the cells have about the same height, width, and depth, it is called cuboidal; if the height of the cells exceeds their width, it is called columnar.

Part 2:

1. Connective is largely extracellular whereas epithelium is entirely cellular.

2. Collagen.

3. Four functions of connective tissue is support, connect, defense and diffusion.

4. Loose and dense connective tissue.

5. The arrangement of collagen fibers are all linear in regular dense connective tissue (e.g. tendon) while the fibers are woven in irregular dense connective tissue (e.g. dermis of skin or organ capsule).

6. Blood is considered a connective tissue because it is clearly not epithelial, muscular or nervous and blood is largely extracellular.

7. Elastic connective tissue provides elasticity to connective tissue. Without elastin, woven dense connective tissue such as the dermis would not recover its original shape when stretched.

8. The supporting connective tissues are cartilage and bone (they support the body).

9. Fibroblasts make connective tissue fibers (collagen).

10. Macrophages ingest and destroy foreign or worn out cells as well as other debris.

11. Plasma cells are white blood cells that produce antibodies.

12. The space between loose connective tissue fibers is largely occupied by water in the form of a gel.

13. Mast cells are granular connective tissue cells that produce histamine and are typically found near blood capillaries.

14. Fibroblasts contain a lot of rough endoplasmic reticulum because they are secreting the soluble precursors of collagen to make collagen fibers.

15. Tropocollagen is the soluble precursor of collagen fibrils.

16. The elasticity of fibrous connective tissue is a result of the woven nature of collagen fibers and also the presences of elastic fibers.

17. Under the light microscope plasma cells have a distinctive “clock face” nucleus due to the clumped chromatin in the nucleus, and abundant rough endoplasmic reticulum which causes the cytoplasm to stain in a basophilic manner.

18. Plasma cells have a lot of rough ER because they are secreting a lot of immunoglobulin (antibody) for export from the cell.

19. Two locations where we would find irregular dense connective tissue would be in the dermis of skin and in organ capsules. In both cases this tissue forms a tough but elastic layer that serves as mechanical protection.

20. Two locations where we would find regular dense connective tissue would be in

ligaments and tendons. This type of connective tissue is very strong with limited flexibility (keeping ligaments and tendons from breaking.

21. A collagen fiber is visible in the light microscope and is made up of many closely packed smaller collagen fibrils that are only visible in the electron microscope.

22. No. A collagen fibril is much too small to be seen in any light microscope.

23. Adipose tissue is fatty connective tissue made up largely of fat cells (adipocytes). Fat cells look like hollow bubbles in most microscope slide preparations because the technique for fixing, imbedding and staining these preparations includes lipid solvents that remove all the fat leaving an empty spherical space that makes up most of the cell.

24. The role of elastin in irregular dense connective tissue is to restore stretched tissues to their rest condition after stretching.

25. The role of elastic membranes in an artery is to allow the artery to stretch when its blood pressure is high (when heart beats) and to recoil to a more relaxed condition between heart beats. This serves to level out the pressure in the artery rather than have large peaks and dips in blood pressure. The elastic membranes are found as layers in the muscular tunica media of elastic arteries.

26. The three types of muscle found in our body are skeletal muscle, cardiac muscle and smooth muscle. Skeletal muscle is made up of many fused cells (100-1000), is striated and typically under voluntary control. Cardiac muscle is striated but unlike skeletal muscle is made up of individual cells that form branching attachments. Cardiac muscle does not require nerves to contract. Smooth muscle is made up of individual cells which are not striated, and is generally not under voluntary control. Smooth muscle is capable of contracting to a small proportion of its rest length, and resists fatigue under continuous contraction.

27. Skeletal muscle would be found in Association with the skeleton, cardiac muscle would be found in the heart, and smooth muscle would be found in the intestines, uterus, and walls of blood vessels.

28. Smooth muscle is usually not under voluntary control and can sustain prolonged contraction without fatigue. Skeletal muscle is usually under voluntary control and becomes fatigued with prolonged contraction.

29. The nucleus is in the center of each smooth muscle cell and as a result under contraction the nucleus may be come wrinkled or distorted into a cork-screw shape.

30. A skeletal muscle cell is formed from the fusion of many cells called myoblasts and may have from 100 – 1000 nuclei.

31. Skeletal muscle cells are a multinucleate syncytium formed by the fusion of many myoblasts.

32. In skeletal muscle cells, the nuclei are located just under the cell membrane, whereas in both smooth muscle cells and cardiac muscle cells, the nuclei are located in the center of the cell.

33. The banding in striated muscle cells is caused by the overlap of thick and thin filaments within each sarcomere.

34. A muscle fiber is a single muscle cell which can contain many nuclei from fused cells in the case of skeletal muscle cells, whereas a muscle cell will contain many myofibrils.

35. The T tubule system of skeletal and cardiac muscle conducts the wave of electrical depolarity across the cell fiber to initiate muscle contraction.

36. The sarcoplasmic reticulum of skeletal muscle releases calcium which initiates contraction.

37. The sarcomere is a functional contractile unit of skeletal muscle. It extends from one z-line to the next z line and contains the overlapping thick myosin ranching filaments and the thin actin filaments.

38. The intercalated disks of cardiac muscle attach the branching cardiac muscle fibers to one another.

39. Skeletal muscle fibers attach to tendons by means of the woven fibers of the connective tissue endomysium which wraps around micro processes of the cell like a “Chinese finger trap.”

40. The central nervous system is located in the brain and spinal cord, whereas the peripheral nervous system is outside the brain and cord. The fibers of the central nervous system are fiber tracts invested with glial cells, whereas the fibers of the peripheral nervous system are nerves invested with Schwan cells.

41. Central nervous system fiber tracts do not heal when cut whereas peripheral nerves do heal when cut. You would find nerves in the nerve fibers of the peripheral nervous system and fiber tracts in the brain, optic “nerve” and spinal cord.

42. Dermatomes are areas of the skin supplied by single spinal nerves emerging from between the vertebrae.

43. The epineurium is the tough outermost coating of a nerve and is made up of dense connective tissue.

44. The endoneurium is the connective tissue coating of each individual axon in a nerve fascicle.

45. Myelin is the jellyroll like wrapping that wraps around some individual nerve axons. It serves as an electrical insulating layer that speeds up the conductivity of nerves.

46. The Schwann cells are the glial cells that coat the individual axons of the peripheral nervous system. They form the myelin sheath of fast conducting axons.

Answers to Questions from "Skeletal System"

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Part 1:

1. The steel truss used in construction that is said to be the strongest for its weight.
2. In the metacarpal bones of the wing of a vulture.
3. God thought of it first! The Warren truss was obviously designed by an intelligent person; finding such design in nature speaks of an intelligent designer, as well.
4. "If I have spoken of earthly things and you do not believe, how will you believe if I speak of heavenly things? (John 3:12)" If the Bible is not true when it touches on areas we can test and observe (such as biology and geology), why should we believe it when it teaches about heavenly things—things we can't measure or observe?
5. Job 10:10–11.
6. Connective tissue.
7. A baby in the womb starts out with most of its bones being cartilage.
8. Ear, nose, ends of ribs, disc between vertebrae, ends of all long bones.
9. Provides a smooth flexible joint surface and prevents bones from scraping against each other; bones of joints in direct contact would fuse together.
10. The vault of the skull (calvaria) and mandible.
11. Chondroblasts—secrete type II collagen and cartilage matrix; chondrocytes—mature chondroblasts that become hypertrophic, secrete alkaline phosphatase promoting calcification of cartilage; chondroclasts break down calcified cartilage.
12. Hypertrophic: cells that become bigger; hyperplastic: something becomes bigger because it has more cells.
13. To form calcified cartilage and break down.

14. Collagen - (type two)basic fiber of connective tissue; proteoglycans—bind water; water—provides flexibility.
15. Calcified cartilage is fragile and short lived.
16. Calcified cartilage provides the framework on which bone is built.
17. Cartilage doesn't require blood vessels; if blood vessels were part of articular cartilage, they would become flattened during joint movement, cutting off the blood supply.
18. Cartilage can grow from the inside (interstitial growth) and at the surface by accretion (appositional growth); bone grows only by accretion (or apposition).
19. Hyaline cartilage is "glassy" in appearance ; rings in trachea and ends of ribs where they attach to the sternum.
20. Clusters of daughter cells from one stem cell; this demonstrates interstitial growth in cartilage.
21. Between two bones where they meet at a joint.
22. Found in the ear; Elastic cartilage is more rubbery than hyaline cartilage.
23. Intervertebral disks, pubic symphasis; fibrocartilage is stronger.
24. Tendon fibers that penetrate the bone or fibrocartilage.
25. Intervertebral disks partially collapse as we age.
26. 207.
27. Femur.
28. Ear bones or auditory ossicles.
29. Only bones that never grow after birth; only bones that are solid (no marrow or air space).
30. Red marrow has red-blood-cell-producing-cells; yellow marrow consists of mostly fat cells.
31. Sinuses of the skull.
32. Mechanical support—holds us up; protection—skull, vertebrae, rib cage; levers—humerus/radia/ulna; produces blood in the marrow; calcium homeostasis.

33. Heart, lungs, kidneys, spleen, thymus.
34. Joint.
35. Origin is non-movable; insertion is the moveable part.
36. Part of cell adhesion molecules that glue the cells of the body together; regulates muscle contraction; communication between cells.
37. In breaking down bone, osteoclasts may release calcium into the body.

Part 2:

1. Cartilage doesn't have any blood vessels; bones have blood vessels.
2. Cartilage has anaerobic (without oxygen) metabolism; bone has aerobic (with oxygen) metabolism.
3. Cartilage grows appositionally (at the surface) and interstitially (inside); bone grows appositionally only.
4. Cartilage is not mineralized (except for calcified cartilage that quickly breaks down); bone is mineralized with hydroxyapatite.
5. Water comprises 70% of total weight of cartilage; water comprises 8% total weight of bone.
6. Hyaluronate.
7. Osteoblasts (secrete organic components of bone matrix); osteocytes (buried in bone); osteoclasts (remove bone).
8. Osteoid is the first bone material made by osteoblasts; pulls calcium into the bone.
9. Osteocytes are buried in bone and have no room to divide further.
10. Osteoclasts shape the bone as it grows and increase the size of the marrow space.
11. Osteopetrosis ("rock bone") is a condition in which bone isn't removed properly during growth. Because the cavity for bone marrow doesn't form, the bones aren't able to make enough blood and severe anemia results.

12. Stem cells are used to induce osteoclast formation to encourage bone breakdown.
13. Periosteum is the outer surface of the bone; endosteum is the inner surface (towards the marrow space).
14. The cells in our body are continually dying and new ones are made. The epidermis of the skin turns over every month. Lining of the GI tract turns over every 4 days. Rods and cones in retina turn over every few weeks.
15. Red blood cells last 120 days.
16. Repairs small fractures in the bone; continually turn over the bone
17. In osteoporosis, osteoclasts take away more bone than the osteoblasts makes. In osteopetrosis, the osteoclasts don't take away bone fast enough.
18. Calcified cartilage provides the framework (like lathwork) on which bone is deposited.
19. Osteoclasts result from the fusion of precursor cells.
20. Osteoclasts secrete a chelating agent that dissolves the mineral in bone (removes the calcium).
21. Osteoclasts secrete the enzyme collagenase to dissolve the collagen.
22. Howship's lacuna is a pit where an osteoclast has dissolved bone.
23. An osteon is a cylindrical structure made up of concentric rings of bone around a blood capillary (found in compact bone). Osteons form from cylindrical channels eroded by osteoclasts and form from the outside in toward the blood capillary.
24. Haversian canals hold the blood vessels that run through the center of the osteons.
25. Organic component (30% of dry weight) is made of collagen and ground substance; inorganic matrix (70% of dry weight) is made of salts and hydroxyapatite.
26. Hydroxyapatite.
27. A composite material is made from two or more materials that when put together benefit from the properties of each. Bone is made of strong but flexible organic collagen fibers and hard inorganic calcium containing minerals so it is a composite material.

28. Bone formation that begins with cartilage.
29. Cartilage plate across near the end of a bone that turns into calcified cartilage and is replaced by bone during growth.
30. Cartilage covers both ends of long bones (at joints) and cannot be covered by bone; the growth plate provides an area for cartilage to grow interstitially and be replaced by bone resulting in growth in lengthen.
31. Growth hormone from the pituitary gland stimulates the growth plate.
32. The growth plate completely mineralizes and closes off.
33. Acromegaly is when growth hormone continues to be produced in an adult after closure of the growth plates. This causes cartilage to grow after bones have stopped growing in length (but not width). Symptoms include large nose, large ears, and barrel chest.
34. Gigantism results from growth plates that don't close off and continued production of growth hormone, causing bones to continue to grow in length producing a "giant."
35. Spongy bone is mostly in the ends of the bones; spongy bone gives strength without extra weight to the bone; spongy bone doesn't have osteons.
36. Gustav Eiffel used the trabecular stress lines found near the neck of the femur to design the base for his tower.
37. Spongy bone changes its shape and orientation of its trabeculae (modeling) to best accommodate those stresses that come to bear on the bone.
38. Volkmann's canals carry blood vessels latitudinally across the bone; Haversian canals carry blood vessels longitudinally along the length of the bone.
39. Osteons grow from the outside in.
40. Osteoclasts hollow out and area into which a blood vessel intrudes. Osteoblasts then begin forming bone in concentric circles from outside in around the blood vessel.
41. The osteocytes have cell processes that touch one another through tiny canals in the bone called canaliculi thus providing a way to pass nutrients from cell to cell.
42. Bending bone generates current. Hydroxyapatite and collage appear to be involved in generating the current. The current is believed to recruit osteoblasts and osteoclasts to reshape the bone as a result of the stresses and bending.

43. Astronauts are weightless in space, so their bones aren’t given much resistance and stress.
44. The two ends of the bones are put back together. Since the blood supply is lower in that area, chondroblasts form from the stem cells forming a cartilage callous. When the blood supply is reestablished, osteoblasts are produced which eventually replace the cartilage callous with bone.
45. The cast keeps the newly formed cartilage callous from bending and forming the bone improperly.

Answers to Questions from “Integumentary System”

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Part 1:

1. The skin is the largest organ in the body. In an adult male, it would weigh about 10 pounds.
2. About an hour.
3. Keeps water from leaving our body and prevents chemicals and germs from penetrating; temperature regulation (allows heat to escape from the body); blood pressure regulation (allows blood vessels to be filled or constricted); sense of touch (nerves running through the skin allow for sensing pressure and temperature); friction grip (finger prints allow us to keep a grip on things); synthetic (makes Vitamin D3); excretory (sweat glands secrete salts, urea, toxins); identification (the way our skin is shaped over our bodies allows us to identify one another).
4. Epidermis (epithelial barrier); dermis (tough connective tissue layer); hypodermis (fatty layer).
5. Collagen.
6. Fat.
7. Hair follicles and sweat glands.
8. Stratum corneum.
9. Collagen fibers that anchor the skin to deep tissues to prevent the skin from sliding.
10. Tight skin stays closer to the body; loose skin is able to move more freely from the body. Humans have tight skin; most animals have loose skin.
11. Thin skin covers most of our body; thick skin covers our palms and bottoms of our feet.
12. Our dermis is woven together like a fabric.

13. Langer's lines show the collagen fiber weave, the pattern of how the skin is woven together; they follow the principle lines of tension. Langer used an awl to poke holes in a cadaver and then drew lines along the long access of the holes, showing the pattern.

14. Gives our skin elasticity and the ability to return to the resting state after being stretched.

15. We lose elasticity as we age.

16. They are willingly ignorant of the truth and suppress the truth in unrighteousness because they don't want to acknowledge there is a God to whom they are accountable.

17. The Rete ridges in thin skin are not as pronounced as those in thick skin. The stratum corneum is thicker in thick skin.

18. Stratum granulosum—most superficial layer has granules that help to form keratin filaments; Stratum Malpighi—epidermis cells fill themselves with keratin filaments to make a woven matrix of keratin; basal layer— normally all cell division occurs here and this layer contains most of the pigments that result in the various skin shades

19. Keratin filaments are linked by di-sulfide bonds that make them strong.

20. Melanin is the color-producing pigment produced by melanocytes in the basal layer.

21. Papillary dermis is a loose connective tissue that allows the maximum diffusion of nutrients and gasses. Reticular dermis is an irregular dense connective tissue for strength.

22. Papillary dermis allows the blood vessels to go to the surface of the skin to release heat and allows them to fill with blood, causing the overall blood pressure of the body to lower.

23. Meissner's corpuscles are found in the dermal papillae on the tips of fingers and have nerve endings that enable us to sense things through touch.

24. Sweat glands enter through the Rete Ridges, travel through the stratum Malpighi and stratum corneum, and exits at the crest ridges.

25. Cools the body via evaporation; the water softens the stratum corneum.

26. The cells in the stratum granulosum go through programmed cell death as they move into the stratum corneum.
27. Corneocytes are dead skin cells found in the stratum corneum.
28. Thick skin corneocytes have a special provision to resist friction that removes the cells from the skin.
29. All cell division occurs in the basal layer.
30. If the stratum corneum cells were lost at just 1% faster than the cells were made, the stratum corneum would be lost and death would occur. If the cells were made faster than they were lost, the stratum corneum would get too thick.
31. Nearly 10 pounds of corneocytes.
32. They are stacked in columns with interwoven edges.
33. They are held together with desmosomes and intracellular cement.
34. They are woven together in bundles.
35. The close-packing phenomenon seems to explain how the cells are stacked.

Part 2:

1. Melanin gives the skin its shade.
2. Melanocytes differentiate from melanoblasts which form during the third or fourth month of a pre-born baby.
3. Melanocytes reside in the basal layer of the epidermis.
4. Melanocytes produce pigment granules called melanin granules.
5. The relative number of melanocytes is the same no matter what skin shade a person has.
6. Melanin granules are taken into keratinocytes.
7. Basal cell carcinoma.
8. The cells in the basal layers that are dividing.
9. Melanin granules form a supra nuclear cap which covers the nucleus, protecting the DNA from the sun’s rays.
10. In darker skin, the pigment is retained throughout the upper layers of the skin.

11. As soon as the melanocytes produce the pigment, it leaves the cell and is collected by the stem cells.
12. Stem cells (cells in basal layer still capable of dividing).
13. Anchoring cells anchor the epidermis so that it doesn't pull away as in a blister.
14. The pigment covers the nucleus of the cell on the sunny (upper) side, shading it from the sun.
15. Spider-shaped with long processes.
16. Keratinocytes bite the ends off the melanocyte's process taking some of the granules into the cell; the granule is turned loose in the cell; the membrane surrounding the granules is lost; the granules form a cap over the top of the nucleus.
17. God gave Adam and Eve great variety in their genes, enabling them to produce a wide variety of children. For more information, see http://www.answersingenesis.org/articles/nab/are-there-different-races.
18. A few million.
19. A quart of sweat per hour.
20. Sweat helps to regulate body temperature by evaporative water loss and sweat also softens the stratum corneum (particularly on thick skin).
21. Dogs pant and evaporative water loss from the tongue cools the blood in the tongue.
22. Horses.
23. Sweat glands are found on the bottoms of feet and the tips of noses in all mammals.
24. Eccrine sweat glands are found over most of the body, including the palms and soles, and secrete sweat at the skin's surface. Apocrine sweat glands are found with the hair follicles and secrete sweat into the hair follicle.
25. Apocrine sweat has an organic material that harbors bacteria. The bacteria impart the odor.
26. .2% salt and urea.

27. Loose connective tissue; capillaries need to be in contact with the glands to provide nutrients and water to them.
28. Apocrine glands have a huge lumen in the secretory part.
29. They are attached to the side of hair follicles and secrete into the hair follicles.
30. Provides oil to the hair and keeps water from seeping from the hair into the skin.
31. Cells break down and the cells are the secretory product.
32. Terminal hairs grow in the scalp, arms, chest; vellus hairs are invisible; lanugo hairs are on babies in the womb.
33. Vellus; they are generally not noticed because they are small, colorless and almost invisible.
34. Lanugo hairs form on the baby in the womb and are usually shed before the baby is born.
35. We have the same number of hair follicles throughout our lives; however the types of hairs produced by the follicles can change. Those who are “bald” produce vellus hair instead of terminal hair.
36. Loose connective tissue.
37. In the growth matrix down in the hair bulb.
38. Erector pilli muscles. They help to raise or lower the hair.
39. Cuticle cells are dead, over lapping shingle like cells on the outside of the hair shaft; cortical cells are bundles of long cylindrical shaped cells that make up most of the inside of the hair shaft.
40. Cuticle keeps the hair packed together to prevent split ends; it also keeps our hair from becoming snarled; the cuticle also locks the hair in the follicle so that it is not easily pulled out.
41. 3/10 of a millimeter per day.
42. The hair growth cycle is repeated periods of growth, resting, and hair falls out This is repeated by the growth of a new hair.
43. Their hair growth cycle is shorter so that their hair stops growing and falls out before it gets too long.
44. Those who can produce longer hair have longer hair growth cycles.

45. Poodles have a continuous hair growth cycle as a result of a mutation.
46. Dogs that don’t shed have a continuous hair growth cycle.
47. It locks the hair in the follicle.
48. It prevents the hair from being easily pulled from the follicle which could be fatal for many mammals (like the polar bear).
49. Two thirds of the hair follicle.
50. The inner root sheath must grow with the hair; desmosomes which attach the inner root sheath to the outer root sheath must be repeatedly broken and refastened.
51. Fluid can build up between the epidermis and the dermis and lift the epidermis up. In another type of blister, fluid fills between the epidermal cells that have pulled apart.
52. The erector pilli muscle contracts and pulls the hair creating a bulge in the skin.
53. Generate heat for the skin and body core.
54. Allows us to have a variety of facial expressions.
55. The ones around the mouth (so we can suckle, whistle, and eat) and around the eyes (to blink).

Answers to Questions from “Cardiovascular System”

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Part 1:

1. A normal heart should be the size of a person’s fist.
2. 5–6 liters (6–7 quarts).
3. 72 times per minute.
4. 1 million barrels of blood.
5. Heart muscle cells don’t replace or repair themselves so when heart muscle cells die during a heart attack, they aren’t replaced with new cells but with connective tissue, removing functionality from the heart.
6. The heart needs to pump blood to the body (left side of the heart) and also to the lungs (right side of the heart), which are a separate system.
7. Oxygenated blood needs to circulate from the lungs throughout the body, so the pump needs to send blood to the lungs, back to the heart, out to the body, back to the heart, etc.
8. From the head and arms.
9. From all parts of the body except the head and arms.
10. Left atrium.
11. Right atrium.
12. Arteries carry oxygenated blood away from the heart; veins carry poorly oxygenated blood to the heart. Veins coming from the lungs to the heart carry oxygenated blood.
13. Two veins return blood from each lung.
14. Atria contract together; ventricles contract together.
15. Tricuspid valve.

16. Regular dense collagen fibers attach the valves to the papillary muscles.

17. Papillary muscles contract as the ventricles shorten during their own contraction. This prevents the reflux of ventricular blood back into the atria during ventricular contraction.

18. Blood from the right ventricle goes to the lungs; the name of the vessel is the pulmonary trunk.

19. The walls of the ventricles are thicker because they have to pump the blood farther; the atria just need to pump the blood to the ventricles.

20. Bicuspid valve or mitral valve; Mitral valve comes from the name of the Pope's hat—the Miter.

21. The left ventricle pumps the blood to the body under a higher pressure than the right ventricle, which pumps the blood to the lungs. *(NOTE: In the video at 18:28, Dr. Menton misspoke and stated that the left ventricle pumps the blood to the lungs and the right ventricle to the body.)*

22. The lub-dub sound comes from the alternating sets of valves opening and closing.

23. Ligamentum arteriosum is a ligament that was formerly a blood vessel that shunted blood from the pulmonary trunk to the aorta. Thus in the fetus, blood bypassed the lung and went directly to the aorta and out to the body.

24. The "tailbone" functions as an anchor for the entire pelvic diaphragm and is not a vestigial tail from imaginary evolution. The arterial ligament, on the other hand, is observed to be a true embryological vestige because it is leftover from embryonic development.

25. Without the sac, the heart would rub against the wall, creating friction and heat, causing the body core temperature to rapidly increase beyond tolerable limits and inducing death.

26. The parietal layer is on the outside; the visceral layer is on the inside, touching the organ.

27. The right atrium is closer to the front of the body than the left atrium.

28. The auricles are pouches off of the atria.

29. The coronary arteries that branch around the heart can get plugged, cutting off the oxygen supply to heart muscle and resulting in the death of heart muscle (a heart attack).

30. Coronary arteries form a “crown” around the heart.

31. The heart muscle doesn’t repair or replace, so it forms connective tissue that doesn’t contribute to the function of the heart.

32. They turn into a coronary artery.

33. The heart doesn’t require a nerve supply to beat; the eye requires the optic nerve which does not heal or regenerate.

34. The sympathetic nervous system increases the heart rate; the parasympathetic reduces the heart rate.

35. The transplanted heart doesn’t respond to the nervous system and so doesn’t increase and decrease its rate as well.

36. Synoatrial node.

37. Contracting the ventricle from the top down would push the blood into a dead end; contracting from the bottom up pushes the blood into the lungs and body.

Part 2:

1. Man suppresses the truth in unrighteousness (Romans 1). If there is a Creator, we are accountable to Him.

2. Cardiac muscle cells generally have one nucleus in each cell; muscle cells may contain hundreds of nuclei. The heart muscles branch and skeletal muscles don’t.

3. Purkinje fibers are modified muscle cells designed to send a contraction signal.

4. Arteries and veins together along with a nerve form a neurovascular bundle.

5. They are elastic because of the expansion and contraction of the vessels as the blood is pumped through them. The elastic tissue allows the vessels to be stretchy and store energy.

6. Systole is the contraction of the ventricle; diastole is the relaxation of the ventricle.

7. Muscular arteries distribute the blood; the muscles can change the diameter of the artery, changing the amount of blood flowing through automatically.
8. Arterioles are tiny arteries that have only one layer of smooth muscle.
9. Capillaries are the smallest blood vessels—slightly bigger in diameter of one red blood cell. They provide nutrient and gas exchange and allow white blood cells into the body to fight pathogens.
10. 60,000 miles of capillaries.
11. Postcapillary venules are the ends of capillaries and provide places for the cells to get out and in—providing nutrition and oxygen.
12. Veins don't have as much muscle and elastic tissue as arteries. Arteries carry blood away from the heart; veins carry blood back to the heart.
13. Veins have valves that allow the blood to flow only one way—toward the heart. As muscles contract, they squeeze the blood back toward the heart.
14. The giraffe has valves in its arteries. (For more information on the giraffe, see http://www.answersingenesis.org/articles/am/v5/n2/giraffe-video)
15. The resistance of the wall (semi permeable membrane) to the entrance of tissue fluids.
16. Blood plasma is fluid in the capillary; tissue fluid is fluid outside of the capillary.
17. Lymphatic vessels end instead of making a loop through the body, as blood vessels do. Lymph is formed from tissue fluid as it moves into the capillary.
18. Lymphatics have collagen fibers attached to their outer walls that hold open the walls of the vessels, allowing lymph to enter.
19. Hypertonic solutions have more salt than normal, causing the water in RBCs to leave and shrinking the RBCs. Isotonic solutions have just the right concentration of salt and allow the RBCs to keep their shape. Hypotonic solutions have less salts or proteins than normal and cause RBCs to balloon or become bigger because water enters the cell.
20. Endothelium—simple squamous layer on the inside of the blood vessel; Tunica intima—connective tissue to support the endothelium; Internal elastic lamina—sheet of elastic tissue in arteries with holes in it; Tunica media—layer of muscle and collagen; Tunica adventitia—connective tissue.
21. The endothelium on the inside of blood vessels doesn't cause clotting.

22. Elastic arteries have many elastic fibers or layers in their tunica media; muscular arteries have a lot of smooth muscle tissue in their tunica media; veins have much less muscle and are bigger in diameter compared to an accompanying artery in a neurovascular bundle.
23. Arteriole has one layer of smooth muscle tissue compared to other arteries which have many layers.
24. The mesentery is where the layers of tissue surrounding an organ come together to attach to the wall of the cavity.
25. The blood moves faster in arteries.
26. Veins have larger lumen.
27. Lymphatics have an even thinner wall than an accompanying vein and do not carry red blood cells like veins and other blood vessels.
28. The artery will have a thicker wall than the vein but be smaller in diameter.
29. The larger lymphatic vessels have valves similar to those in veins in the lower part of the body.
30. The lymphatic capillary is held open by connective tissue fibers attached to its outer wall. When loose connective tissue swells with tissue fluid, the fibers pull the lymphatic walls open.
31. The heart is working too hard to pump blood through restricted blood vessels and becomes enlarged as any muscle does when it is constantly worked hard.
32. Larger cells filled with more muscle protein.
33. Pushing on the sternum during CPR compresses the heart and makes it continue to pump the blood through the body.

Answers to Questions from “Respiratory System”

Note to parent:

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Part 1:

1. Bony ridges in the nasal cavity (turbinates) covered with well vascularized tissue that warm and humidify the air before it enters the lungs.
2. They help to keep the trachea open.
3. The esophagus is behind the trachea and the horseshoe shape allows the esophagus to expand without bumping into a hard surface.
4. Intercostal muscles between the ribs help to elevate the ribs, bringing air to the lungs.
5. When the ribs that are sloping downward elevate, it creates more space for air to enter the lungs, both front to back and laterally.
6. Right lung has three lobes; the left lung has two lobes.
7. Heart
8. The lungs move as we breathe so the lubricant between the parietal and visceral layers of the pleural sac helps to keep the lungs from creating too much friction and heat as they expand and contract.
9. Surface tension
10. The diaphragm is located under the lungs, and divides the top half of the body from the bottom half.
11. Esophagus and aorta
12. Lubricated hinges in the back; cartilage in the front
13. The elastic connective tissue in the lungs contracts the lungs to their resting state
14. The act of breathing is involuntary in most cases so that we don’t need to think about each breath, yet the muscles are voluntary so that we can control our breathing if we want to.

15. Liver, stomach, intestines
16. Each organ is encased in a peritoneal sac that has lubricant between the visceral and parietal layers, allowing for slippage without friction.
17. The bronchi
18. The right bronchus would allow something to drop straight into the right lung, while the left bronchus veers off steeply.
19. Cartilage rings or plates
20. Bronchioles don’t have cartilage.
21. Nasal cavity; pharynx; larynx; trachea; bronchi; lungs
22. The olfactory mucosa is located at the top of the nasal cavity. The epithelial cells interact with the nerves coming from the brain to produce our sense of smell.
23. The olfactory mucosa in humans is about the size of a postage stamp. In some dogs, it can approach the size of a handkerchief.
24. The pharynx and larynx are located at the back of the throat.
25. The tissue investing the turbinates is filled with big blood vessels that give off heat, warming the air as it passes through the nasal cavity.
26. At the top
27. Odorant-binding proteins bind to odorant molecules and help us to detect different smells.
28. The trachea is not in the main line of food exiting the oral cavity into the esophagus, also the epiglottis helps to prevent food from entering the trachea when swallowing.
29. Speech is possible by having the trachea connected to the vocal chords and oral cavity.
30. Hyaline cartilage
31. Goblet cells make mucous to line the respiratory tree acting as a filter to trap dust and other particles that enter through the mouth or nose.
32. Cells that line the trachea and bronchi have tiny hair-like filaments (cilia) that move the mucous up toward the mouth.

33. Cilia move in a coordinated wave called a metachronal rhythm, which is like the "wave" you see spectators do at a ballgame.
34. The cells produce a layer of fluid the same height as the cilia—as the cilia move through the fluid, the tips move the mucous over the fluid.
35. An axoneme is made of tubules—nine doublets of tubules around the outside and one set in the middle.
36. One of the tubules in each doublet has cross-bridges which oscillate causing the tubules to slip in relation to each other, bending the cilium one way or the other.

Part 2:

1. Cartilage.
2. Alveolar ducts have alveoli attached to them whereas bronchioles do not. *(NOTE: at 2:48 Dr. Menton misspoke and referred to an olfactory duct as an alveolar duct.)*
3. Alveoli.
4. An alveolar sac is at the end of an alveolar duct.
5. Gas exchange occurs through the walls of the alveolar ducts so the walls need to be thin to facilitate the exchange.
6. Type one cells allow the diffusion of oxygen from air to blood; type two cells are foamy looking and produce surfactant to break the surface tension on the alveolus.
7. Type two cells don't develop until the last month of a baby's development *in utero*. So the surfactant isn't produced in a baby born pre-term, and the baby's lungs cling together.
8. The surfactant decreases the surface tension in the alveoli, preventing them from collapsing or sticking, and helping to facilitate gas exchange.
9. Warm water doesn't allow oxygen to dissolve in it as easily as cold water does.
10. Hemoglobin in the blood has a high affinity for oxygen.
11. Bi-concave disk; this shape provides the most surface area possible.
12. They are shaped like a sickle instead of as a bi-concave disk due to a mutation in one amino acid.

13. A cytoskeleton holds the RBC in the right configuration.
14. As the blood circulates through the spleen, the spleen destroys RBCs that are not right. So the spleen destroys sickle cell RBCs. The spleen is removed to prevent destruction of sickle cells.
15. 1x10^600; only five configurations are known to work normally.
16. Neutrophils contain lysosomes that eat bacteria. Their tiny granules don't show up as well so they don't stain as much as the others.
17. Eosinophils defend against parasites. They contain red granules that stain with the dye eosin.
18. Basophils carry histamine and act as inflammation mediators. They contain large blue granules that stain with basic dyes.
19. Macrophages.
20. B lymphocytes make antibodies; T lymphocytes kill virus infected cells.
21. Platelets make blood clotting factors.
22. Marrow.
23. Megakaryocytes are large cells in the bone marrow that produce platelets.
24. Basophilic erythroblasts; polychromatophilic erythroblast; picnotic nucleus is ejected; reticulocyte; mature erythrocyte.
25. Erythroblasts make red blood cells; erythrocytes are the mature red blood cells that lack a nucleus.
26. Internal bleeding could cause more immature blood cells in the peripheral blood.
27. Smoking particles get caught in the mucous; those particles that aren't caught in the mucous get gobbled up by macrophages. The macrophages with the carbon migrate to the connective tissue of lung lobules and stay there.
28. A lobule is a unit of lungs supplied with a terminal bronchiole.

Answers to Questions from “Digestive System”

Note to parent:

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Part 1:

1. The alimentary canal is 30 feet long in adults. It goes from the mouth to the anus.
2. 20 feet of small intestine; 5 feet of large intestine.
3. Trachea.
4. Diaphragm.
5. Wrinkles in the stomach.
6. The duodenum is the entrance to the small intestine—the point where the food first enters the intestine.
7. Pancreas.
8. The cecum is a sac that allows for expanded colonic digestion.
9. Mastication is chewing the food and is important for moistening and lubricating the food so that it can easily slide down the esophagus.
10. Mechanical and chemical breakdown of food.
11. Ingestion; digestion; absorption; egestion; excretion.
12. GALT is collections of white blood cells and lymphocytes found along the alimentary canal. Examples include tonsils, adenoids, Peyer’s patches, and appendix. They combat infections of the GI tract.
13. Filiform papillae are small hooks on the top of the tongue that help to pull things into the mouth.
14. Circumvalate papillae are at the back of the tongue, where valleys surround papilla. The valleys are filled with water. This is where many taste buds are.
15. Taste buds have epithelial cells that interact with nerves and are located all over the mouth.

16. Hold your nose and eat strawberries and notice the difference in taste when not holding your nose.
17. Odontogenic organ makes the tooth.
18. The mature tooth enamel has no living cells and so is unable to change shape or repair itself.
19. Ameloblasts are cells that make enamel and are located on the inner epithelium. Ameloblasts secrete a matrix with an affinity for mineral that eventually forms something harder than bone.
20. Enamel (solid hydroxyapatite) is hard and brittle; dentin is under the enamel; cementum is under the dentin.
21. The different layers of progressive hardness allow the tooth to give as its used, instead of shattering as it would do if it were completely hard.
22. Odontoblasts are located under the ameloblasts.
23. Secondary teeth are necessary because they are bigger and there are more of them—better filling the adult mouth. They develop from a bud.
24. Loose connective tissue inside the tooth is the pulp. It is essential to keep the tooth alive because it provides the nutrition for odontoblasts throughout life.
25. Dentin is made of living cells and so is able to repair itself; mature enamel is not made of living cells.
26. Cementum is most similar to bone in that it has a similar structure and the same hardness as bone.
27. Cementum has ligaments embedded in it, attaching the tooth to the jaw.
28. Periodontal ligament is connective tissue that holds the tooth relatively flexibly in place.
29. On the gum during the time when teeth are protruding through.
30. The gingival sulcus attaches to the enamel as the teeth breaks through the gum, preventing bacteria from penetrating to the periodontal ligament.
31. Teeth are demineralized before sectioning so that the enamel doesn’t break the blade. Demineralizing enamel completely removes it from the tooth.

32. At the top, the fibers are straight across; as they progress down they tooth, they begin to angle down so that they resist the pressure on the tooth that would cause it to bottom out in the socket.

33. The periodontal ligament fibers penetrate into the bone (Sharpie's fibers) and into the cementum.

34. The tooth grows layer by layer at its surface (appositional growth) as bone does.

35. Tetracycline fluoresces under fluorescent light, so when the tooth of a person who has taken tetracycline is sectioned and put under a microscope, it shows the layers of when the tetracycline was taken.

36. Enamel contains the most inorganic mineral; cementum contains the most organic material.

Part 2:

1. Parotid glands are located just underneath the skin on the side of the face below the ears. Submandibular glands are located under the mandible. Sublingual glands are located under the tongue.

2. Parotid glands produce a watery saliva. Submandibular makes a mixture of water and mucous. Sublingual makes mostly mucous. Different saliva is appropriate for different types of food (mucous lubricates and water dissolves).

3. Serous acini produce a watery saliva (containing enzymes); mucous acini produce a mucous secretion.

4. They look like grapes (the acini) attached to branching stems (the ducts).

5. Some of the minor salivary glands are located on the inside of the lip, and they function to keep the lip from sticking to the teeth.

6. They secrete a mucous that coats the lining of the esophagus to aid in swallowing.

7. Mucosa—stratified squamous epithelium in the esophagus and anus is good to resist wear and tear (a columnar absorptive or secretory epithelium elsewhere); Lamina propria—thin layer of loose connective tissue; Muscularis mucosa—thin layer of smooth muscle; Submucosa—connective tissue that may contain glands; Muscularis interna—innermost layer of muscle that is circumferential; Muscularis externa—outermost layer of muscle that is longitudinal; Serosa is an outer simple squamous epithelial covering of the intestines and other abdominal organs and is the inner layer of the mesentery.

8. The muscularis interna squeezes the tube; the muscularis externa shrinks the tube. Working in concert, these muscles produce peristalsis, which moves the food down the tube.

9. The autonomic nervous system controls peristalsis so that we don't have to think about moving each bit of food through the tract.

10. In the intestinal tract.

11. Involuntary smooth muscle.

12. The esophagus contains some voluntary striated muscle unlike the rest of the GI tract which contains exclusively involuntary smooth muscle.

13. The first third of the esophagus is voluntary striated muscle so that food can be deliberately swallowed muscle; the second third is a 50-50 mixture of voluntary striated muscle and involuntary smooth muscle; the last third is involuntary smooth muscle. The smooth muscle propels the food through our digestive system without conscious effort.

14. Stratified squamous lines the esophagus and is designed to resist damage from the food moving through it.

15. Storage; grinding; secretion hydrochloric acid (HCL), water, mucous, pepsin; digestion; endocrine.

16. HCl breaks down the food; water is added to food; mucous keeps the stomach lubricated to pass things through; pepsin breaks down proteins.

17. Pepsin is an enzyme that breaks down proteins.

18. Chime is the product produced in the stomach after digestion has happened—a relatively liquid material that can flow through the rest of the intestinal tract.

19. The pyloric valve is located at the exit of the stomach and allows food to enter the duodenum.

20. Bile is produced in the gall bladder and it serves as an emulsifier of fats (makes tiny droplets) so that the fats can be more easily absorbed and broken down.

21. Surface mucous cells lubricate the stomach pathway and protect the stomach from the acid; stem cells help to make new cells; parietal cells make HCl; zymogen cells ("chief" cells) makes pepsinogen; endocrine cells aren't discussed.

22. If you don’t have a proper lining in your stomach, the acid begins to eat away at the stomach, causing an ulcer.

23. Parietal cells use carbon dioxide and water to form a bicarbonate. The hydrogen atom is secreted into the lumen where it is joined by chloride ions. This combination forms HCl at the last minute so as not to destroy the parietal cells themselves.

24. Zymogen cells secrete pepsinogen, a precursor to pepsin.

25. Duodenum; jejunum; ileum.

26. The mesentery is the attachment point of the sac that suspends and attaches the intestines to the dorsal body cavity wall. It consists of two layers, between which, blood vessels nerves and lymphatics enter the intestines.

27. Villi line the small intestine and increase the surface area of the small intestine.

28. The lymphatics.

29. Microvilli are much smaller than villi (can only be seen in the microscope) and increase the surface area further, aiding in digestion and absorption of nutrients.

30. (This is a repeat of question 20.) Bile is produced in the gall bladder and it serves as an emulsifier of fats (makes tiny droplets) so that the fats can be more easily absorbed and broken down.

31. The large intestine absorbs the water from the digested food so that the body doesn’t lose massive quantities of water.

32. Ascending colon; transverse colon; descending colon.

33. Diarrhea occurs when the large intestine is incapable of pulling the water out.

34. Crypts of Lieberkuhn are simple tubular glands at the base of the villi in the small intestine which produce stem cells, digestive enzymes and mucous.

35. As the food moves through the intestinal tract, it gradually loses water and becomes more and more solidified which requires increasing lubrication (mucous from more goblet cells) to keep moving.

36. Pancreas secretes enzymes that digest many different things (proteins, lipids, DNA, etc.); and the liver which secretes bile (stored in the gall bladder) for emulsifying fats.

37. Into the duodenum.

38. Exocrine glands secrete things for export; endocrine glands secrete things that will go into the bloodstream.
39. Islets of Langerhans secrete insulin, which goes into the blood stream.
40. The exocrine glands of the pancreas secrete several different enzymes (protease, lipase, amylase etc.,) that play an important role in the digestion of food.
41. Liver.
42. Blood goes from a capillary bed to bigger vessels and then back to another capillary bed.
43. Stores bile.
44. The liver makes bile, synthesizes plasma proteins, makes prothrombin (involved in blood clotting), stores glucose, and metabolizes drugs and alcohol.
45. Kupffer cell is a macrophage that removes old red blood cells.
46. The appendix is located off the cecum.
47. The appendix is not useless—it has functions.
48. The appendix may function as a reservoir for useful bacteria that line the intestinal tract.
49. We may not know what the function of an organ is but that doesn't mean it doesn't have one.
50. Salivary amylase begins to digest starches.

Answers to Questions from “Urinary System”

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Part 1:

1. They sit under the ribs at the back part of the body so that they’re protected.
2. They are behind the peritoneum.
3. In the developing baby, they are lower and attached to the iliac artery.
4. The testes began up farther where the kidneys sit in an adult.
5. Kidneys are connected to the aorta by the renal artery and the inferior vena cava by the renal vein.
6. Adrenal gland.
7. Ureters carry urine from the kidneys to the bladder.
8. The urethra carries urine from the bladder out of the body.
9. One ureter is attached to each kidney, so there are two. Only one urethra is needed to empty the bladder.
10. The prostate gland is located under the bladder.
11. 300 milliosmoles.
12. Hypertonic solutions have a greater concentration of salts than the surrounding cells. Hypotonic solutions have a lesser concentration of salts than the surrounding cells.
13. Filtration; resorption; secretion.
14. Urea is the nontoxic waste product of protein metabolism.
15. Kidneys eliminate waste products of protein metabolism; eliminate excess salts and other compounds; adjust the pH of body fluids; help to control blood pressure; help to control the number of red blood cells.
16. Erythropoietin.

17. The renal pelvis that that is like a funnel that collects the urine from each kidney.
18. 1000 L/day of blood enters the kidneys; 180 L/day of ultrafiltrate.
19. 178.5 L/day.
20. 1.5 L/day.
21. Electrical charge.
22. Red blood cells; white blood cells; platelets; larger protein molecules.
23. Our bodies would lose massive quantities of water, salts and nutrients if reabsorption didn't take place.
24. Some foreign substances like penicillin need to be completely cleared from the blood in the kidneys so they are secreted from the blood in the peritubular capillaries into the nephron.
25. A renal lobe is a functional unit of the kidney that includes all the nephrons that supply a minor calyx; there are typically ten or more lobes.
26. Medulla.

(Note: The original study guide has the following questions listed for Part 2, not part 1.)

27. Each kidney has between 1–4 million nephrons.
28. Minor calyx (funnel).
29. The renal pelvis collects all the urine that has been produced by all the lobes of the kidney and dumps it into the ureter.
30. Collecting duct; minor calyx; major calyx; renal pelvis; ureter; bladder.
31. Interlobar artery; arcuate artery; interlobular arteries; afferent arterioles; capillaries; efferent arteriole; peritubular capillaries; interlobular vein; arcuate vein.

Part 2:

1. Nephrons are the smallest functional unit of the kidney. *(Note: This was question 6 in the original study guide.)*
2. The afferent arteriole feeds into the glomerular capillary bed that filters stuff out of the blood; the blood then travels through another arteriole (efferent arteriole) to

the peritubular capillaries that surround the nephron tubes to reabsorb things back into the bloodstream.

3. Renal corpuscle is where the ultrafiltration happens.
4. Throw everything out except the large items (e.g., furniture) and then go through all of the thrown-out pieces and bring back in what you want.
5. Renal corpuscle; proximal convoluted tube; descending thick limb; descending and ascending thin limb; ascending thick limb; distal convoluted tube; collecting tubule.
6. Cortex or renal columns.
7. Cortex.
8. The loops of Henle *(Note: This was misspelled "Henley" in the video)*, collecting ducts and peritubular capillaries (vasa recta).
9. The loops of Henle create a salt sink in the renal pyramid which concentrates urine.
10. Top of the renal pyramid—300 mOsm; farther down—600 mOsm; farther down—900 mOsm; apex—1200 mOsm.
11. The salt sink in the renal pyramid absorbs water out of the variably permeable collecting ducts by a process of osmosis producing hypertonic urine from hypotonic urine in the ducts.
12. Antidiuretic hormone (ADH) can cause the impermeable collecting duct to become variably permeable to water.
13. The kidneys can't handle such a hypertonic solution like seawater.
14. Mallards can develop an accessory salt gland—the supraorbital gland—when the duck is exposed to higher salt concentrations and concentrates salt better than the kidneys.
15. The cortical nephrons surrounding the medullary rays are the lobule.
16. Glomerular capillaries are the capillaries of the renal corpuscle.
17. Podocytes; they look like feet with toes sticking out.
18. The ultrafilter is believed to be the slit diaphragm between the pedicles of the podocytes.

19. Pores in the endothelium; basement membrane; slit diaphragm.
20. 40 Angstroms.
21. Sodium chloride, potassium, water, bicarbonate ion, glucose are removed. Residual uric acid is secreted.
22. Sodium chloride, potassium, water are removed.
23. Sodium chloride, calcium, water are removed. Residual uric acid is secreted. Hydrogen ions and potassium are removed.
24. 200 mOsm.
25. Proximal tubules have a fuzzy border (many microvilli); distal tubules don't have a brush border (don't have the microvilli).
26. Blood pressure is controlled through the renin-angiotensin system.
27. Those tubules need a lot of energy to do active transport; the mitochondria supply that energy.
28. The cells fit together like gear wheels; they interdigitate which make the cell walls difficult to see.
29. ADH causes the collecting ducts to be permeable, able to pull salt out and produce hypertonic urine.
30. They must stretch without leaking; they must resist being exposed to 1200 mOsm liquid.

Answers to Questions from “Hearing Ear & Seeing Eye”

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Part 1 (Ear):

1. They don’t want to be accountable to a Creator who can hear all and see everything, and they suppress the truth in unrighteousness.
2. Air compresses as the sound is made and the compressed air travels in waves to the hearer.
3. Outer ear (air); middle ear (bone); inner ear (liquid).
4. The cells in the inner ear would dry out and die in air—so they need to be under a specific liquid with the right salt concentration and pH.
5. The cells lining the outer ear canal grow sideways, carrying wax and particles out.
6. The auricle collects sound and helps us tell where the sound is coming from.
7. Hammer (malleus); anvil (incus); stirrup (stapes).
8. They restore the energy that would otherwise be lost in transmitting the sound waves from air in the outer ear to water in the inner ear.
9. We hear our voice through the air and through the bones of our skull when we speak.
10. Less than the diameter of a hydrogen atom.
11. It is made of the cochlea (used for hearing) and semicircular canals (sense of position in space).
12. The semicircular canals are used to help us sense our movement in space. The liquid in the canals move as we move a sail-like structure in the ampulla that transmits a signal to our brain telling it which way we’re moving.
13. Tiny stones sit on the floor of the saccule and the nerves in the floor sense the movement of the stones when the body moves thus the brain can tell whether a person is upright or upside down.
14. *Cochlea* means snail shell and this is appropriate because the cochlea is snail-shaped.

15. The organ of Corti converts the mechanical movements of sound into electrical signals the brain perceives as sound. It spirals around inside the cochlea.
16. The oval window receives the compression of the stirrup increasing the fluid pressure in cochlea; the round window relieves the pressure created by the stirrup pushing in at the oval window.
17. As the organ of Corti moves up and down, the tectorial membrane causes a shearing force on the hairs of the hair cells. This causes ion channels to open on the tips of the hairs which generate electrical signals the brain can interpret as sound.
18. The tectorial membrane is a flat membrane over the hair cells in the organ of Corti that causes the hairs to bend which creates electrical signals that the brain perceives as sound.
19. The hair cells tear out of the tectorial membrane.
20. The hairs have a hole that allows sodium ions in and out; a trapdoor covers the hole; a spring is attached to the trapdoor; the spring controls the opening and closing of the trapdoor; the spring is attached to a bracket on the next longer hair; the bracket moves up and down. The ions entering the hair send signals to the brain that interprets the signals as sound.
21. 20,000 cycles/second.
22. Tubes help to equalize the pressure on both sides of the ear drum if the Eustachian canal is blocked.
23. If the air pressure isn't the same, the ear drum will be pulled one way or the other producing pain and interfering with the perception of sound.
24. Eustachian tube.
25. Yawning kinks the Eustachian tube, causing whatever is clogging the tube to move out of the way.

Part 2 (Eye):

1. All vertebrates have such an eye.
2. The cornea is a clear window in the skin; the sclera is opaque and has blood vessels.
3. The cornea and lens are derived from embryonic skin.
4. Brain (diencephalon).

5. Changes the diameter of the pupil adjusting for the brightness of light.
6. The apple of the eye.
7. “I will protect you like the apple of my eye.” It means that God will protect His children in the same way people protect their eye—instantly and reflexively and to the death.
8. Since the eye is part of the brain, the signal doesn’t have to travel that far, so the blink reflex is the fastest in the body.
9. The blink reflex protects the eye. It happens when something comes near the eye.
10. Touch the cornea over the pupil to see if the blink reflex still functions.
11. Apes and monkeys have a flat forehead and the bone comes right up to the outer edge of the orbit, so you can’t see into the orbit, as you can with human orbits.
12. The medial and lateral recti move the eyeball left and right; the superior and inferior recti move the eye up and down.
13. The oblique muscles rotate the eyeball like a doorknob keeping our horizon level as we tilt our head.
14. The superior oblique runs down the length of the orbit, and its tendon bends at an angle going through a little pulley before it attaches to the eye. The inferior oblique simply crosses under the eye.
15. Optical axis is straight forward; anatomical axis is at an angle because of the way the orbits slope in on the outside.
16. We have control over the rectus muscles but do not have control over the oblique muscles—they are controlled automatically.
17. They keep the horizon level when the head is tilted.
18. You would see double.
19. To move the eye up and down, three different muscles are involved, with three different nerves.
20. The inner layer forms the retina; the outer layer is the sclera/choroid.
21. The lens buds off a layer of embryonic skin. At first it is a hollow ball, but then the cells on the rear of the ball become greatly thickened filling in the empty space.
22. The cornea bends the light four times more than the actual lens.

23. The lens focuses by changing its shape. Camera lenses move in and out.
24. Spherical, focused close.
25. The eye closes the iris diaphragm to make it smaller, only using the center of the lens and minimizing the spherical aberration.
26. Because the iris is more closed with close work, it requires more light to see.
27. It gets its oxygen from the air.
28. The black pigment (melanin) in the back of the iris helps to prevent too much light from entering the eye.
29. Lens fibers are long cells that go from the front of the lens to the back.
30. The lens gets harder, losing its ability to focus well, and often becomes more yellow and develops cataracts.
31. The anterior lens cells are cuboidal in shape and can divide. The posterior cells of the lens become greatly elongated to form lens prisms.
32. Crystalline.
33. Thousands of peg-and-socket joints lock the lens prisms in place.
34. Fiber tracks, in the central nervous system, don’t heal when cut, unlike nerves.
35. Ring-like sphincter muscles close the iris opening. Radially oriented muscles open the iris.
36. The iris diaphragm is located between the cornea and lens.
37. Muscles of the ciliary body attach by means of tiny tubular fibers to the capsule of the lens.
38. The vitreous body formed from very loose connective tissue when the hollow ball from the brain that formed the eye got pushed in.
39. Aqueous humor is produced by the ciliary processes. It is continuously produced and maintains the specific shape of the eye.
40. So that it stays just the right physical dimensions for optical reasons.
41. They claim that the retina is facing upside down.

42. The pigment epithelium traps the photons so that they don't bounce off the rods and cones more than once. The photoreceptor cells need a rich blood supply which is near the back.

43. The Muller cell goes from top to bottom in the retina. It is a living fiber optic.

44. Fovea centralis; our minds are designed to concentrate on one thing at a time, so the fovea allows us to focus on one area or thing at a time.

45. The brain has a rule, "if it doesn't move, ignore it." Because the blood vessels don't move in relation to the retina, the brain ignores them.

46. With one eye, look at a brightly lit blank white surface through a small hole in a card. Close the other eye. Move the card from side to side quickly in front of the open eye. This causes the shadow of the blood vessels on the front of our retina to move, thus making them visible.

47. They are located above the eye ball near the outer rim of the orbits.

48. There are small holes (puncta) and pumps in the eyelids near the nose that remove the fluid.

49. Tear fluid is optically part of the lens.

50. It removes debris, provides antimicrobial help, and covers the rough surface of the cornea making it smooth so it doesn't scatter light.

51. Oil glands on the edges of the lids provide a hydrophobic barrier that keeps the fluid in place.

52. The eyelid pumps the water into the nose, causing the sniffles. When too much fluid is produced and the pumps can't keep up, and a thicker layer of tear fluid changes the focus of the eye causing bleary vision.

53. The shape of the eyeball—if it's longer front to back, it causes nearsightedness; if the eyeball is flatter front to back, it causes farsightedness.

54. The space created between the retina and the choroid can cause the retina to detach if there is a jarring or some type of disease. The space between the retina and choroid resembles the embryonic condition.