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THE UNEVOLVABLE CIRCULATORY SYSTEM

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INTRODUCTION

The circulatory system performs many different functions just below the skin. Not only is it responsible for carrying oxygen to all of the cells that compose the body, but it also delivers nutrients, which the body uses to produce heat and energy. Additionally, the vascular system acts as a delivery system for hormones, carrying these biological compounds to specific target organs. Another process the circulatory system performs is collecting metabolic waste and delivering it to excretory organs. Lastly, we now know that the circulatory system plays a critical protective role by combating infections and helping to establish an immune system defense. The existence of these complex multiple functions points **away from** an evolutionary accident of random chance, and points **toward** an overall body-plan that was conceived by an omniscient Creator.

Evolutionists would suggest that this multifaceted system evolved as a result of animals no longer being able to diffuse water and nutrients. We know today that animals like the flatworm (class *Tubellaria*) exhibit no circulatory system, but rather are able to obtain nutrients, water, and oxygen by diffusion. Evolutionists contend that as animals became more complex, a transport system was needed. This "need" indicates an active selective process, and yet scientists recognize that mutations and natural selection (the two "pillars" of evolutionary change) are unable to **add** information or material. So exactly how did this vascular system come into existence?

There are two types of circulatory systems in existence today: open and closed. Evolutionists maintain that the open circulatory system eventually gave rise to the predominant closed system. The **open** circulatory system can be found in arthropods and most mollusks and contains no capillaries or veins. In open circulatory systems a heart pumps blood (more properly called hemolymph) through arteries and into spaces around the organs. This close proximity allows tissues to exchange materials with the hemolymph, which is then drawn back into the heart as it relaxes. However, we now know that even this open system is complex. As Brian McMahon noted: "Despite their apparently simple morphology, recent work in my laboratory has shown hemolymph circulation in these animals (brine shrimp—BH) to be **relatively complex**, with hemolymph flow following **highly organized, specific circuits**, both within each segment and within the body generally" (2001, 204:923, emp. added). McMahon went on to declare: "we find no evidence to support the original description of crustacean circulatory systems that suggested sluggish and random movement of hemolymph through tissues" (p. 924). If something is found not to be random, then it must therefore be purposeful—and purposeful movement reflects design. In discussing the open system, McMahon concluded: "These morphologically simple blood vascular systems therefore are of high functional efficiency and have all the functional features of the most complex systems, differing only in the complexity of the arterial distribution system" (p. 926). And that is supposed to be the "simple" system! Vertebrates, annelids (e.g., earthworms), and cephalopods (e.g., squids and octopuses) use a **closed** circulatory system. Blood within a closed system never leaves the arteries, capillaries, and veins. This is a pressurized system that depends on multiple arteries and veins.

A simplistic approach maintains that once animals could no longer utilize diffusion they "evolved" an open circulatory system, which then "evolved" into a closed system. This "simple-to-complex" response for the existence of the circulatory sys-

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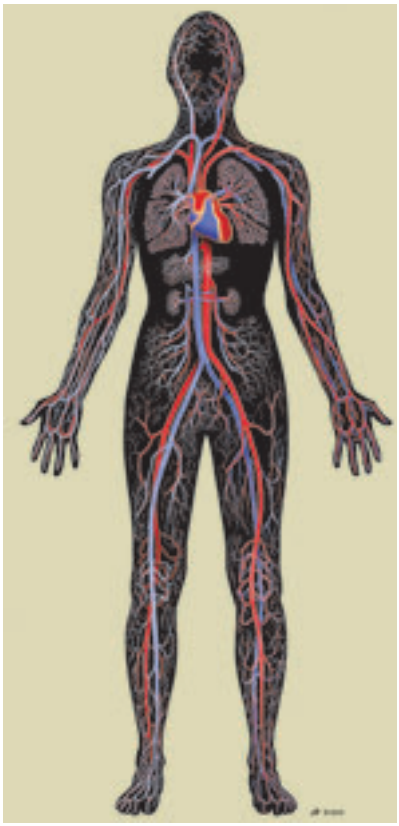
tem may seem logical—at first glance. But a closer inspection reveals that the vascular system depends on too many complex components, a perfectly balanced chemical composition, irreducibly complex constituents, a meticulously maintained feedback mechanism, and a purposeful arrangement. Consider that even organs that play an active role in the circulatory system—such as the heart that is responsible for pumping blood, or the endocrine system that secretes hormones and salts into the vascular system—are themselves dependent on oxygenated blood. While the heart serves as a "pump" to deliver blood throughout the body, it also requires oxygenated blood in order to remain healthy. Or consider that the production of red blood cells, one of the major constituents within the vascular system, is regulated by erythropoietin—a hormone produced in the kidney. Yet that kidney requires red blood cells to deliver oxygenated blood. So which evolved first? Did the red blood cells produce in lethal quantities until a kidney had evolved the ability to produce erythropoietin, or did the hormone exist before the production of these red blood cells? The human circulatory system is far more than a series of evolutionary steps that evolved to increase gas and nutrient transport efficiency. A close examination of this complex network reveals architectural planning and design that can only be comprehended in light of an intelligent Designer. Our extensive knowledge of the human circulatory system is tremendous evidence of the existence of Almighty God.

THE WELL-DESIGNED ANATOMY OF THE HUMAN CIRCULATORY SYSTEM

In humans, the circulatory system is comprised of blood, the vascular system, including the lymphatic drainage system [NOTE: the lymphatic system will be covered with a detailed examination of the immune system in a future issue of *Reason & Revelation*], and the heart (Netter, 1994; Moore, 1992). When a human is at rest, the heart propels about five liters of blood through the body each minute. In order to carry out all of its complex functions, the circulatory system relies on an estimated 60,000 miles of vessels (Van de Graaff and Fox, 1989, p. 615). Can the evolutionary theory sufficiently explain the existence of these components?

The Heart

The central hub of the circulatory system is the "pump" or heart which is roughly the size of a clenched fist and averages only 280-340 grams in men and 230-280 grams in women (Williams, et al., 1989, p. 460). It has been estimated that the heart contracts "some 42 million times and ejects 700,000 gallons of blood during a year (Van de Graaff and Fox, p. 619). Marcos Simões-Costa and his colleagues defined the anatomy of the heart as "chambered circulatory pumps" (2005, 277:2). They went on to note that vertebrate hearts "are endowed with an additional level of **mechanical sophistication** that **markedly improved** circulatory efficiency" (277:3, emp. added). From whence did this "mechanical sophistication" and "marked improvement" originate?



Humans possess a four-chambered heart that acts as a double-cyclic pump (Van de Graaff and Fox, p. 615). Of the four chambers, the left atria and left ventricle are responsible for pumping oxygenated blood throughout the body. The right atria and right ventricle pump deoxygenated blood to the lungs. Anatomists often refer to this separate action as a "double" circulatory system which consists of two separate but connected divisions: the pulmonary circulatory system and the systemic circulatory system. The pulmonary circulation carries deoxygenated blood to the lungs, where it releases carbon dioxide and uptakes oxygen from the air. The systemic circulatory system supplies the body with oxygenated blood and nutrients, and carries away waste and carbon dioxide.

The presence of the heart in the circulatory system poses an irreducibly complex problem for evolutionists. In order for the circulatory system to function properly at least five things must be present: (1) a respiratory organ (lungs or gills) that can enrich the blood with oxygen; (2) hemoglobin or hemophlegm to bind the oxygen; (3) red blood cells to carry the hemoglobin to cells throughout the body; (4) blood vessels to transport the red blood cells; and (5) a pumping mechanism (heart) that can transport oxygenated material throughout the body. How functional would each of these be without all com-

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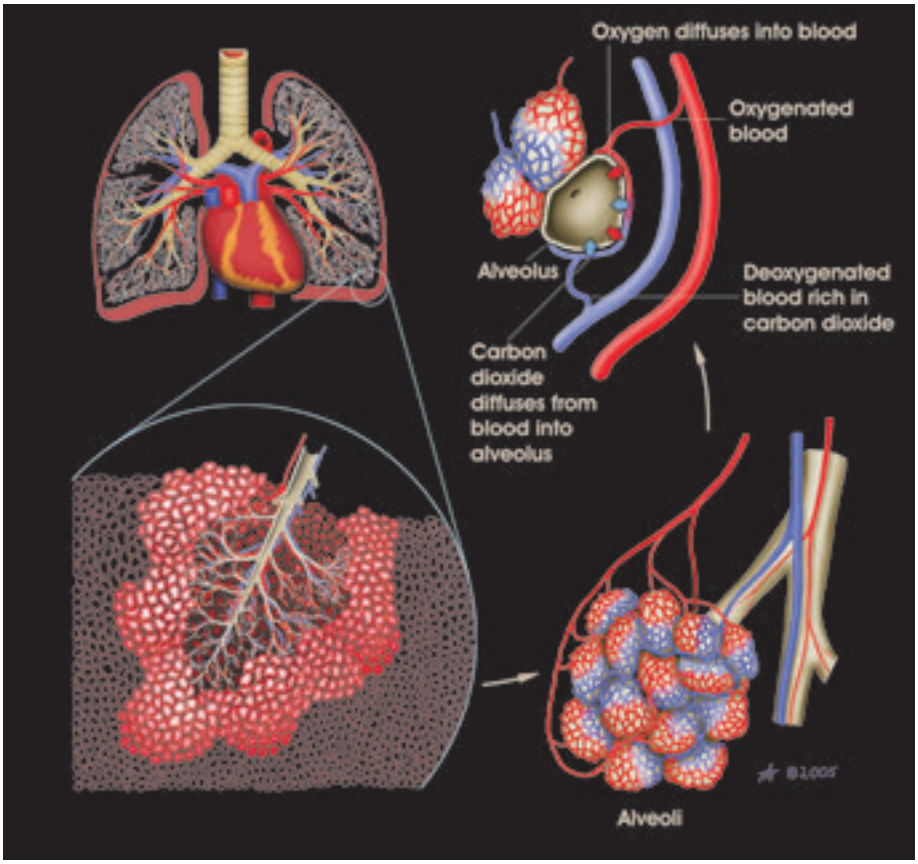
ponents present? What good are respiratory organs if the oxygen cannot be bound to hemoglobin? What good are vessels without a pump? What good is hemoglobin if it cannot be carried to all parts of the cell? Any step-by-step scenario evolutionists propose would immediately cause this entire system to be ineffective.

A closer look at the complex anatomy reveals the **impossibility** of evolving specific parts of the circulatory system in a step-by-step fashion. For instance, evolving heart chambers is not as simple as developing another heart compartment over millions of years. Most fish possess a two-chambered heart that draws deoxygenated blood into a single atrium and then pumps it out of a single ventricle towards the gills. Once the oxygenated blood leaves the gills it then makes its way to capillaries and back to the two-chambered heart. This is commonly referred to as **single circulation**. To shift to a **double circulation** circuit would require the animal to have evolved a pathway from the heart to the lungs and then back to the heart to be pumped out to the body—an irreducibly complex system. Consider that the hagfish (family *Myxinidae*) possesses a three-chambered heart (see Randall, 1968; Kardong, 2002; Pough, et al., 2002). Lampreys, jawless vertebrates that prey on other fish, possess four chambers (Fange, 1972, 2:287-306). Most amphibians and reptiles possess a three-chambered heart. However, crocodiles possess four chambers and varanid lizards are reported to have five chambers—two atria and three ventricles (see Burggren, 1988). Five chambers!? These differences mean evolutionists are unable to demonstrate a neat linear progression that corresponds to their evolutionary tree of life.

With additional heart chambers comes the possibility of blood being forced backwards into the wrong chamber. We know today that separating each chamber is a complex system of valves (see Netter, 1994, pp. 210-211) that prevent back-flow as the heart contracts. But how did these valves arise? Did they evolve simultaneously with the advent of new chambers? Additionally, from what material did they originate? Consider that these valves must be rigid enough to restrict blood flow backwards, but they must also be flexible enough to collapse and allow blood to flow freely without clotting. The two-cusped mitral valve separates the left atrium from the left ventricle. The right atrioventricular (or tricuspid) valve separates the right atrium from the right ventricle. These valves are controlled by fibrous threads known as *chorda tendineae* (Moore, 1992, p. 94). At the end of each *chordae tendinae* are small papillary muscles. Is it logical to assume that these papillary muscles evolved intricate attachments to these fibrous threads, all the while evolving a separate and distinct nervous innervation that would allow for the synchronized propulsion of blood through the heart? Additionally, balloon-shaped semilunar valves are positioned at the top of each ventricle, preventing blood from seeping back into the heart. How long would it take to "evolve" a cusp, and how beneficial is a half-cusp?



Assuming for just a moment that heart chambers could be duplicated in a creature, consider the number of anatomical changes that would be required to go from single circulation to double circulation. With a two-chambered heart the vessel leaving the heart contains primarily deoxygenated blood that travels toward the gills to be oxygenated and then on throughout the body. Evolving "up" to a three or four-chambered heart would necessitate the addition of a new vessel that carries deoxygenated blood to the lungs or gills, and then a new vessel to return that oxygenated blood back to the heart. The heart would then need to be re-piped so that it could efficiently pump oxygenated blood throughout the body, thus requiring increased blood pressure. These irreducibly complex steps negate any chance of the heart evolving through some Darwinian step-by-step process.

Furthermore, evolutionists must explain how the heart and vessels came to be so well laid out within the human body—how the heart came to be protected by a bony cage, and how the vessels are able to navigate around bones. Are we to believe that this was simply a "trial-and-error" experiment of nature over millions of years?

Consider the explanation Muster, et al., give for why mammals possess only a left-sided aorta. They noted:

> At some point during vertebrate evolution from species dwelling in water to living on land, the ancestral double or right aortic arches became single and left-sided in mammals, including humans, as the result of synchronous developments in cardiovascular and respiratory embryogenesis.... **Due to natural selection, and survival of the fittest**, the left-sided arch became the norm in mammals (2001, 11: 111, emp. added).

How do we explain the complexity and design of the circulatory system? Just chalk it-up to "natural selection" and "survival of the fittest." That explanation does little to suggest how that aorta or heart arose in the first place!

If "natural selection" were able to explain the existence of a chambered heart

(and the progression from two to four chambers), then it must also give an indication of the origin and evolution of the nerve innervation responsible for heart contractions—especially in light of going from a two-chambered heart to a double, self-adjusting, four-chambered pump. The human heart possesses a sinuatrial node (SA node) in the wall of the right atrium that initiates the impulses for contraction. The SA node has often been called the "pacemaker of the heart" (Moore, 1992, p. 104; Van de Graaff and Fox, 1989, p. 627). There is also an atrioventricular node (AV node) located in the "interatrial septum on the ventricular side of the orifice of the coronary sinus" (Moore, p. 104). As Moore explained: "Impulses from the cardiac muscle fibers of both atria converge on the AV node, which distributes them to the ventricles via the atrioventricular bundle" (p. 104). This does not sound like the description of an organ that was formed simply by time and chance. How did these specialized cardiac muscle fibers evolve into a complex conducting system for a four-chambered heart?

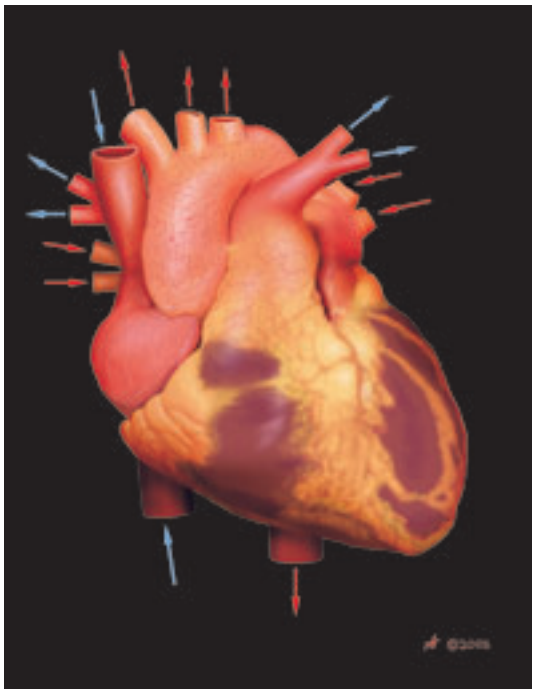
While we have uncovered some of the anatomy involved in heart contractions, evolutionists still struggle with where that heart beat originated. As Hertel and Pass admitted: "The origin of the rhythmical heart beat is one of the central questions in cardiac physiology" (2002, 133:559). They went on to point out:

> For a myogenic trigger of heart beat rhythm, **two essential physiological prerequisites are necessary**: (1) the presence of a pacemaker that is either concentrated in a pacemaker center on a part of the muscle or an inherent character of all muscle cells. (2) The electrical coupling of all muscle cells with each other via low ohm junctions (133:559, emp. added).

To put this in perspective, evolutionary scientists do not know where the heart beat originated, but they recognize that at least two "essential physiological prerequisites are necessary to trigger heart beat rhythms." They have not identified the transitional animal that evolved from a two-chambered to a three-chambered heart, but they insist that was the progression. These evolutionists do not know how the nerves continuously (and simultaneously) contract the heart and coordinate the opening and closing of the cusps (or the origin of the cusps), but they know this occurs without fail thousands of times each day. Yet, such scientists are 100% sure that this entire system evolved. Does that seem logical?

Even simpler creatures pose serious questions for evolutionists. Marcos Simões-Costa and his colleagues noted: "We observe a **striking discontinuity between the blueprints** of pumps in hemichordates (e.g., acorn worms—BH), urochordates (e.g., tunicates and sea squirts—BH), cephalochordates (e.g., amphioxous or lancelets—BH), and those of vertebrate hearts. Particularly impressive is the apparent **abrupt appearance** of four-chambered hearts in hagfishes and lampreys" (2005, 277:3, emp. added). A "striking discontinuity between the blueprints" and the "abrupt appearance" of a four-chambered heart does little to support an evolutionary explanation for the origin of the circulatory system.

Simões-Costa, et al., lamented:



> **However, it is difficult to envision how the sophisticated, pericardially enclosed pump of urochordates is a predecessor for the simpler, nonstriated contractile vessels of amphioxus** (2005, 277:7, emp. added).

Sophisticated indeed! Consider for just a moment our attempts at engineering an artificial human heart. Dr. William DeVries implanted the first Jarvik-7. By the late 1980s, surgeons at 16 centers, including the Texas Heart Institute, had implanted more than 70 Jarvik-7 devices in patients as a bridge to transplantation. While they were hemodynamically stable, patients implanted with the Jarvik-7 did suffer from many complications (hemorrhage, stroke, sepsis, etc.). Additionally, they were forced to live a restricted lifestyle with little autonomy apart from the external console. In 2001, the AbioCor™ Implantable Replacement Heart was introduced (see Abiomed, 2005). This latest attempt is made of plastic and titanium and, weighing less than two pounds, is powered through the skin by an external battery pack. On October 12, 2000, the Abiomed Company that produces the AbioCor™ artificial heart announced that it had received a $1.8 million federal contract. That same year, the company's employee base was expanded to more than 200, and it completed a $96 million public offering on the stock market.

With the millions of dollars used to produce this new heart, and the countless hours of research and development that was required, one would expect that this artificial heart was nothing less than a state-of-the-art wonder! A lab full of highly specialized technicians and physicians would seem to ensure success. However, the first patient to receive an AbioCor™ heart lived only 151 days. The individual that received the fourth implant, who according to his (and his family's) wishes, never has been identified to the public, survived only 56 days. How is that? Is not the human heart just another product of evolution? It seems as though creating something that merely evolved over time would not be all that difficult (after all, we can put water fountains in skyscrapers). And yet millions of dollars, hundreds of highly educated researchers, and countless hours of work can extend life only a hundred days or so?

The Vascular System—Blood Vessels

The vascular system of the human body is also dependent on a tubular network that courses throughout the body. Evolutionists are faced with not only explaining the mere existence of vessels, but they must also give a logical account for the existence of multiple types. There are three types of arteries which carry blood away from the heart: arterioles, muscular arteries, and elastic arteries (Moore, 1992, p. 23). Arterioles are the smallest with a narrow lumen, and they possess thick muscular walls. Muscular arteries are chiefly responsible for distributing oxygenated blood to various parts of the body. The walls of these vessels are primarily composed of smooth muscle which allows the arteries to contract, constricting blood flow to certain areas (e.g., dilating vessels to the digestive system and constricting vessels to the extremities following a big meal). Elastic arteries are the largest types of arteries in the

body, and their walls consist of elastin, which helps prevent distal shear stress and prevents damage as blood under high pressure is forced out of the heart (Moore, p. 23). Are we to assume that elastin co-evolved with arteries? French molecular biologist Gilles Faury suggested:

> To achieve this goal, networks of resilient and stiff proteins adapted to each situation—i.e. low or high blood pressure—have been developed in the arterial wall to provide it with nonlinear elasticity.... In vertebrate development, elastin is incorporated in elastic fibers, on a earlier deposited scaffold of microfibrils. The elastic fibers are then arranged in functional concentric elastic lamellae and, with the smooth muscle cells, lamellar units (2001, p. 310).

Does Faury give any indication of how this "adaptation" took place? Not even a hint. Thus, we are left with yet another "just-so" story of how elastin became incorporated into vascular arteries.

Veins, on the other hand, take blood from the capillary beds and return it to the heart. Small veins are often referred to as venules. Veins do not possess strong muscular walls, but instead have been designed with a valve system that prevents the backflow of blood. The *Oxford Companion to the Body* records: "Veins possess valves and many run deeply in the limbs, surrounded by muscles.... When the muscle contracts the veins are compressed, so blood is forced along them. The valves ensure that blood can only move toward the heart" (Blakemore and Jennett, 2001, p. 88). How did natural selection produce valves in the venous system but not the arterial?

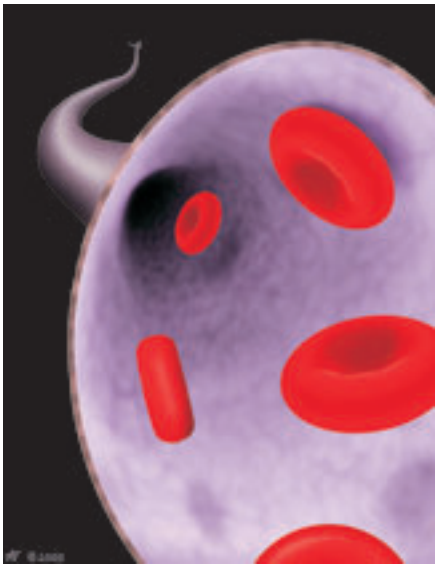
Capillaries can be described as tiny vessels that connect arteries and veins. It is here that we find the complex exchange of blood gases and dissolved molecules. Arteries deliver blood to literally billions of capillaries, which provide a total surface area of 1,000 square miles (Van de Graaff and Fox, 1989, p. 653). This extensive branching is supported by the fact that all tissue cells are located within a distance of only 60-80µm of a capillary. Commenting on this massive engineering feat, Wayne Jackson observed:

> If all of the body's pipelines were connected end-to-end, it is estimated that it would stretch out from between 60,000 to 100,000 miles. The system is "so efficient" that the entire process of circulation, "during which every cell in the body is serviced, takes only a total of 20 seconds." Would any rational person deny that a major city's pipeline system was carefully designed? Hardly (2000, p. 47).

Hardly indeed!

The Blood

In order to perform the functions of (1) transportation, (2) regulation, and (3) protection, the circulatory system relies on several key components. All of these components can be found in the fluid that travels within these living tubules—blood. Commenting on the remarkable properties of this fluid, Bruce Alberts and his colleagues noted: "Blood contains many types of cells with very different functions, ranging from the transport of oxygen to the production of antibodies. Some of these cells function entirely within the vascular system, while others use the vascular system only as a means of transport and perform their function elsewhere (1994, p. 1161).



The total volume of blood represents only 8% of the total weight of a human (Van de Graaff and Fox, p. 655). Ironically, it is classified as a tissue, but it is one of the few substances in the human body that is not "fixed" in place. Tissues such as nerves, muscles, and organs have a specific function and are limited in movement. Blood, however, is not limited to any one part of the body. This ability to move allows blood to provide these "fixed" tissues with nourishment and then carry off waste products. Blood itself is composed of a cellular portion referred to as **formed elements**, and a fluid portion designated as **plasma**. The formed elements constitute approximately 45% of the total volume of blood (Van de Graaff and Fox, p. 655) and are comprised of erythrocytes (red blood cells), leukocytes (white blood cells), and platelets. Plasma is a straw-colored liquid that consists primarily of water and dissolved solutes. Approximately 89% of plasma is water, 9% is protein material (e.g., albumins), 0.9% is salts, and 0.9% is sugar, urea, etc.

In considering whether the circulatory system could be the product of evolution, one must consider that the acidity of blood is critical to survival. Key salts provide basic ions, such as sodium, potassium, phosphate, and magnesium that help maintain a steady pH value for the blood. These bicarbonate ions remove carbon dioxide from the tissues and help maintain a slightly alkaline pH of 7.4. During traumatic injuries or surgeries, a great deal of attention is given to the pH of the blood since a significant decrease or loss of this alkalinity can cause rapid and violent breathing, with death likely to occur at a pH of 7.0 or below. Conversely, if the pH of the blood is allowed to go beyond 7.6, it also can prove fatal. The *Lange* medical book on "Fluid and Electrolytes" records: "The control of blood pH is critically important since modest swings—e.g., 0.10-0.20 pH unit in either direction—can cause symptoms referable to impaired cardiopulmonary performance and neurologic function. More extreme pH changes can be fatal" (see Cogan, 1991, p. 175). This narrow, "unforgiving" pH range would not be expected if blood were the product of millions of years of evolution. If blood were the product of evolution and millions of years of random change, one would expect nature to have selected for a fluid that was not dependent on such a critical pH level—especially since slight pH variations can prove fatal!

The salinity in our blood stream has made some evolutionists speculate that this is evidence we evolved out of the sea. For instance, Robert Lehrman noted:

> One human characteristic, a chemical one, harks back to our ancestry in the ocean.... The percentage of sodium, potassium, calcium, magnesium, iodine, chlorine, and other minerals in human blood salt coincide with those of sea water. Our ocean-living ancestors developed cells adapted to the chemical environment of sea water. When they left the ocean, they took a part of the environment with them in the form of a fluid that bathes the cells; later it was incorporated into the blood stream (as quoted in Batten, 1997, p. 24).

However, on average, the concentration of sodium chloride (salt) in sea water is 2.7% higher than we find in the human blood stream (additionally, the sea contains 0.8% other salts, some of which are not present

in blood and would not benefit the cardiovascular system). Creationist Don Batten carried out an extensive comparison demonstrating the actual percentages of salts and minerals found in human blood and seawater. He noted that there is little similarity between human blood and seawater and reported that "even the blood of sea creatures such as crabs is quite different from seawater" (1997, p. 24). If evolutionists took the time to do the math, they would find that the Baltic Sea—one of the "fresher" large bodies of water—still is much too salty to have played any physiological part in the production of blood.

Erythrocytes (also known as red blood cells) are the most common of the formed elements. Adult humans have approximately 2-3 x 10^{13} red blood cells at any given time (see Wikipedia, n.d.). These cells provide oxygen to tissues, and assist in the disposal of carbon dioxide. In humans, red blood cells are devoid of nuclei (i.e., they are anucleated) and intracellular organelles, while birds, amphibians, and other animals have red blood cells that are nucleated. This key difference should not be overlooked in light of our alleged evolutionary origins. All cells require a nucleus for replication and maturation. Even red blood cells have a nucleus during their very early stages of development. However, in humans, the production of red blood cells occurs in the bone marrow, and thus we do not normally see these nucleated cells in the circulation (although they occasionally are found in newborns). An obvious question is: How did humans "evolve" cells that would mature without a nucleus? And furthermore, why would nature select for this? By losing their nuclei, these cells are unable to replicate like other cells within the body. The body is dependent on pluripotent stem cells within bone marrow for future erythrocyte production. With a lifespan of only 120 days and no nuclei, they must be constantly produced in order to carry oxygen throughout the body. Each second about 2.5 million new erythrocytes are produced or about 200 billion each day (see "Cardiovascular System," 2004)! Some animals produce these cells intravascularly (i.e., in the blood stream), whereas humans and other animals produce them extravascularly (in the bone marrow or other hematopoietic tissue). Additionally, this loss of cellular organelles means that these cells are unable to produce energy, and thus, they must get energy from anaerobic respiration. Anaerobic respiration in red blood cells is a complex cascade of events that puts even more impossible explanatory demands on evolutionists.

Red blood cells are formed by a process known as erythropiesis. It takes approximately seven days for these cells to develop, and then they are released into the blood stream. Old red blood cells are "engulfed by phagocytes, destroyed and their materials are released in the blood. The main sites of destruction are the liver and spleen" (see Wikipedia, n.d.). During their lifetime these specialized cells travel

> over 100 miles, are buffeted at high velocities during their passage through the heart, and have to negotiate tiny capillaries.... As they age, subtle structural changes occur which render them identifiable to scavenger cells in the spleen and elsewhere, and they end their days being devoured and digested by these predators (Blakemore and Jennett, 2001, p. 85).

However, this process must be orchestrated or else the individual will suffer from having too many or insufficient numbers of red blood cells in the blood stream. Consider the fate of an individual unable to break-down aged red blood cells, or someone who is unable to produce replacements. How did this feed-back mechanism arise? Blakemore and Jennett observed:

> Their rate of production is **beautifully adapted** to this function. It is regulated by a hormone called erythropoietin, produced in the kidney in the adult and in the liver in the fetus. Close to the gene that regulates erythropoietin production are regions of DNA that sense oxygen tension; when this falls, erythropoietin synthesis is stimulated, and more red cells are produced in the bone marrow. When adequate oxygenation of tissues is achieved, erythropoietin production is reduced. By this biological feedback loop the body is able to respond to varying oxygen demands by modifying the rate of red cell production (2001, p. 85, emp. added).

This system is also irreducibly complex. All of the parts are necessary in order for the feedback mechanism to work properly. So how was this "beautifully adapted" feedback loop able to evolve in a series of evolutionary steps? The truth is that it could not!

As the red blood cell matures and is ready to leave the bone marrow, it expels its nucleus. The reason for anucleated red blood cells in humans is directly related to function—the unique shape and loss of nucleus provides added surface area through which gas can diffuse (Van de Graaff and Fox, 1989, p. 656; Blakemore and Jennett, p. 85). The anucleated biconcave shape increases surface area and allows the cell to remain flexible enough to squeeze through small capillaries. Even an anucleated red blood cell is larger (8μm) than capillaries (2-3μm). However, without the nucleus present, the red blood cell is flexible and able to fold over on itself. For how many "millions of years" was development limited as red blood cells slowly "evolved" the ability to shed their nucleus, develop anaerobic respiration for energy needs, and finally become flexible and able to fold into capillaries? The functional design of the anucleated red blood cell's shape (a biconcave disc) can only be explained by the ultimate Designer.

In addition, red blood cells contain **hemoglobin**, which is responsible for carrying oxygen to every cell in the body. Hemoglobin is a complex protein that has two pairs of chains (referred to as alpha and beta) which bind to the red-pigmented molecule known as heme. As Blakemore and Jennett described: "In most mammals, adult hemoglobin (hemoglobin A) comprises two unlike pairs of chains of amino acids, or globin chains, called α and β, each of which is folded round one iron-containing heme molecule, to which oxygen can bind" (p. 85). This configuration allows hemoglobin to transport four molecules of oxygen. Given the added surface area from the anucleated biconcave disc, each cell would contain "about 280,000,000 molecules of hemoglobin" (see "Cardiovascular System," 2004). What are the odds that this engineering accomplishment happened by random chance? Consider that an evolutionary origin of hemoglobin would require a minimum of 120 mutations to convert an alpha chain to a beta. At least 34 of those changes require changeovers in 2 or 3 nucleotides. Yet, if a single nucleotide change occurred through mutation, the result would ruin the blood and kill the organism. Simply put, evolution cannot explain the existence of hemoglobin molecules in the circulatory system of humans.

Another component of formed elements are **leukocytes** (white blood cells). Unlike red blood cells, leukocytes contain nuclei and mitochondria and can purposefully move in an amoeboid fashion (Van de Graaff and Fox, p. 657). Leukocytes serve as the primary line of defense in the vascular system. There are five different leukocytes present in the blood: neutrophils, eosinophils, basophils, lymphocytes, and monocytes. These cells will be covered in greater detail with the immune system, but the point should not be missed that these specialized cells traverse the circulatory system and are critical to the survival of individuals (e.g., consider immune deficient individuals). Yet, evolutionary theory is unable to explain adequately their origin.

The final formed element found within the blood is **platelets**. Platelets are much smaller than red blood cells, and serve to stop blood loss from wounds (hemostasis). Consider for just a moment the conundrum posed by blood clotting. It is critical that the circulatory system have a means to prevent blood loss when it is damaged, but this process must only occur when needed, and humans cannot afford to have this clot spread to healthy vessels. Not only must a clotting network be available, but also there must be an effective means of terminating the clotting cascade once the vessels have been repaired. In his book *Darwin's Black Box*, biochemist Michael Behe observed:

> When a pressurized blood circulation system is punctured, a clot must form quickly or the animal will bleed to death. If blood congeals at the wrong time or place, though, then the clot may block circulation as it does in heart attacks and strokes. Furthermore, a clot has to stop bleeding all along the length of the cut, sealing it completely. Yet blood clotting must be confined to the cut or the entire blood system of the animal might solidify, killing it. Consequently, the clotting of blood must be tightly controlled so that the clot forms only when and where it is required (2003, pp. 78-79).

Behe then goes into painstaking detail to record the biochemical cascade that must transpire in order for blood clotting to occur. For over fifteen pages he records all of the events that are required in order for this process to occur (see pages 81-97). Figure 4-3 of his book shows a flowchart of the proteins involved in the blood coagulation cascade. Aside from there being dozens of proteins required, many are produced in response to complex feedback loops within the cascade itself. The statistical odds of evolving those specific proteins in just the right manner, in just the right location, and having them available when that first land animal was getting scratched up as it slowly crawled over rocks and shells onto dry land are incalculable! Only God could create such a complex system that can heal itself so precisely.

CONCLUSION

Man's million dollar attempts to create an artificial heart have failed miserably. Yet, we are told to believe the human heart is merely a product of organic evolution? It is impossible to proceed in a Darwinian step-by-step fashion from a two-chambered heart to a three or four-chambered heart. Additionally, in order for the circulatory system to function properly at least five components must be present and functioning—demonstrating irreducible complexity. The frequently used banners of "natural selection" and "survival of the fittest" are insufficient to explain the complexity and design found within the circulatory system. God—the ultimate Author of science—is the only reasonable explanation.

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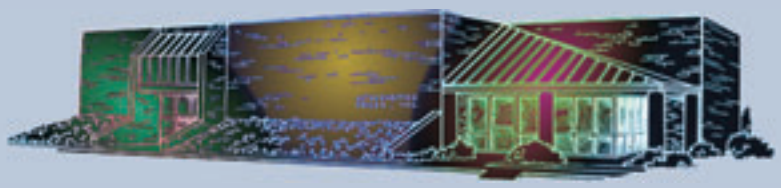

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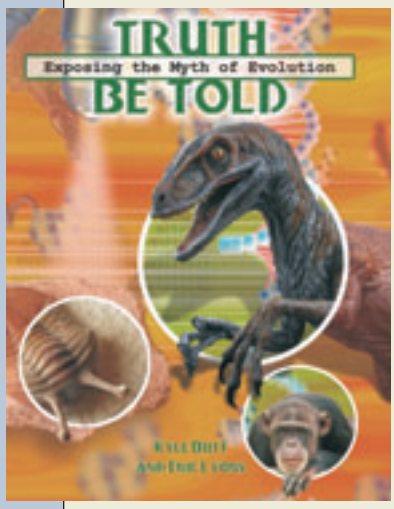

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Sprinkled in among the accurate, solid scientific facts are evolutionary assumptions and unproven assertions. These evolutionary ideas do not always make up the bulk of the textbooks, but they do permeate them in such a way as to contaminate the text for those students who are unprepared to recognize and react to them. Kyle and Eric have spent many hours pouring over the most popular science textbooks to find the most frequently repeated alleged proofs used to promulgate the theory of evolution. The result of this tedious investigation is a monumental compilation and refutation of these false evolutionary ideas.

Truth Be Told is designed and written—not as a comprehensive science textbook—but as a guide for preparing and equipping students to deal with false evolutionary assumptions that riddle the science textbooks to which they are exposed in public school. One church in Tennessee is so convinced of the enormous value of this volume that they pre-purchased 1,000 copies to distribute throughout their county!

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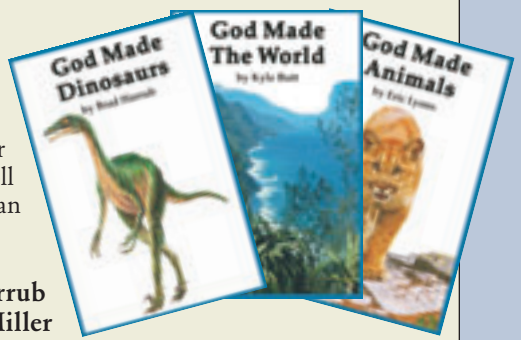

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