http://biomedx.com

Email: sales@biomedx.com
Phone: 1-847-299-0236

BioCellular Analysis is a diagnostic screening method that is able to measure several factors of the internal environment of the body. This environment is often referred to as the “terrain” or “biological terrain”. While other fields of medicine examine, isolate or treat one particular part or system of the body, BioCellular Analysis monitors the entire internal biochemical environment of the body. This complete information gives the physician a baseline to determine the course of treatment, as well as an objective procedure for monitoring the effectiveness of the treatment.

The analysis helps you to uncover the underlying cause or causes of the patient’s imbalance or illness, rather then treating a list of "symptoms". This allows the practitioner to recommend appropriate treatment to help the patient regain and then maintain good health. Changes made at the chemical level can, in time, improve the vitality and health of every cell, tissue, organ, and gland within the body.

The science of BioCellular Analysis is quite rudimentary in that it utilizes fundamental concepts of biochemistry and physiology as it applies to proper health and nutrition. The idea can be equated with a fish in an aquarium. The fish corresponding to a cell in your body and the water being the extra-cellular environment. If the fish becomes ill, you do not look to the fish for the cause; rather you investigate the water’s chemistry for impurities or imbalances that may be responsible. If you bring the water back to the optimum conditions, the fish will become well. However, the longer you wait, the harder it will be to reverse any adversities that a poor cellular environment has caused. This is why BioCellular Analysis is such an important tool in preventive medicine.

The fundamental information revealed by BioCellular Analysis provides a comprehensive overview of the biochemical status of an individual patient. Like the fish in the water, when a patient’s chemistry is balanced and maintained with a healthy diet, proper vitamins and mineral supplementation, and adequate amounts of water, exercise, and rest, the body can remain strong and healthy and nourish a vibrant immune system.

BioCellular Analysis offers an objective assessment of a patients overall health. With the BL5000 series BioCellular Analyzer™ —a state of the art in-office testing device—you can test saliva, urine and blood, to get a great deal of information on the status of enzymes, amino acids, and other vital building blocks of life. Simply put, the saliva represents digestive function, the blood represents the amount of toxicity one is carrying, and the urine represents elimination capability.

More specifically, you will discover if the patient's system is too acidic or too alkaline, whether they have optimum amounts of minerals, and their oxidative stress levels.

The measurement of pH indicates whether or not the body's biochemistry is to acidic or too alkaline, whether enzymatic activity in the body is occurring properly, and if digestion and absorption of vitamins, minerals and nutrients are adequate. This measurement can also alert the practitioner to environmental or industrial contaminants, substances that can prove very damaging to the body's delicate chemistry.

Oxidative-stress values indicate the electron movement and concentration in the individual's system. The effects of stress, poor air quality, and food lacking in nutritional value, along with lack of aerobic exercise generally result in values much higher than optimal. If these values continue to remain elevated for extended periods of time, the body becomes more susceptible to illness, disease, degeneration, and premature aging.

Resistivity indicates the gross mineral concentration of the fluid. If minerals are deficient, enzymatic reactions cannot occur; conversely, if a mineral content is elevated, congestion, and stagnation of vital dynamic fluids may ensue.

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pH

One of the primary values in BioCellular Analysis is pH, the analytical measurement representing the activity and potential energetics found within the hydrogen ion. It is well known in the field of biochemistry that pH is associated with the life-sustaining fluid of water, and no living species on this planet can survive without water…nor can one single living cell. The chemistry of the human body is considered to be analogous to the chemistry of water.

When water dissociates, it forms ions known as hydrogen and hydroxide. This dissociation can be understood by examining the equation:

$$\mathbf{H_20 \longrightarrow H^+ + OH^-}$$

As the equation illustrates, water will separate into its basic elemental components. This separation process is known as dissociation or the rate of dissociation. The rate at which water dissociates into its basic elements is equal to 1 x 10^{14} moles per liter. This occurs under specific, definable parameters such as constant temperature of 22°C and constant atmospheric pressure of 1 ATM. Based on mathematical representation of negative logarithms, the concentration of the hydrogen ions is more easily expressed in terms of whole numbers. Therefore, pH is in fact, related to the hydrogen ion concentration and can be represented by the equation:

$$\mathbf{pH = Log\ 1/[H^+] = -\ Log\ [H^+]}$$

When expressed in these terms, the concentrations of the hydrogen ion can be placed on a scale ranging from theoretical 0 to 14.14. Upon further, and more comprehensive examination of the above equation, it must be noted that as the hydrogen ion concentration *increases*, the resulting pH *decreases*. This consequence creates what is termed an **acidosis**. Similarly, as the hydrogen ion concentration *decreases*, the resulting pH *increases*. This consequence creates what is termed as an **alkalosis**.

The words "acidosis" and "alkalosis" are meant to refer to the relative concentrations of either an abundance of acid to a base or an abundance of a base to an acid. Now that we know what creates an acid or a base, we must more fully understand their definitions:

An **acid** is a molecule or ion that can function as proton donor.

A **base** is a molecule or ion that can function as a proton acceptor.

More definitively stated, an acid is an ion or molecule that can furnish a hydrogen ion (H^+) to a solution. This is viewed as HCL ionizes in water to form hydrogen ions (H^+) and chloride ions (CL^-), and therefore is the acid known as hydrochloric acid. The hydrochloric acid has donated a proton (the H^+ ion) to the solution. Other vital acids that function in a powerful biological capacity are: carbonic acid, acetic acid, uric acid, phosphoric acid, and nitric acid.

Similarly viewed, a base is an ion or molecule that will combine with hydrogen ions (H^+) and remove them from the solution. An example of this is the bicarbonate ion ($HCO3^-$), which combines with a hydrogen ion (H^+) and forms the new compound known as carbonic acid (H_2CO_3). The bicarbonate ion has accepted a proton from the solution and is therefore responding as a base. Other vital bases which function in a powerful biological capacity are: sodium bicarbonate, sodium phosphate, special inter-cellular proteins and even hemoglobin in the blood.

One of the most important aspects about acid and base physiology and their relative concentrations is that they help to maintain a definitive biochemical balance within the body. Through the balance created by the concentrations of these compounds, proper and biologically compatible pH levels are sustained. These levels are very precise and must be carefully guarded and perpetuated in order for cellular function and chemical reactions within the body to occur. Without this delicate balance of pH within the body, life as we know it today would not exist. A number of vital pH measurements for the body have been accurately determined in the following chart:

Tissue or Fluid	pH	Tissue or Fluid	pH
Saliva	6.0 – 7.0	Urine	4.5 – 8.0
Gastric secretion	1.0 – 3.5	Arterial Blood	7.4 – 7.45
Pancreatic secretion	8.0 – 8.3	Capillary blood	7.35 – 7.4
Bile	7.8	Venous blood	7.3 – 7.35
Small Intestinal secretion	7.5 – 8.0		

Vital pH Measurements for the Body

As demonstrated by the chart, pH must fall within a very narrow band in order for proper biochemical function to occur. If the pH values fall outside of the ranges described, either cellular function diminishes or death to the organisms will ensue. Therefore, it is critical that the body regulate and maintain all of these varying pH measurements in order to function effectively, and more importantly, to survive. As a safeguard, the body has created a number of elaborate and complex systems that carefully monitor and then control any aberrant acid/alkaline deviations. The systems designed to correct these fluctuations are known as acid-base buffer systems.

A buffer is a solution containing two or more chemical compounds that prevent significant alterations in pH regardless of whether an acid or a base is added to the solution. The buffer systems, which are the most active, and therefore the most critical, are: the bicarbonate/carbon dioxide system; the extra cellular system (which is mainly comprised of the relative concentration of phosphate); the intercellular system (which relies on the buffering integrity of the intercellular proteins and in the hemoglobin within the erythrocyte); and the bone. Although this intricate web of powerful buffers is very complex and effective, variances in the pH of many of the more significant bodily fluids do not often occur. Acids, both from an internal metabolic production perspective, as well as from exogenous sources, are constantly bombarding the body. It is this on-going onslaught of acids that begins to wear on the efficiency of the biological buffers, as well as deplete the necessary components that allow for proper buffer functioning.

The body, as a normal function of cellular metabolism produces acids. These acids are greatly increased during times of stress and through factors that stimulate the sympathetic nervous system. Exercise also increases the rate and concentration of indigenous acids. Even with all of these many factors contribution to the problem, the largest culprit in the excess acid production area comes from the oxidation of fats, carbohydrates and proteins.

In a normal 70kg male, the metabolism and oxidation of dietary foodstuffs produce a wide array of chemical components that acutely impact the acid-base condition. When insulin is present, and the tissues are adequately perfused with oxygen, cellular oxidation of carbohydrates and fats produces an excessive quantity of CO_2. This massive production of CO_2 is potentially toxic and stressful to the organism as a whole. Depending on the ability and the level of efficiency of the respiratory system, some CO_2 (although usually only a trace amount) will be vented out through the lungs. The remaining concentration of CO_2 will combine with H_2O and produce a volatile acid known as carbonic acid (H_2CO_3).

Concentrations of carbonic acid are not only difficult for the body to store, but in fact must be readily converted into their base components for immediate removal, or stored for later disposal from the body. The body will breakdown the carbonic acid into a hydrogen ion and a bicarbonate ion as illustrated in the following:

$$\mathbf{H_2CO_3 \longrightarrow H^+ + HCO_3^-}$$

This breakdown creates a higher level of efficiency to aid in the removal of this excess acid production. A portion of the newly formed hydrogen ions will be removed by the body through normal renal physiology. However, as kidneys are excreting the acid out through the renal tubules, they are concurrently reabsorbing the bicarbonate ion. The re-absorption of the bicarbonate ion is vital, for without this compensatory mechanism, the loss of this valuable ion would be similar to the addition of greater amounts of acids. Unfortunately, when the bicarbonate ion is reabsorbed, it greatly influences, and thereby increases, its own concentration in the plasma. This increased bicarbonate concentration can easily lead to an increase in the very stable iso-electric pH of the blood. Therefore as the renal tubules are collecting, condensing and ridding the body of the excess acids, they are also allowing for the continual re-absorption of the base. This re-absorption will directly effect the plasma pH. When the body is saturated with acids and the kidneys are able to continue their vital role in the removal of these acids, the body will prevent the occurrence of a metabolic acidosis. However, to compensate, the biological systems are creating a plasma alkalemia.

Under these circumstances, if the body fails to produce adequate levels of insulin, or if it is functioning in a varying state of hypoxia, oxidation of these fats and carbohydrates takes on a different outcome. When either of these two scenarios occur, the body will produce large quantities of nonvolatile acids, namely lactic acid and keto-acid. The process in which the body manipulates and attempts to store or dispose of these nonvolatile acids is identical to the procedures utilized in exchanging acids, which are produced though the oxidation and metabolism of protein.

The oxidation of amino acids forms the nonvolatile compounds of sulfuric acid, hydrochloric acid, nitric acid and phosphoric acid. These acids are all poisonous and highly destructive to the body. Therefore, the body must eliminate or store the less harmful constituents of these acids as quickly as possible. Through a simple chemical reaction these acids are successfully neutralized by a family of complex mineral compounds. When these mineral compounds react with the toxic acids, they create a product that is either no longer poisonous to the body or which can be readily and safely stored.

The family of mineral compounds that are so successful in the neutralization of these acids is known as the carbonic salts, often marked in chemistry texts as $X\text{-}CO_3$. The X represents any one of the four alkaline elements Na, Ca, K, or Mg. When carbonic salts meet with strong acids such as sulfuric acid, phosphoric acid, hydrochloric acid, lactic acid, or acetic acid, the alkaline minerals that are bound to the carbonate leave the salt and recombine with the acids to make a new less detrimental salt. An example of this type of reaction would be:

$$\mathbf{X\text{-}CO_3 + H_2SO_4 \longrightarrow X\text{-}SO_4 + H_2O + CO_2}$$

In this example, the toxic, highly dissociated sulfuric acid combines with the carbonic salt to form a less poisonous sulfuric salt, water and an additional molecule of carbon dioxide. The new product, the carbonic salt, can more readily be excreted though the kidneys than can its predecessor. While this process is effective, the entire premise is predicted on two key factors. First, that there are adequate numbers of readily available organic minerals to provide the initial creation of the carbonic salt; secondly that the production of additional levels of carbon dioxide can be eliminated by the body though the already overburdened respiratory system. Unfortunately, neither of these assumptions is always the case. Often, organic mineral concentrations are depleted form the body, and the respiratory system is virtually incapable of ridding the system of greater concentrations of CO_2. Either of these scenarios will force the renal tubules to once again collect, condense, and rid the body of this excess acid production and cause the re-absorption of the critical bicarbonate ion. This re-absorption has the great potential of adversely affecting the delicate balance of the plasma pH. When the kidneys are over-stressed in their attempts to stay relatively current with the increased acid load, the blood is also stressed attempting to maintain homeostasis with respect to pH. The stress placed on the blood will often create a shifting of the pH values further into the alkaline range. These stressors, playing out continually over many months and years, can create far-reaching distortions within the entire physiological climate.

In the final analysis, the typical adult American consumes over 150mEq/day of volatile and nonvolatile acids. This large, excessive dietary acid consumption, coupled with diminishing tissue stores of alkaline minerals, further complicated by excessive simple sugar intake and compounded by an inability to adequately saturate the tissue with oxygen, all spells excess overburdening of the surrounding interstitial cells with acids. When the body reaches a point where its ability to remove the excess acids is overcome by the acids both produced and consumed, the body must resort to storing the acids within. In its initial stages, the body will always store the acids in a region that represents the least amount of biological threat to the species. This area is the interstitial spaces or the extra-cellular matrix. When this area becomes saturated, the body will begin to store these acids anywhere it can. Unfortunately, the other storage places are not nearly as benign. As the interstitial space becomes loaded with acids, the cellular metabolism, respiration and ultimately cellular integrity are all greatly compromised. When all of these changes occur on a cellular level, the cell has become diseased and pathology is most certain to follow.

When the pH of a cell is altered, the normal enzymes utilized by or produced from the cell are also affected. Science has documented that enzyme kinetics is greatly dependent upon pH and temperature to maintain enzymatic integrity. When the pH is even slightly altered, the overall enzyme function of many associated systems will also be detrimentally affected. The far-reaching influence of the pH alterations can be felt in the digestive system, the immune system and even in the lymphatic system. With this abbreviated approach to the understanding of the biochemistry and physiology reactions, it becomes increasingly apparent that a simple, yet accurate assessment of the varying fluid pH levels can give valuable information. This can include endogenous and exogenous acid and alkaline production, physiological stress placed on varying organs and systems of the body, compensatory accomplishments and ultimately, enzyme kinetics.

Metabolic Production of Nonvolatile and Volatile Acids from the Diet

Food Source	Acid Produced	Quantity (mEq/day)
Carbohydrates & Fats	Volatile Acids	20
Amino Acids:		
a. Sulfur-containing	H_2SO_4	
b. Cationic	HCL	
c. Anionic	HCO_3	100
Phosphate	$H_2PO_4^-$	30
	Total Acids Consumed:	150

Application of pH

Of the three specimens tested, blood pH is the single most important reading, because it is affected by biocellular activity more directly than any other reading. The pH of venous blood is a reflection of three factors:

- Respiratory rate; chronic stress combined with improper breathing results in a chronic respiratory alkalosis.
- How much oxygen the tissues are taking up. When the tissues poorly take up oxygen, a higher percentage of it remains in the venous blood. Since oxygen is an alkalinizing substance, this results in an increase in the venous pH.
- How effectively the tissues are using the oxygen to generate energy. The most effective way for cells to produce energy from oxygen is through oxidative phosphorylation in the mitochondria. This process involves the production of carbon dioxide. The only other way to produce energy though oxygen is through the anaerobic metabolism of glucose, which does not produce carbon dioxide. Therefore, effective energy production results in an increase in carbon dioxide production, whereas inefficient production results in a decrease. Venous pH is determined almost exclusively on the amount of carbon dioxide in the blood due to the following equation:

$$\mathbf{H_2O + CO_2 \rightleftharpoons HCO_3 + H^+}$$

It can be observed that the higher the CO_2 concentration, the higher the hydrogen ion concentration, resulting in a lowered pH. Conversely, the lower the CO_2 concentration, the lower the hydrogen concentration, and hence the higher the pH.

Ideal blood pH is about 7.35, or very slightly alkaline. This is controlled by a strict and sensitive system in the body to keep it near that level. This is done by adjusting the amount of carbon dioxide (acidic) and bicarbonate (alkaline) in the blood. If the blood becomes too acidic, more acid is excreted in the urine, and more carbon dioxide is expelled from the lungs. The opposite is set into motion if the blood becomes too alkaline. A tendency towards acidity, rather than alkalinity, will usually be seen in practice. This is due to the fact that western diets are full of protein rich foods and refined carbohydrates, which create acidity in the body. On the other hand, most fruits and vegetables create alkalinity.

Urine pH reflects the amount of acid residual that is being eliminated from the body. A normal urine pH is around 6.8 (on first morning void), but when significant interstitial acid accumulation has occurred, the pH can fall to as low as 4.5. The degree of interstitial acid accumulation can be estimated by comparing the pH of the first morning urine to the pH of a specimen taken at least 30 minutes later. The second specimen should ideally show a significantly higher pH than the first specimen. If it is nearly the same as the first specimen, the degree of acidosis is quite marked.

Of all the biocellular measurements, the saliva values are the most difficult to interpret. It is important to note that they are influenced greatly by the measurements of the blood. Thus when interpreting the saliva values, one must do so by comparing the measurements to those of the blood. For the most part, saliva pH can be attributed mostly to digestive impairment.

Mitochondria function, hormone receptor sites, and many other functions of the body are extremely dependent on pH balance. Being able to test the pH of blood, urine and saliva is essential to helping your patients achieve optimum health.

Oxidative-Reduction/Redox

During the 1920's biological medicine scientists and chemists began to discover that the monitoring and assessment of the movement of electrons or electron potential of bodily fluids was as critical in the biochemical equation of BioCellular Analysis as pH. Therefore, the second factor in the assessment of BioCellular Analysis is called the *oxidation-reduction potential*. This analysis is predicated on the understanding that all chemical reactions are dependent upon the ability of electrons either to attract or repel one another. Before one can fully understand the dynamic role that these electrons play in the chemical reactions of molecules, an in-depth look at the basic structure and function of molecules and atoms would be prudent.

All life is composed of *molecules*. Molecules are made up of tiny particles known as *atoms*. An atom consists of a positively charged nucleus that is surrounded by one or more negatively charged particles called electrons. The positive charges must equal the negative charges so that the atoms can maintain electrical neutrality. The majority of the atom's mass is found in the *nucleus*. In comparison, the mass of an electron is only 1/1836 the mass of the smallest and lightest of all the nuclei. The nucleus of the atom contains both protons and neutrons. The masses of *protons* and *neutron* are almost equal but they differ in charges. A neutron lacks a charge while a proton has a positive charge that exactly balances the negative charge of a single attached electron.

When two atoms are close enough to combine and react chemically and form chemical bonds, it is the electron that determines or "sees" the incoming reagent and determines the chemical compatibility. The electrons in the outermost shell of one atom analyze the electrons in the outermost shell of the other atom and an instantaneous determination is made in accordance to binding congruity. Therefore, it is the electron that is the key to the ratability and chemical behavior of all atoms. Neither the neutron nor the proton can rival the significance of this tiny negatively charged particle.

In order to determine the chemical cohesiveness of an atomic or molecular compound, a monitoring device can be placed within the reaction confines of a solution. This device is oftentimes a metal electrode arranged in a solution containing a reversible oxidation-reduction system. The primary focus of the electrode is to detect the system's ability to gain or lose electrons until it has reached a state of equilibrium. A heterogeneous complex that will donate electrons is considered to be a reducing system; a heterogeneous complex that will accept electrons is considered to be an oxidizing system.

In living tissue, oxidation-reduction systems can be divided into two types:

1. Those in which the oxidized and reduced forms differ solely in the number of electrons, e.g. in which a change in valence of an element has occurred.

2. Those in which "hydrogen transfer" has occur.

When a metal electrode is placed into a solution containing a reversible oxidation-reduction system, the electrode will analytically measure the oxidation-reduction potential (ORP). A relative measurement, the ORP determines the tendency for a reaction to occur. It is measured in the electrical value of millivolts (mV), and is most often represented by the letter E.

Reduced substance $\longrightarrow$ Oxidized substance + Electron = E

If E is +, the reaction has a greater tendency to occur in the direction that the arrow is drawn, and hence favors the oxidized state. However, if E is -, the reaction has a greater tendency to occur in the direction opposite to the way the arrow is drawn, and hence will favor the reduced state. Examples of this would include:

$Na \longrightarrow Na^{+} + e^{-}$ E = +2.71 mV
$Ag \longrightarrow Ag^{+} + e^{-}$ E = -.80 mV

In the first reaction, E is a positive number. Therefore, the reaction will favor the products that are in the oxidized state. In the second reaction, E is a negative number. The reaction will favor the reactants that are in the reduced state. The entire purpose of the occurrence of oxidation and reduction is found in two very simple yet extremely powerful premises:

1. To create high cellular energy in the form of ATP

2. To oxidize or burn up invading pollutants, xenobiotics and some species of microorganisms.

These two premises are so significant that without them our life, as we know it, would cease to exist. ATP energy is the high cellular energy that runs each and every cell of our body. Without the adequate production of ATP, our bodies would rapidly run out of the fuel that enables them to work. When our cells stop functioning, so does our body. Many forms of disease, as well as many conditions that manifest by creating fatigue in the host, are inhibitors or depletors of ATP. The ability of our cells to oxidize invading pollutants, xenobiotics, and some species of microorganisms is paramount to survival in this contaminated, polluted world. If the oxidation-reduction reaction were not able to burn up these contaminants, then with our body's first exposure to these factors, cellular integrity would most certainly be compromised. This would ultimately lead to death. Therefore, it becomes increasingly obvious to understand not only whether or not an oxidation-reduction reaction is occurring or will occur, but to fully appreciate the significance of the relative concentrations of electrons.

When a life-sustaining fluid such as blood is loaded with electrons, and therefore has a negative E value, there is a great potential for potent life-giving chemical reactions to occur. However, when the blood becomes depleted of these essential life-providing electrons, and the E value becomes more positive, the potential energetics of the fluid have been spent. To more completely comprehend what the change in the E value has on the energy of the fluid or cell, one must begin to think in terms of potential and kinetic energy. A fluid that has a positive E value has just sent all of its kinetic energy and accordingly is void of all potential energy. The fluid or cells that make up this entity are incapable on their own to create a chemical reaction. Conversely, a fluid that has a negative E value has a warehouse of available kinetic energy and therefore a very high potential energy. This fluid is able to donate its electrons and prime the system to create a chemical reaction.

Understanding the value of E can easily provide tangible analytical evidence of the potential energetics and life-sustaining properties of a fluid. However, in a true biological system, E is replaced by a factor called rH_2, which is considered to represent the partial pressure of hydrogen that is exerted on the cathode. It is calculated form the Nernst equation:

$E = E_o + (RT/nF) \quad \log ([Oxid] / [Red])$ where:

E = oxidation-reduction potential in millivolts
R = gas constant
T = Absolute Temperature
n = number of electrons involved in the half reaction
(equivalents/mole)
F = Faraday constant or the number of electrons reacting

[Red] = concentration of the reduced form of the substance
[Oxid] = concentration of the oxidized form of the substance

In a biological system, the new equation becomes:

$$E = E_o + 2.3\ RT / F \quad \log ([H^+] / [rH_2])$$

If one solves the equation for rH_2 and factors in the concentration of the hydrogen ion (pH), the resultant is an oxidation reduction potential calculated in respect for a true biological system. Since rH_2 is a relative factor representing partial pressure, it is denoted in terms of bar. The balance point of the rH_2 scale ranges from 0 to 42 where 0 corresponds to the maximal hydrogen partial pressure of 1 bar, and 42 corresponds to the minimal hydrogen pressure of 1 X 10-42 bar. The balance point of the rH_2 scale, where the concentration of reductants is equal to the concentration of oxidants, is 28. Any rH_2 value determined below 28 represents a reduced state; any rH_2 value above 28 represents an oxidized state.

The measurable and definable scale of rH_2 allows the assure practitioner immediate access to the electron potential of the three majors fluids of the body. In this easy and straightforward test, high versus low potential energy can be determined. This provides a window into the full biochemical make-up of the patient. In today's world where harmful oxidative stress comes from so many varying sources, having the ability to quickly and precisely determine the extent of the damage created from the stress is an essential tool that each and every practitioner should have at their disposal. Through the assessment of the rH_2, the underlying cause of the biochemical imbalance becomes even more readily available and assessable.

Application of Redox

The rH_2-value indicates the amount of electron potential in the fluid tested. A high number of available electrons in human cells is an optimum situation, signifying a healthy and productive Krebs Cycle. In other words, the oxidative stress values show the concentration of electrons and their movement in the body. Nutritional deficiencies, stress, over stimulation of the immune system, lack of exercise, exposure to radiation, and toxicity can all lead to higher than optimum levels. The individual can then be more prone to disease and premature aging. rH_2 values can range from 1-42, with 28 being the mid-point. A value of rH_2 under 28 is reduced, with a higher number of electron donors than acceptors. A value higher than 28 infers that the fluid is oxidized, with a lower number of electron donors than acceptors.

Ideal blood rH_2 values should ultimately be between 23 and 24. Readings that are less than 23 are caused by artifact. Readings that are greater than 24 reflects increasing oxidative stress. Oxidative stress is caused by mitochondria insufficiency, but antioxidant deficiency is often a contributing factor. Saliva rH_2 values seem to be more often associated with liver function.

In order to lessen oxidative stress, the physician will make several recommendations to the patient. It is essential to stimulate and drain the lymphatic system, through the use of homeopathic and herbal drainage remedies, and the use of massage, deep breathing, and exercise. Invading toxins should also be addressed, such as insecticides, mercury (possible from dental fillings), and heavy metals. The patient's diet should be addressed, with special limitation of alcohol, cigarettes, sugar, and non-organic foods. Liver function should be assisted with the use of herbal and homeopathic remedies, plus reduced glutathione. Stress must be dealt with, as it has such a negative effect on immune function, and enzymatic action within the body. An individual program of nutrients, especially anti-oxidants, vitamins and minerals should be followed.

Resistivity

The third parameter that defines BioCellular Analysis is "Resistivity." Of the three values, resistivity, which is represented by the small letter *r*, is perhaps the easiest to understand and to integrate. Resistivity is a simple measurement of the fluid's ability to conduct an electrical current. In actuality, resistivity is inversely proportional to the more common electrical testing parameter of conductivity. By first understanding the value of conductivity, then applying that understanding to the relationship between itself and resistivity, the ability of an electrical current to pass through a given medium. If the electrical current can readily flow through the solution (in this case the fluids in the body), then the conductivity is considered to be very high. However, if an electrical current has great difficulty in passing through a solution, the solution is then said to have very poor electrical conductivity. The factor that dictates whether or not a solution is electrically conductive or not, is dependent upon the relative concentration of electrically conductive biological ions. In the body, these ions are present in the form of mineral salts, which are very electrically conductive. When the presence of miner salts is substantial, the ability of an electrical current to flow through the solution is tangible. As the relative concentration of mineral salts increases, the ability to conduct an electrical current also increases and the conductivity is therefore elevated. Conversely, as the relative concentration of mineral salts decreases, the ability to conduct an electrical current also decreases and the conductivity is therefore diminished.

Recall that the relationship between electrical conductivity and electrical resistivity is inversely proportional; therefore, as the mineral content increases, the conductivity increases and the resistivity decreases. Conversely, as the mineral content decreases, the conductivity decreases and the resistivity increases. Resistivity is a simple and relative measurement of the concentration of electrically conductive ions in solution. It is referred to and stated in the electrical scale in terms of *ohms cm*. The simplicity in comprehending and testing for this last parameter is by no means a suitable representation of its relative significance. The resistivity values of the three biological fluids are a definitive analytical evaluation that yields a great deal of information.

As is found in any biological system, a balance or homeostasis must be maintained in order for maximum function to be perpetuated. A set concentration of conductive ions e.g. mineral salts, is essential to allow the body the ability to carry out its many complex and diverse chemical reactions. If the concentration of these mineral salts deviates from a normal and acceptable range, the underlying biochemical function is greatly affected. Mineral salts are designed to exist in relatively small and balanced concentrations in the saliva and blood. Conversely, mineral salts are ideally designed to flow freely through the excretable urine. This process assures that the kidneys are adequately removing excess minerals from the body and that the influx of essential conductive ions remains competent and stable. If the body loses too many minerals though the urine, then the biological function of all of the remaining systems of the body will be greatly affected. Conversely, if the body does not remove the mineral salts in sufficient enough concentrations, then the body will also become toxic and the underlying function will suffer. Osmotic gradients, cellular integrity, chemical reactivity, and proper neurological function are all dependent upon proper balance and elimination/retention of mineral salts.

Much has been written on the importance of minerals and the dynamic roles that they serve in the integrity and function of the body. Through this last parameter of resistivity, indications of blood purification, kidney excretion, enzymatic concentration, dietary factors, and alkaline reserve potential can easily be inferred. Therefore, the overall value and significance of the assessment of the parameter defined as resistivity is not only crucial in determining valuable biological functions, but must be considered on equal ground with the factors of pH and rH_2.

Application of Resistivity

The r-value refers to resistivity, or the relative concentration of conductive ions in the biological fluid. Therefore, testing the r-value can indicate the levels of minerals in the body, especially sodium, chloride, calcium, magnesium, and potassium. When the r-value it increased, there is low mineral concentration; when r-value is decreased, mineral concentration is increased. Therefore, the relationship between electrical resistivity and electrical conductivity is inversely proportional. When minerals are deficient, enzymatic reactions are poor, and if the mineral content is too high, the fluids of the body can become stagnant and congested.

It is fairly common to see a raised r-value, indicating a lack of minerals, due to many factors. Many experts agree that minerals are becoming depleted in our soils, due to intensive farming practices. Also, the amount of sodas consumed in the western diet contributes to mineral loss from the body, from the phosphorus and sugar levels in soft drinks. Dairy products and refined carbohydrates also take a toll on the levels of minerals in the body, and these are usually high in the western diet.

There are several factors that cause changes in resistivity within the patient's body. These are excess or loss of minerals, poor kidney function, electrolyte imbalance, or sluggish and congested lymphatic system. The patient must have an individualized program that detoxifies the lymphatic system through the use of drainage herbals and homeopathics, balances the pH, detoxifies the liver, and aids kidney function. Plenty of pure water, massage, and diet will also be important to changing the R-values for the patient.

Summary

There exists a strong inter-relationship of the values of pH, rH2 and resistivity. One of these alone is not adequate; two together are more valuable, but only the three parameters together can successfully and completely define BioCellular Analysis. In a world of at least three dimensions, finding a point in space cannot be defined by only one component. In fact, in such a model, three directions or mapping points must be labeled. Most often these three points are referred to as the X, Y, and Z coordinates. Therefore, in a three dimensional human body, one should not expect the laws of physics to apply any differently. Thus, to clinically monitor and evaluate the overall biochemical function, and to plot BioCellular Analysis, the three independent values must be utilized.

Strong and highly emphasized words of guidance need to be imparted in relationship to the assessment of the three factors, which define Biological Assessment. While the information these three factors impart can aid in the ascertainment of many valuable biological and chemical occurrences within the body, they DO NOT diagnose any specific pathology or disease states. They are 100% analytical guideposts or road signs, which aid tremendously in the overall evaluation of the patient. Additionally these three factors allow the practitioner to document a starting pint, or reference pint, to determine if the methodology chosen for therapeutic purposes is appropriate. Also they give the practitioner a teaching guide to share with the patient, thus allowing the patient to take an active role in continuing health care. Finally, they provide the practitioner with immediate, in-office information that is easily ascertained and irreplaceable in helping to determine the need for additional and specific laboratory assays.

As practitioners begin to work with, and to evaluate, BioCellular Analysis, they will realize that never before in the history of medicine has one simple test provided such a strong base of active and tangible information. The assessment of BioCellular Analysis is a tool that can be easily and effectively implemented into any type of practice. The foundation for all of the factors is straightforward basic biology and chemistry, and therefore will stand up to the highest levels of scrutiny and inspection.

Our way of life and our level of health are rapidly and dramatically changing. It is vitally important that today's health care providers take quantum leaps in their understanding, appreciation, and treatment of these new health challenges. Also, it is extremely important that they be prepared and equipped to provide their patients with the information and strategies to deal with these expanding and, at times overwhelming health concerns. The study and practice of BioCellular Analysis is the medicine of the future, and is the filed of science that is now fully equipped to meet these needs and to address these clinical challenges. It is an extremely valuable field of science that necessitates a strong degree of knowledge, respect, and appreciation for not only the chemistry of the body but more importantly, for the underlying forces of nature, which control and dictate the body's internal environment. BioCellular Analysis is a field of science and study which enables both the allopathic and alternative health care professional to clinically validate and monitor these subtle, yet powerful forces of nature, while providing a means of verifying the effectiveness of the practitioner's therapeutic protocols.