I  Blood Vessels (See Figure 42.10)

There are five types of blood vessels: arteries, arterioles, capillaries, venules and veins. Capillaries have thin walls, because gas and chemical exchange with tissues takes place with capillaries (at least in a closed circulatory system). Arteries, arterioles, venules and veins have thick walls, and are not intended for gas or nutrient exchange. They are only meant to carry blood from one place to another. Blood pressure tends to be high in arteries, and you can feel a pulse (systole vs. diastole). Blood pressure is lower in veins, and the pulse is absent, having been ‘damped’ by passage through capillary beds. Thus, blood flows from the heart in arteries that lead into arterioles, and eventually into capillary beds. After passage through capillary beds, and exchange of gasses, nutrients and waste products with tissues and organs, blood flows back to the heart via venules that lead into veins.

Arteries: Large, strong tubes that carry blood AWAY from the heart (whether the blood is oxygenated or not). They are built to withstand the high pressure of blood going away from the heart, and have a single layer of epithelium (called ‘endothelium’) lining the inside, surrounded by a thick layer of smooth muscle. The smooth muscle can be contracted to either narrow the arteries (‘vasoconstriction’) or widen them (‘vasodilation’). The smooth muscle is then surrounded by a thick layer of connective tissue to give it extra strength. Arteries lead into arterioles, which are smaller versions of arteries, and eventually into capillaries.

Capillaries: Are microscopic blood vessels having a very thin wall. Capillary walls are only one layer of endothelium, surrounded by a very thin layer of connective tissue. Capillary walls are thin to allow diffusion of gasses and chemicals across them. Capillaries are organized into networks called capillary beds. All of the major organs, as well as the lungs, are supplied with oxygen and nutrients by networks of capillary beds. Cells and organs are supplied with oxygen and nutrients from capillary beds, but the capillary beds also remove carbon dioxide (waste product of the Krebs Cycle) and other waste products from cells. Carbon dioxide is then emptied into the lungs (and traded for fresh oxygen), and liquid wastes are removed by the kidneys.
The amount of blood entering a capillary bed from an arteriole is controlled by a series of **precapillary sphincters** (Figure 42.14). The ability to control the amount of blood sent into the capillary beds of different organs is useful because it allows animals to prioritize blood use. More blood is sent into the capillary beds of the digestive system just after eating, and is diverted away from other organs. (This is why you sometimes can’t concentrate after eating a large meal. Blood is actually being diverted away from your brain.) When an animal is cold, it may cut off the blood supply to outer extremities (toes, fingers etc.) in order to keep its core body temperature high, and internal organs warm. And when an animal becomes frightened or angry (the ‘fight or flight reflex’) blood will be diverted away from the digestive system and other places, and channeled into muscles needed to run or fight. Blood leaving capillary beds then flows into venules, which are smaller versions of veins, and eventually into veins.

**Veins:** Blood pressure is high in arteries, but drops considerably once it passes through a capillary bed (Figure 42.11). Blood pressure is much lower in veins, and therefore veins do not need to be as strong as arteries. Veins are composed of the same three layers of material as arteries: endothelium, smooth muscle and connective tissue. However, the layers of smooth muscle and connective tissue are thinner. Another structural difference between veins and arteries is that veins have **valves** to prevent backflow. Because the pressure is so high in arteries, backflow is never a problem. However, blood pressure is sufficiently low in veins that backflow can sometimes be a problem, so valves are used to make sure the blood only flows in the right direction (back to the heart).

**Capillaries:** Capillaries are microscopic blood vessels that are often only the diameter of one blood cell (ie-10 micrometers in diameter). They have a very thin wall, consisting of only one layer of endothelium (essentially squamous epithelial cells) and a thin layer of connective tissue. The walls are thin to allow gasses, liquids and chemicals to cross them. Most large proteins, by contrast, cannot cross the capillary wall. (As we will see, the inability of a protein called Serum Albumin to cross the capillary wall is critical to maintaining blood pressure.) Capillaries are organized into extensive mesh-like networks called capillary beds that supply the organs and tissues with fresh oxygen and nutrients. The capillary beds also remove cellular waste products and carbon dioxide. The waste products are cleaned from the blood in the kidneys, and the carbon dioxide is exchanged for oxygen in the lungs. Blood pressure is typically high on the arteriole side of the capillary beds, and low on the venule side. Capillary beds also act as ‘dampers’ for the pulse, so that a pulse can be felt in arteries, but not in veins.

### II Major Arteries and Veins of the Human Body

**Major Arteries:** Blood leaving the heart goes into the **Aorta**. The aorta then branches off in three main directions. One branch bends downwards to become the **Thoracic Aorta**, and later the **Abdominal Aorta**, delivering blood to the thorax (chest) and lower body. Two other branches branch off to the left and right arms. Each of the branches leading to the arms further branches into a branch leading to the head. **Often the same artery will have a different name, depending on which part of the body it is passing through.** That’s why the aorta is named the thoracic aorta as it passes through the thorax, and is then renamed the abdominal aorta as it passes through the abdomen (belly); despite the fact that it’s still the same artery.
Arteries Supplying the Heart Itself: Several smaller arteries branch off from the aorta, and supply blood to the heart itself. These are called the Coronary Arteries. (Each one has a name, but you’re not required to memorize them.)

Arteries Supplying Blood to the Lungs: As mentioned in the previous section, blood is pumped to the lungs via the left and right. Pulmonary Arteries The main purpose of this is to oxygenate the blood, rather than to supply blood for lung function.

Arteries Supplying the Body Below the Heart: As mentioned above, the aorta bends downwards, becoming the thoracic artery, and then the abdominal artery. It eventually branches into two main arteries that supply the legs, called the Femoral Arteries (the ‘femur’ is the large bone in your upper leg).

Arteries Supplying the Head and Arms: Two large arteries branch off from the aorta, supplying blood to the head and arms (in that order). They are called the left and right Brachiocephalic Arteries. ‘Brachial’ refers to arms, and ‘Cephalic’ refers to the head. Thus ‘brachiocephalic’ refers to the arteries that supply blood to both the arms and head. Each brachiocephalic artery then branches into one branch leading to the head, called the Common Carotid Artery; and another branch leading to the arm, called the Subclavian Artery. (It is only called the subclavian artery while it is running across the shoulder, parallel to the collar bone. The technical term for the ‘collar bone’ is the Clavicle, so the veins and arteries that run underneath it are called ‘Subclavian.’) There is both a left and a right Common Carotid Artery and a left and a right Subclavian Artery. When the subclavian arteries bend downwards to supply blood to the arms, they are renamed the left and right Brachial Arteries. The brachial arteries can be used to measure blood pressure (see below). The common carotid arteries branch into internal and external carotid arteries, depending on whether they supply blood to the inside or the outside of the head, but you are not required to memorize this.

Major Veins: A parallel system of veins returns blood to the heart. Blood returns from the head via the internal and external Jugular Veins. Blood returns from the arms via the left and right Subclavian Veins. Both the jugular veins and subclavian veins lead into the Superior Vena Cava, which leads directly into the Right Atrium of the Heart. Blood returns from the lower body via the Inferior Vena Cava, which also empties directly into the Right Atrium. As mentioned in the previous section, blood returns from the lungs via the left and right Pulmonary Veins.

Veins Delivering Digested Food to the Liver: As mentioned in the previous section, an extensive network of veins carries nutrients obtained from food digested in the small intestine to the liver, where they will be detoxified and modified before being added to the general bloodstream. This network of veins is called the Hepatic Portal System. All of these veins eventually empty into a single large vein leading to the liver called the Hepatic Portal Vein. After the liver has processed and detoxified the nutrients, they are sent into the Inferior Vena Cava via two Hepatic Veins. Each of the other organ systems (spleen, kidneys etc.) is supplied with a major artery and vein, but you will not be required to memorize them for this course.
III  Regulation of Blood Pressure
The physical pressure of the blood in the blood vessels can be regulated in three ways:

1. By varying the diameter of the blood vessels. **Vasoconstriction** increases blood pressure, and **vasodilation** decreases it. Constriction and dilation of the blood vessels is mediated by the smooth muscles that surround them. Constriction of these smooth muscles is controlled by something called the **autonomic nervous system**, which we’ll discuss later.

2. By varying the volume of liquid in the blood vessels. The amount of liquid in the circulatory circuit can be lowered by sending **blood plasma** out of the capillary beds and into the **interstitial spaces** and soft tissues. The amount of liquid in the circuit can be increased by doing the reverse. How this happens is discussed below.

3. By varying the heart rate. As you would expect, when the heart beats faster, blood pressure goes up.

**Measurement of Blood Pressure** (Figure 42.12): Blood pressure is measured with an inflatable cuff that fits over the arm (called a **sphygmomanometer**), and a listening device called a **stethoscope**. The cuff is inflated with air until the **brachial artery** is pinched shut. The stethoscope is placed below the cuff, and the operator listens for thumping sounds called **Korotkoff Sounds** (named after a Russian physician who invented this technique). The pressure in the sphygmomanometer is measured in millimeters of mercury (mm of Hg). When the brachial artery is pinched shut, no Korotkoff sounds can be heard. Pressure is then let out of the cuff until the sounds can be heard again. This is literally the sound of the blood pounding on the narrowed arterial walls, trying to get through the pinched-off space. As the cuff continues to deflate, the sounds will disappear, as the blood flows freely through the brachial artery. The pressure at which the Korotkoff sounds are first heard is taken to be the Systolic Pressure, and the pressure at which they disappear is taken as the Diastolic Pressure. Blood pressure is then reported as the systolic over the diastolic pressure, in mm of Hg. For a healthy, young person this is typically **around 120/80 or 120/70**.

IV  Regulation of the Amount of Fluid in the Interstitial Spaces of the Body
The amount of fluid located in the interstitial spaces and soft tissues can be varied in three ways. First, high blood pressure flowing through the capillary beds will literally push **blood plasma** (but not blood cells or proteins) through the capillary walls, and into the interstitial spaces. Blood pressure in capillary beds can be controlled in one of three ways, including increasing the heart rate, constricting the arteries (vasoconstriction), or opening the **precapillary sphincters**. Blood pressure in capillary beds, as it relates to fluid going in and out of the capillaries and interstitial spaces is called the **Hydrostatic Pressure**.
The second way to vary how much blood plasma leaks out of or into the capillaries is by varying the amount of protein in the blood. (Remember osmotic pressure!) If there is a low concentration of protein inside the blood relative to the concentration in the interstitial spaces, water will flow out of the capillaries into the interstitial spaces. If the concentration of proteins is higher inside the blood than in these spaces, water will flow back into the capillaries from the interstitial spaces. This is known as the Oncotic Pressure; and the main protein used to regulate it is a protein called Serum Albumin (referred to from now on as simply ‘Albumin’).

Finally, there is a second method for fluids to get out of the interstitial spaces besides the capillaries. Tissues are also fed and drained by a parallel series of tubes called the Lymphatic System (to be discussed in Chapter 43). These tubes are called Lymphatic Vessels, and they are also capable of draining fluids out of the interstitial spaces. The fluid that flows through the lymphatic system (called Lymph) is similar to blood plasma, and is originally derived from blood plasma. The lymphatic vessels are also capable of draining fluid from interstitial spaces. This large series of vessels pumps fluid upwards through the body, and the entire lymphatic vessel system is ultimately dumped back into the main blood stream at the Subclavian Veins.

An excess buildup of fluids in the interstitial spaces, leading to swelling is called Edema. Edema can be potentially life threatening if it happens inside a body compartment where it will interfere with the functioning of vital organs (ie-Pulmonary Edema, where fluid accumulates in the chest, making it hard to breathe). Blockage of lymphatic drainage can also cause problems with swelling (ie-Elephantiasis, which is caused by a microscopic worm named Wuchereria bancrofti blocking the lymphatic vessels).

V Components of Blood

If you centrifuge (spin down) blood in a test tube it will separate into two phases, a liquid phase (plasma) and a solid phase (cells; see Figure 42.17). Plasma constitutes about 55% of the blood volume, and cells constitute about 45%. The percentage of the volume taken up by the blood cells is referred to as the Hematocrit.

The Blood Cells: About 99% of the cells in blood are erythrocytes (red blood cells carrying oxygen), and only 1% are leukocytes (white blood cells involved in the Immune System). There are two types of leukocytes: A) Granulocytes (divided into Basophils, Eosinophils, Neutrophils and Monocytes), and B) Lymphocytes (B Cells and T Cells). Lymphocytes are involved in the production of antibodies, and Granulocytes are involved in the direct attack of invading organisms. Granulocytes are easily recognized under the microscope because they have a ‘granular’ (spotty) appearance. They also have oddly shaped nuclei. Instead of having round nuclei like most cells, the nuclei are either shaped like dumbbells or bunches of bananas, having between two and five lobes. Because granulocytes have several shapes to their nuclei, they are also referred to as the ‘polymorphonuclear’ cells, or the PMN Cells. Lymphocytes, by contrast, have a round nucleus that takes up most of the cell volume.

Blood Clotting: Platelets are another solid component of the blood. They are actually fragments of cells, and not whole cells (see Figure 42.17). Platelets are tiny fragments that break off of larger cells called Megakaryocytes. Platelets are involved in blood clotting, and in the patching of holes in blood vessels. If a hole forms in a blood vessel platelets will swarm to the
area and plug the hole, and also convert a soluble protein called **Fibrinogen** into solid fibers called **Fibrin**. They do this by converting an inactive enzyme in the blood (called **Prothrombin**) into its active form (**Thrombin**). It is actually thrombin that converts fibrinogen into fibrin. Thus, the platelets will plug the hole in the blood vessel by forming a patch (clot) made of platelets, red blood cells and fibrin fibers (see Figure 42.19). If the clot remains attached to the side of the blood vessel it is called a **Thrombus**. If it breaks loose, and circulates in the blood it is called an **Embolus**. An embolus circulating in the blood can be dangerous, because it may lodge in an artery or arteriole, and block blood flow to some part of the body. When this happens it is called an **Embolism**.

**Protein Constituents of Blood**: The three main types of proteins present in blood are **Albumin** (involved in regulating Oncotic Pressure), **Fibrinogen** (involved in blood clotting, and sealing holes in broken blood vessels), and the **Immunoglobulins** (antibodies involved in the immune system).

**Synthesis of Blood**: The **kidneys** are able to sense how much oxygen is being carried by blood. If the concentration of oxygen is too low, the kidneys will send out a protein signal (a cytokine) telling the body that it needs to produce more erythrocytes. Kidneys will produce a cytokine called **Erythropoietin** (abbreviated **Epo**) that is sent out into the blood stream. Epo then makes its way to the bone marrow where **Hematopoietic Stem Cells** (often referred to simply as ‘stem cells’) are located. Bone marrow stem cells have the ability to develop into any type of blood cell if given the correct cytokine signal. Epo signals them to develop into (or ‘differentiate into’) erythrocytes. Erythrocytes are dead cells (at least in mammals), and will not circulate in the blood indefinitely. They circulate for about **120 days** before they are broken down in the **Spleen**. **Macrophages** in the spleen will break down erythrocytes when they sense that their membranes are damaged, rough, or irregular. This is important, because certain types of blood diseases cause the plasma membranes of erythrocytes to be rough or irregularly shaped to begin with. Such cells are prematurely broken down in the spleen, leading to a lack of red blood cells. A lack of red blood cells is a condition known as **Anemia**.

**Blood Type and Blood Transfusion**: Erythrocytes have special glycoproteins on their surfaces. There are two types of glycoproteins, designated **Type A** and **Type B**. Which type you have is determined by which genes you have. There is a gene that codes for each. Because humans are diploid (having two copies of each gene) it is possible for you to have both A and B. Furthermore, there is a non-functioning allele of the gene which does not produce a protein. This allele is referred to as the **Type O** allele. Thus, six blood genotypes are possible: **AA, BB, AB, AO, BO** and **OO**.

Your immune system will not attack proteins that you were born with, but if your immune system sees a ‘foreign’ protein, it will attack it with antibodies. If you were born with the genotype AA or AO, your immune system will recognize the Type B glycoprotein as a foreign protein and attack it. The reverse is true if you were born with BB or BO, and your immune system will attack blood cells with the Type A glycoprotein. If you were born with the OO genotype, your immune system will recognize blood cells displaying either the A or the B glycoprotein as foreign, and attack them. Thus, when you get a transfusion, you must first determine your blood type so that it can be matched with the blood type of a donor. **People with**
genotype AA and AO are classified as Type A, people with genotype BB and BO are classified as Type B, people with genotype AB are classified as Type AB, and people with genotype OO are classified as Type O.

Because a Type O person has neither the A nor the B glycoprotein, they will perceive either the A or the B glycoproteins as foreign, and can only accept blood from another Type O donor. They cannot accept blood from a Type A, Type B, or a Type AB donor. About 50% of the world’s population is Type O. A Type A person can only accept blood from a Type A or a Type O donor, a Type B person can only accept blood from a Type B or a Type O donor; and a Type AB person can accept blood from either a Type A, Type B, Type AB or Type O donor. Because a Type AB person can accept blood from any donor, they are called a ‘universal acceptor.’ Because a Type O person can donate blood to anyone, they are called a ‘universal donor.’

VI Cardiovascular and Blood Diseases

Aneurysm: When the connective tissue surrounding an artery weakens or rips, and the smooth muscle bulges outwards. If the bulge bursts, it can be lethal, especially if the artery is located in the brain.

Dissecting Aneurysm: When a hole forms in the arterial endothelium, allowing blood to get between the endothelium and the smooth muscle, or the smooth muscle and the outer layer of connective tissue.

Edema: Too much fluid in the interstitial spaces, leading to swelling.

Emboli: when a blood clot (a thrombus) forms in a blood vessel, then breaks loose (becomes an embolus), lodges in an artery or arteriole, blocking blood flow to some part of the body. If blood flow is blocked, it will cause the part of the body downstream of the blockage to be starved for oxygen (this is called ischemia). If the oxygen starvation leads to tissue death (necrosis) the area of dead tissue is called an infarction. (Based on this, what do you think a ‘myocardial infarction’ is?)

Three Types of Anemia: For the Lab Exam, you will be required to learn how to differentiate normal blood from anemic blood, and to differentiate between three types of anemia (there are actually many types of anemia, but you are only required to differentiate three types for this course):

1. Iron Deficiency Anemia: People with Iron Deficiency Anemia do not have enough iron to make proper hemoglobin. As a result, fewer erythrocytes are made, and those that are made are thinner because they are carrying less hemoglobin. Regular erythrocytes look like they have a ‘hole’ in the middle (called a ‘central pallor’) because they are ‘biconcave’ shaped. In normal erythrocytes this central pallor takes up about one third to one half of the cell. In Iron Deficiency Anemia, the central pallor takes up most of the cell.

2. Sickle Cell Anemia: Is a genetic disease where there is a mutation in the hemoglobin molecule. The resulting mutant hemoglobin protein has a habit of precipitating
(becoming a solid) under low oxygen conditions. Oxygen is often low in veins and capillary beds, causing the hemoglobin to precipitate, and the cells to collapse, forming a crescent or sickle shape. Because they are irregularly shaped, they are broken down in the spleen, resulting in anemia.

3. **Spherocytosis:** Is a genetic mutation in the cell membrane, causing the cells to have a weaker cell membrane than usual. Too much water is also able to enter the cell, causing them to be spherical shaped, rather than biconcave. Such cells have no central pallor (no ‘hole’ in the middle). Because of their increased fragility they tend to be broken down more easily in the spleen, resulting in anemia.

**PRACTICE QUESTIONS**

**Short Answer Questions:**

1. What term is used to describe the deliberate narrowing of arteries by contracting the smooth muscle that surrounds them?
2. What term is used to describe the deliberate widening of arteries by relaxing the smooth muscle that surrounds them?
3. What is the general term used to describe the widening of a hole or vessel?
4. List three things that can determine blood pressure (3 points).
5. What is the name of the type of blood vessel that is designed for gas and nutrient exchange through diffusion?
6. What do you call the spaces in between cells, which are often filled with fluid?
7. What do you call blood vessels that take blood away from the heart?
8. What do you call blood vessels that take blood back to the heart?
9. What do you call the vessels that carry lymph?
10. Lymph is a fluid that is originally derived from blood plasma. Where does the lymphatic system empty lymph back into the blood stream?
11. What is normal blood pressure (systolic pressure over diastolic pressure) in mm of Hg (mercury)?
12. Name for the arteries that supply blood to the heart?
13. Name for the arteries that supply blood to the head after branching off from the Brachiocephalic Arteries?
14. Name for the veins that return blood from the head before reaching the Subclavian Veins?
15. Name for the arteries that supply blood to the arm?
16. Name for the network of veins that transfers blood (containing nutrients) from the small intestine to the liver?
17. Name for the large vein that returns blood directly to the heart from both the arms and head, and connects directly with the right atrium?
18. Name for the large vein that returns blood directly to the heart from the lower body, and empties directly into the right atrium?
19. Name for the liquid part of blood?
20. What are the three main protein constituents of blood? (3 points)
21. Of the cells that make up the solid portion of blood, approximately what percentage are red blood cells vs. white blood cells?
22. What is the name for the cell fragments that circulate in blood, and patch holes in blood vessels?
23. What is the term used to describe a lack of erythrocytes?
24. What term is used to describe a lack of erythrocytes, and the production of abnormally thin erythrocytes as a result of lack of iron?
25. What is the cytokine signal sent by kidneys to the bone marrow, telling the bone marrow stem cells to produce more erythrocytes? (You can use the abbreviation)
26. In which organ are old, worn out erythrocytes broken down?
27. Would you expect the Hematocrit to be higher or lower in a person who has Sickle Cell Anemia than in a healthy person?
28. Would you expect the Hematocrit to be higher in a woman who has just had her menstrual period, or in a woman who is about to have her menstrual period?
29. Name of the enzyme that converts inactive fibrinogen to active fibrin.
30. Name of the protein that plugs holes in blood vessels. (List both the active and inactive forms. 2 points)

Define the following terms:
1. Vasodilation
2. Vasoconstriction
3. Diastolic Pressure
4. Systolic Pressure
5. Oncotic Pressure (5 points)
6. Hydrostatic Pressure

Essay Questions:
1. Describe what oncotic pressure and hydrostatic pressure are (as they relate to blood), how they are regulated, and how the interplay between them regulates how much fluid is retained in the interstitial spaces of the body. (20 points)
2. Describe how serum albumin is involved in the regulation of how much fluid is retained in the interstitial spaces and soft tissues of the body. (20 points)
3. List two structural differences between arteries and veins. (10 points)
4. What do platelets do, and how do they do it? (10 points)
5. Describe what an embolism is, how it forms, and what consequences it may have. (20 points)
6. Explain how the ABO Blood Typing system works, and who can donate blood to whom. (20 points)
7. Explain what a Myocardial Infarction is and what causes it. (20 points)
8. What is a dissecting aneurysm? (10 points)
9. Describe the life cycle of an erythrocyte, beginning with the role of the kidneys. (20 points)
### Extended Matching: Match the term to the definitions.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>A. Albumin</td>
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<td>B. Aneurism</td>
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<td>C. Brachial</td>
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<td>W. Subclavian</td>
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<td>X. Thrombin</td>
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<td>Y. Vasoconstriction</td>
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<tr>
<td>Z. Vasodilation</td>
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1. ("____ Pressure") Another term for blood pressure, and its specific effect on the amount of plasma that can leak out of capillary beds into interstitial spaces.
2. Name for the arteries that cross the collar bone and shoulders.
3. Technical term for the ‘collar bone.’
4. An enzyme that converts fibrinogen into fibrin.
5. A cell fragment (originating from a Megakaryocyte) that is involved in blood clotting, and repair of damaged blood vessels.
6. Cytokine sent out by the kidneys to the hematopoietic stem cells in the bone marrow to tell them to make more erythrocytes.
7. The soluble, inactive form of a protein that is involved in blood clotting, and the repair of damaged blood vessels.
8. Name for the arteries that supply blood to the head after branching off from the brachiocephalic artery.
9. Term referring to the arms.
10. The active, insoluble form of a protein involved in blood clotting and the repair of damaged blood vessels.
11. Name for the arteries that supply blood to the heart.
12. Refers to blockage of a blood vessel by a mobile blood clot, leading to the tissues that the vessel supplies being deprived of oxygen.
13. A tear in the outer lining of a blood vessel, leading to a bulging and weakening of the vessel.
14. Term referring to a thrombus that has broken loose.
15. Term referring to the head.
16. Term referring to the percentage volume of blood cells in blood.
17. Refers to retention of excess fluid in the interstitial spaces and soft tissues of the body.
18. An inflatable cuff used to measure blood pressure.
19. A loose blood clot.
20. Name for the sounds made by the brachial artery when measuring blood pressure.
   (Named after a Russian physician of that name.)
21. Excess retention of fluid in interstitial spaces and soft tissues of the body.
22. The main protein involved in regulation of oncotic pressure in blood.
23. Widening of blood vessels.
24. Special name for the type of epithelium that lines the inside of blood vessels (essentially the same as squamous epithelial cells).
25. A blood protein used to regulate the amount of water that goes into or out of capillary beds.
27. (“______ pressure”) Type of pressure that is based on protein concentration in the blood, and determines how much fluid will be stored in interstitial spaces.

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