

Science is Theory of Empirical Data

Reza Ladjevardi M.D.

Electric potentials

- Electric potentials and currents can be measured on the body's surface. After all, electrocardiogram, electroencephalogram, electromyogram etc. are among the established methods of medical diagnostics.
- These potentials are generated by an unequal ion distribution between the intracellular liquid (ICF) and the extracellular liquid (ECF) and are subject to continuous change.
- differences of 20-100mV can be measured both at the cell membrane and also on all tissues and organs.
- In this context, the epithelium (cell membrane) **serves as a generator** (Sodium/Potassium Pump) due to its ion transport and at the same time as a **dielectric** (**dielectric** refers to a volume which contains an electric field without any significant electric conductivity).

These are the theories on the development of physiological electric fields in the body

- **Piezoelectricity refers to an electric field** – (electricity or electric polarity due to pressure or mechanical stress especially in a crystalline substance (as quartz) up to a potential difference of some 100 mV may be generated. This is the result of charge transfer in crystal-like macro-molecules. In biological tissue, proteins – especially collagen – take over the role of inorganic components of crystals. However, this is rapidly shielded by ion transfer (physiological anti-regulation process) –. Activities like walking, stretching or spraining of the bones cause endogenous (caused by factors inside the organism) or system potentials with a frequency under 10 Hz. Further potentials –between 20-30 Hz – are generated by contraction of the muscle tissue surrounding the bones.
- **Flow potentials refer to an electric field being generated by the movement of a liquid over a charged surface.** This is the case, for example, if ions flow through capillaries or bony canals whose walls also contain ions – i.e. charges. The resulting charge separation causes an electro-osmotic current (the movement of a liquid out of or through a porous material or a biological membrane under the influence of an electric field) which counteracts the primary current.

Balance potential / steady state

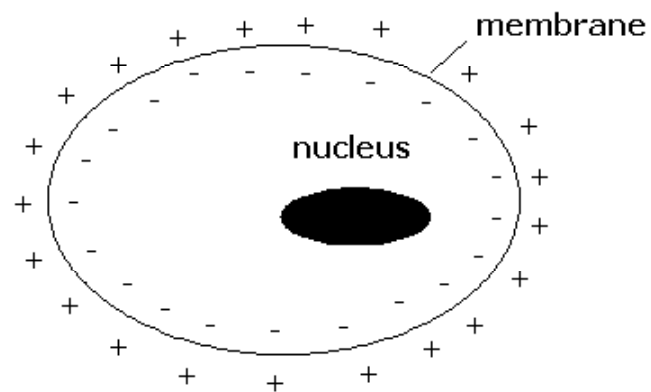
- Na^+ ions are moved out of the cell or K^+ ions into the cell by means of active and energy-intensive transport, among other things through $\text{Na}^+\text{-K}^+\text{-ATPase}$, (ATPases are a class of enzymes that catalyze the decomposition of adenosine triphosphate (ATP) into adenosine diphosphate (ADP) and a free phosphate ion. This dephosphorylation reaction releases energy, which the enzyme (in most cases) harnesses to drive other chemical reactions that would not otherwise occur. This process is widely used in all known forms of life.)

which has an effect like a pump.

- This process generally continues until a "balance potential" is reached for the ion concentration where the diffusion power (chemical gradient) and the counteracting force of the electric potential (electric gradient) are the same.
- The result is a steady state .

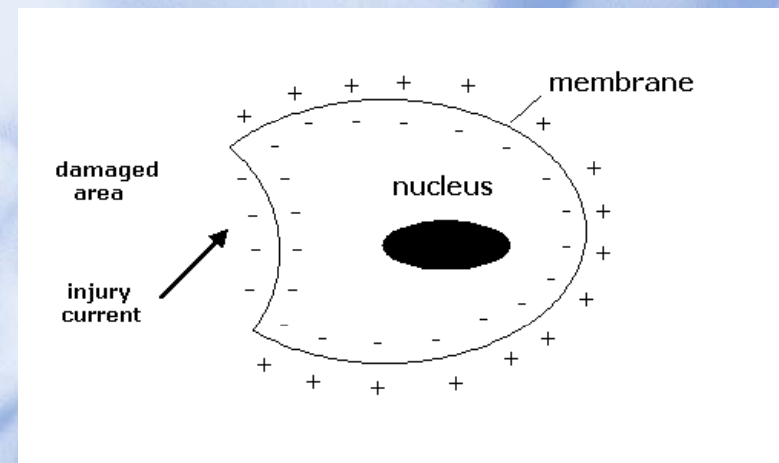
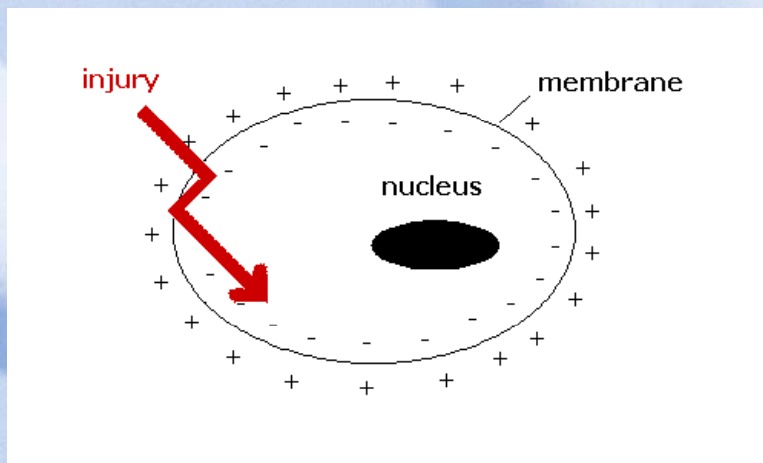
If stress-induced (Piezoelectricity) electric fields influence the bone growth *in vivo*, why should artificially generated fields and currents not have the same effect?

- The discovery and the explanatory model of stress-induced electric potentials resulted in the hypothesis that these phenomena have a physiological meaning and can explain the connection between form and function of the tissue. On the other hand, it would also be conceivable that these potentials are only concomitants (something that accompanies or is collaterally connected with something else) of other primarily biochemical processes.
- **If current generates current potentials in narrow capillaries, an electric field can conversely induce electro-osmotic currents in such systems. Also in this case a therapy might be effective.**
- **An electric potential difference can be measured at the membranes of living cells. It is called "resting membrane potential". With muscle and nerve cells its value amounts to ca. 70 - 90 mV (millivolt) (the inside of the cell is negative).** The Bio Potential of the cell is one of the measurements used as a marker, while treating with the algonix.



pathological or abnormal balance

- However, these potential changes, according to the definition, may also be a **pathological or abnormal balance** which is part of the body's disease **control strategies** (I.E. The body may create this potential difference on purpose) (e.g. elevated temperature/fever), but which becomes pathological when particular tolerance limits are exceeded. This may lead to damage, chronification or even extinction of the organism. (I.E. flu bug)
- In case of a pathological course – chemical or physical – the normal electric potential changes, and also the outside of the cell becomes negative.
- Potassium enters and Sodium exits in a continuous manner until the polarity is reached in the cell. I.E. (sodium/potassium pump)



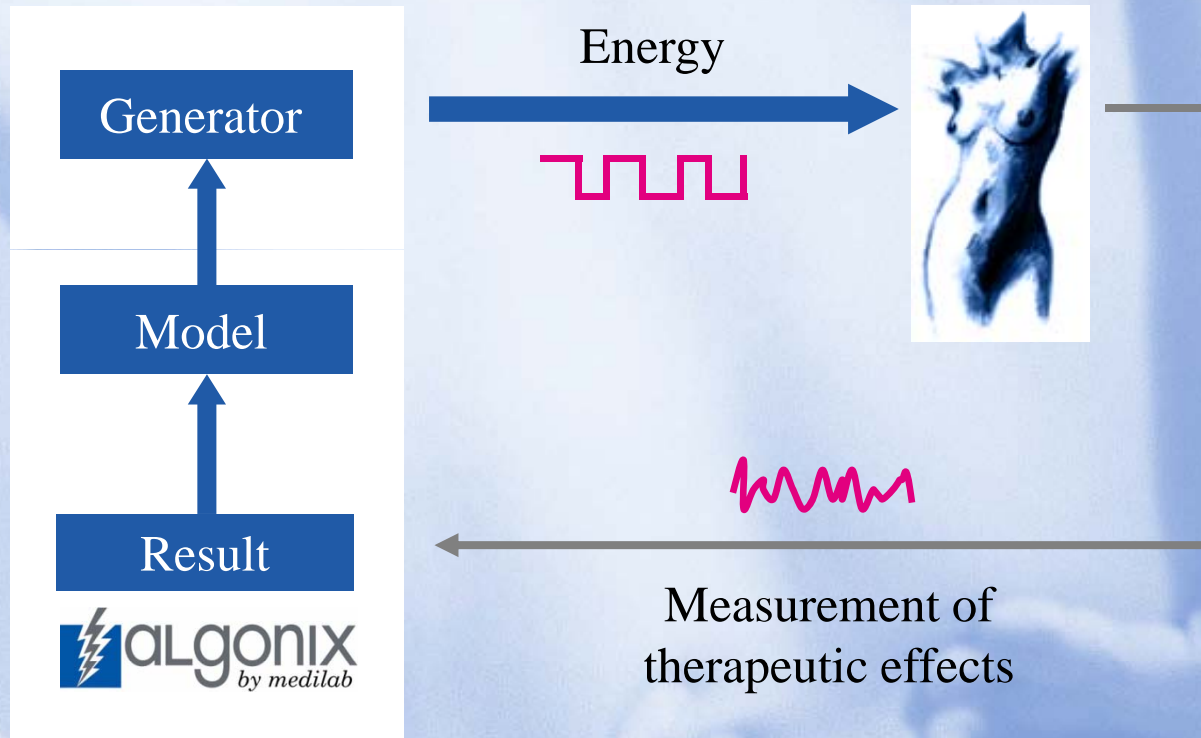
Healing process

- There is a short circuit in the damaged area. Normal electric potentials change and the result may be field strengths up to 200 V/m.
- This field has an effect on both granulocytes (a polymorphonuclear white blood cell (as a basophil, eosinophil, or neutrophil) with granule-containing cytoplasm, fibroblasts etc., for example, and on the growth direction of nerve cells.
- These processes play a key role in wound healing or other repair processes inside the cell.
- This is how the idea came into being to promote the repair processes inside the cell by means of external electric fields.

Empirical Data / Algorithms

- Here, too, the problem is to find an appropriate technology with which electric fields of the required strength can be locally applied.
- As mentioned above, membranes will change potentials depending on their condition. These very weak electric potentials are amplified and analysed (Fourier analysis). The spectrum of the contained frequencies can be processed by fast computers and appropriate software (Algonix or Beautytek).
- **The only method in order to achieve the locally required strength of electric fields is to use model algorithms like with Algonix and Beautytek. These have been developed on the basis of decades of empirical data collections.**

Algonix by medilab



Electrical Stimulation

- The electrical stimulation of cells and tissue has been clinically applied for a long time and with varied indications. This includes the treatment of fractures as well as pain therapy, muscular stimulation, the treatment of motor disorders like Parkinson's disease and cosmetic applications.

Amplitude modulation

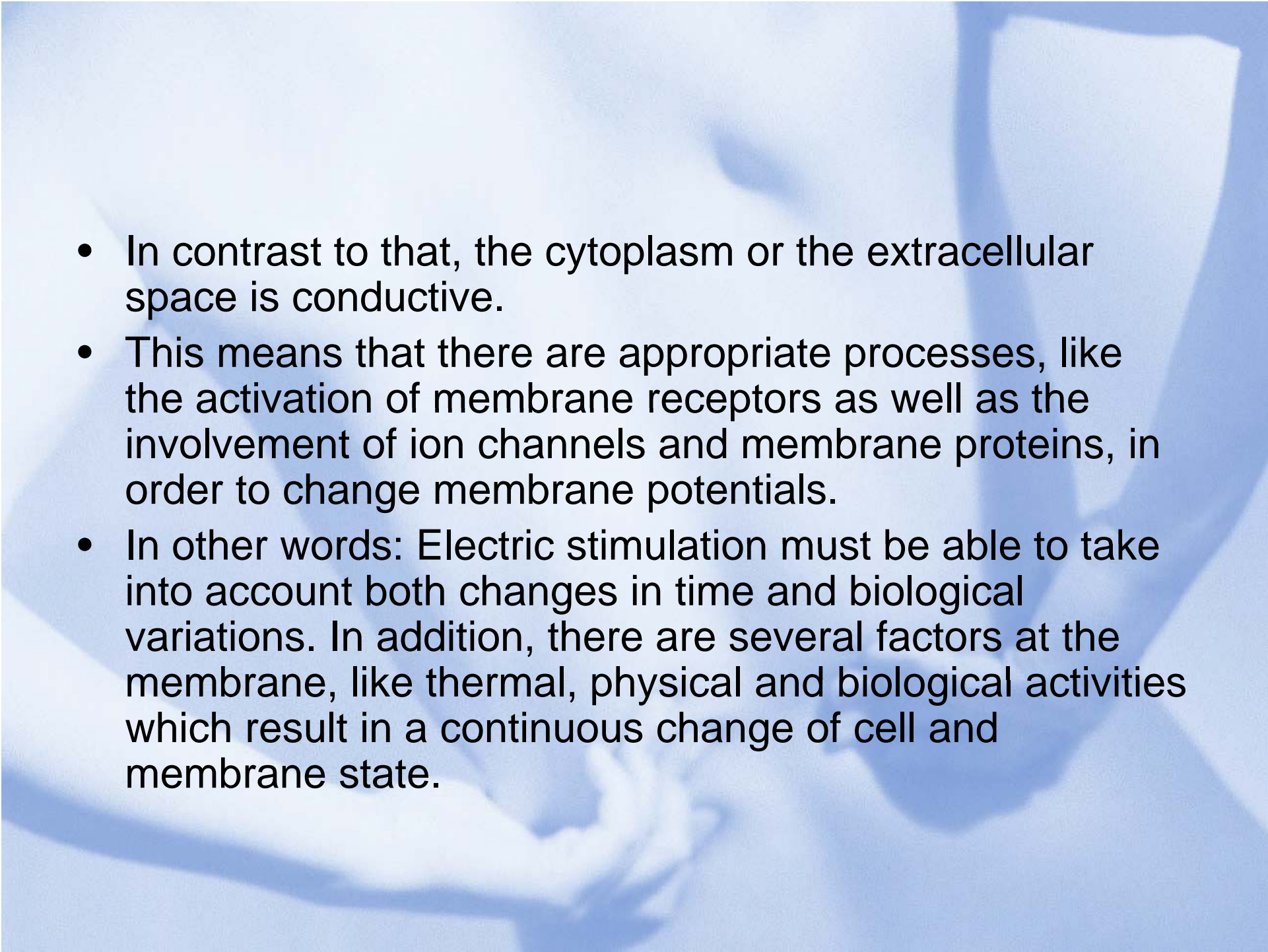
- The pulse repetition with Algonix or Beautytek does not have a constant current strength, but rather the current strength of the individual pulses varies rhythmically.
- The biggest barrier for the current flow is the skin. The skin has an electrical resistance which has an ohmic (resist current) component in addition to a capacitive (stores current) component.
- The combination electrode-corneous layer-subcutaneous tissue has a passive storage capacity and functions like a capacitor. This is connected in parallel with the ohmic resistance (resistance of the corneous layer and the tissue).
- Capacitors can store charge carriers. They are impermeable to direct current, but permeable to A/C alternating current due to the capacity of recharge.
- As a result of the interrupted current flow with pulse currents, the capacitive component of the skin resistance can discharge during the interpulse periods and thus makes a current flow possible without actually penetrating the skin.
- Short pulses can flow over the capacity of the skin more easily and are thus less irritating.

Optimization of the parameters

- The mechanisms of cellular activity have not been explained in detail so far – despite a lot of studies and many years of clinical experience.
- The hypothesis for the therapeutic application lies in the existence of stress-induced electric potentials in the tissue.
- **By means of external application of digitally generated electromagnetic fields, the time and space model of endogenous fields** (produced or synthesized within the organism or system <an *endogenous* hormone>) **can be imitated.**
- Just for this reason and in order to achieve the desired therapy, fields with the most different parameters (I.E. Injured area) are targeted for electric stimulation. The algonix parameters vary in frequency, field strength and wave form as well as in type of application and duration time of application.
- The optimization of the parameters can only be achieved considering a big, empirically generated database. These data are digitally backed up in **calculated algorithms in Algonix or Beautytek and are considered during a real-time analysis to set up the parameters.**

analysis → model → comparison → therapy method by Algonix

- Since it is not clear in detail over which cellular signal paths the effect of electric fields is communicated, many tests have been performed in order to be able to record and identify various potential target molecules.
- The intracellular calcium concentration is one of the parameters which has been paid much attention to. References show a tendency towards calcium signals being triggered as a primary reaction to an external field.
- The cell membranes have a high impedance, which means that they are electrically rechargeable but not conductive, and they keep an external electric field, depending on its frequency, away from the inside of the cell and form a counteracting reaction field.
- The discrepancy between the unexplained effect and the established clinical application shows the necessity of an analysis-model-comparison-therapy-method by Algonix.

- 
- In contrast to that, the cytoplasm or the extracellular space is conductive.
 - This means that there are appropriate processes, like the activation of membrane receptors as well as the involvement of ion channels and membrane proteins, in order to change membrane potentials.
 - In other words: Electric stimulation must be able to take into account both changes in time and biological variations. In addition, there are several factors at the membrane, like thermal, physical and biological activities which result in a continuous change of cell and membrane state.

Algonix

The only useful method of electrostimulation

- Thus, only a real-time analysis of the actual state with a stimulation following is the only useful method of electrostimulation.
- Algonix/Beautytek contains a state-of-the-art, digital signal processing technology for extremely accurate potential measurements. The device integrates a digital frequency synthesizer. Algonix performs high-precision measurements of electromagnetic oscillations coming from the body, processes the received signals by means of a discrete Fourier transformation (DFT) and filters out signals not required. Then, the signals are compared to the stored algorithms and on this basis new therapy parameters are set up (900 times per second).

Influence

Externally applied electric stimulation can influence the following parameters among others:

- tissue growth or regeneration
- DNA and protein formation
- influence on the membrane features (ion transport, potential)
- intracellular ion concentration, e.g. Ca^{2+} is increased
- increase in growth factors and prostaglandin
- biosynthesis of RNA and proteins from genetic information.

Calcium

- By influencing tension-dependent and stretch-dependent ion channels, the membrane potential of the cell is affected or the cell membrane is mechanically deformed due to the electric field or the related electro-osmotic current. Activating tension-dependent and stretch-dependent calcium channels subsequently leads to a strengthened inflow of extracellular calcium into the cell. Furthermore, calcium is released from intracellular storage.
- **Influencing the transport rates of ATP-dependent ion pumps can additionally modulate the intracellular ion concentration.**

Cellular Processes

Many cellular processes like

- **Proliferation** (reproducing freely) and **differentiation** (the sum of the processes whereby apparently indifferent or unspecialized cells, tissues, and structures attain their adult form and function)
- **pH value**
- **degree of polymerisation** (a chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules of structure proteins)
- **activity of many enzymes**
- **PKC, the protein kinase C, playing a central role in cellular signal transmission**
- **MAPK (MAP kinase), one of the most important signal paths on the cellular level,**

are regulated by the intracellular calcium concentration. Moreover, Ca^{2+} is required in muscle contractions, exocytoses etc. (the release of cellular substances (as secretory products) contained in cell vesicles by fusion of the vesicular membrane with the plasma membrane and subsequent release of the contents to the exterior of the cell)

This is why special significance was attributed to the field-induced calcium effects.

Pulsed currents

- An artificial intervention in this regulatory system is only possible if it could be managed to generate field strengths or current densities at the site of the effected area which could modify the physiological parameters in strength and type.
- Of course, the best dosage would be to introduce the current through electrodes, which is however inadvisable due to invasiveness and considerable side effects, e.g. tissue damage in everyday situations.
- As an alternative, pulsed currents are capacitively applied by Algonix.
- In order to reach the desired tissue with the applied current, sinus-shaped alternating currents are transmitted in pulses. Inside the tissue they are forwarded in a cosine wave of the same frequency. If the range of the many unknown dielectric and geometric parameters have changed it is no problem, because with the Algonix's ability to read up to 900 times per second, and armed with the empirical data, a new therapeutic program will be created & calculated with the required parameters.
- **The basis of this hypothesis is taking into consideration that an electric field generated inside the tissue, as in the case of capacitive coupling, can polarize the membrane but cannot penetrate into the cell.**
- **Algonix and Beautytek both work with electric fields which can influence the signal system and the metabolism of the tissue.**

Gap junctions and cross talk

On the other side the cells communicate directly among each other over the so-called “gap junctions”, i.e. membrane proteins forming channels, through which water, ions and small molecules are transported from one cell to the next.

Such signal molecules usually bind to specific receptor proteins on the cell surface. Then, the extracellular signal is converted into an intracellular one.

Cells have different means of communication:

- endogenously chemical by forming “second messengers” (e.g. Ca^{2++} , ATP)
- electrochemically by opening up ion channels
- by means of hormones

These possibilities of signal transmission are applied individually or combined (“cross talk”).

Micro Current

- Biostimulation is a **directed movement of charge carriers**, or so-called micro current. It is more tolerable than any other form of stimulation and can treat the tissue and cells in a gentle manner.
- This current is fine-tuned to the level of **normal electric activities of the body cells** and thus very natural and effective.
- All bioelectrical phenomena are based on the **movement of electrically charged ions**.
- In a living organism **energy and information** flow through the **charge carriers (ions)** into the cells. The energy and information flows can be influenced in a predictable way (algorithms) by subtle energies in the surroundings, diseases and disorders. Apart from electrically charged ions, many other smaller units flow, e.g. electrons, protons and electron holes (sites where an electron is missing).
- Such complex procedures in an organism would not be possible without control, feedback and regulation. Such a feedback control system represents a **control loop**.

Summary

Algonix analyses the actual state of the tissue, taking into consideration empirically collected physiological and pathological data and digitally develops the best possible therapy parameter by means of a learning software. Thus, the device is easy to use, practically without any side effects and very effective regarding the therapy.

Last but not list

Different electrode types and electrolytes show different impedance spectra. In general, the application of specified electrolytes is important, and especially important with Algonix or Beautytek, since the calculated algorithms are very accurately adjusted to the corresponding electrode-electrolyte-border surface (behaviour in this frequency range, double-layer capacitance (adsorption, film formation, roughness) and polarization resistance (charge transfer, diffusion, metal dissolution).)

Specifications of Algonix

- **Digitally modulated, multiphase pulsed current packages**
- **Frequency between 0.35-120 hertz**
- **Intensity between 35-600 micro-ampere**
- **Voltage of 0-20 volt**
- **Analysis software with empirical data as algorithm models**
- **Adaptable software (fuzzy logic) or intelligent system**

<http://go.to/funpic>

