ES, Electro Stimulation

A new approach to healthy aging

Arnaud van der Veere

Arnaud van der Veere

Inhoud

Introduction

Electrostimulation has been around since the '70's. Every few years it has a revival but did not get the attention which it did deserve. Currently, the ES is re-discovered by health care and health clubs. EMS and TENS sales are increasing day by day and the market is exploding.

Scientific developments and application are only a part of the reason. Acceptance of electronics as a major part of life, direct influence on our health of external mediums, the growing interest in robotics, domotica, app-applications and other tech developments has created a welcome environment for the revival of Electro Stimulation programs.

Good marketing proved to be the key to the mind of many fitness entrepreneurs who felt it was worth the investment. The need for limited space, temporarily fixed investment, a nearly guaranteed return on investment and the prospects of fast growth did convince many young fitness professionals. The image of being a Personal Trainer with a clear specialization is appealing.

But there is a problem on the horizon. Most entrepreneurs, fitness professionals, physiotherapists and health professionals invest their money in products of which they hardly know the potential. The lack of knowledge holds them back in the use of their investment for multiple possibilities. Each could make much more of their investment if only they had more knowledge of the possibilities and application of their products.

The reason why ES failed in the past was the lack of knowledge in the application and technical possibilities. This book is intended to supply the needed information to get a maximum of the possibilities ES products offer and how to apply it. Our goal is to make ES last forever and proof that it deserves a rightful priority place in revalidation, healthcare, and sport.

The writer Arnaud van der Veere is an expert in Age Control and visiting Professor of Biochemistry in China, with over 35 years' experience as an entrepreneur in sport and healthcare. He has written 23 books and thousands of professional articles in magazines and newspapers in different countries. More information is available at www.agecontrol.nl and www.arnaudvanderveere.nl.
Professionals can connect through LinkedIn; https://www.linkedin.com/in/arnaudvanderveere/

Before you start.

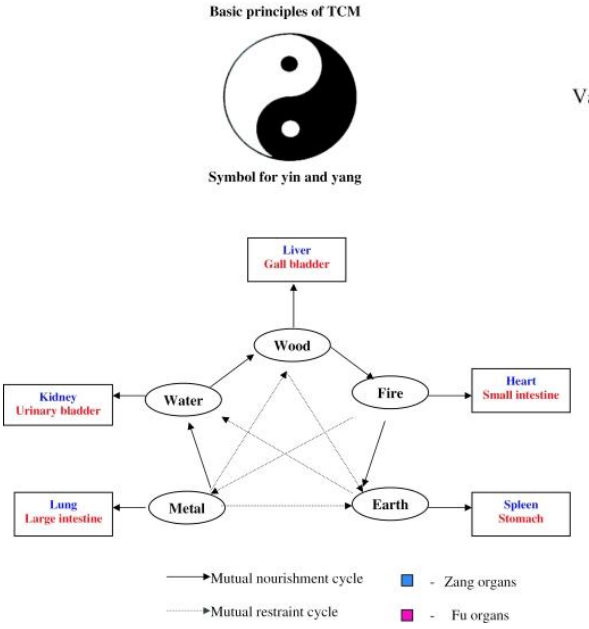
- In this book, I mention **the word chemicals** on a regular basis. This word reflex all chemicals from natural and manufactured origin. As a biochemist I make no difference to avoid misleading information. Nearly all products for human consumption or treatment pass a form of modification which could be mechanical, chemical or fermentable. Each of this processes is a modification of chemical structure leading to availability for the human body.

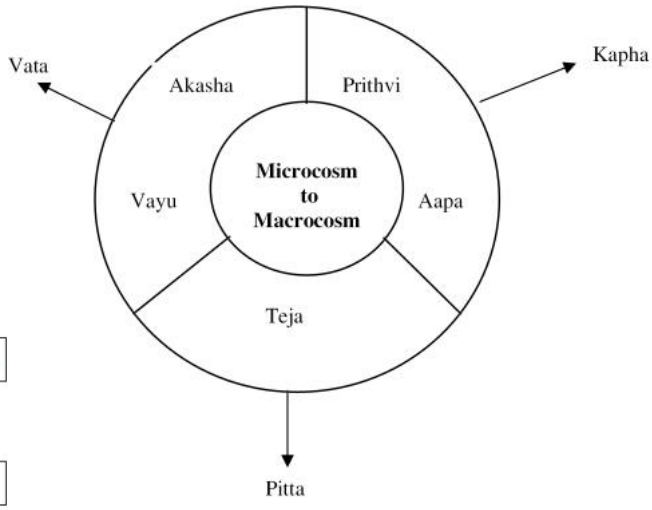
- **ES** is used for every form of **Electro Stimulation** used in this book. The use of ES makes no difference if it is used for brain, muscle or nerve stimulation.

The future of health

The future of health

Healthcare is changing rapidly. The slow development of real healthcare did probably start in India it is guessed around 10.000 years ago. Traveling monks and merchants took it to China where it got another dimension. But the fundaments did stay the same.





India;

TCM (nature): positive/negative energy, hot, warm, neutral, cool, cold; Ayurveda (potency – veerya): warm or cool, vipaka or post-digestive effect and prabhava or specific unexplainable action. Both understand channels exist within the body and aid in the flow of energy or else become blocked and inhibit normal flow.

The essence of both is a direct link with energy. Each of the elements is connected by a flow of energy between them. There is a potential difference which creates a constant stream of electrons from one side to the other. This ancient fact is still very actual and more evidence comes to light to support this ages old theory of health. The use of electric devices is one of the most important proofs of this.

Electricity has an important role in our everyday life. The whole world is connected to an electrical source. Everything around us is using some form of electricity. All our phones, laptops, computers, TV's, radio's, home equipment and soon all transportation is in need of the daily doses of electricity to function.

The sources of electricity are changing. From fire and heat depended on electricity sources we move to more "green" natural energy. Windmills, water turbines, and SunPower deliver "new" energy. From polluting forms to cleaner solutions.

Another development is the change of power used by equipment. From high needs for constant power, most new designs use as less power as possible with low Voltage and Ampere. Saving power at the "end user" makes the source last longer.

The development of low energy equipment is closely related to the use of Electro Therapy in which (very) low levels of energy is needed to create a maximum in physical response in the human body. These developments imitate the naturally occurring potential difference in our body and surrounding us. Nature is a long-term user of minimum energy sources. A very efficient way to use energy.

Western healthcare is equipped with a sheer endless amount of different machines for treatment and diagnostics. Each of these machines is highly sensitive. Until now, most of these machines are still connected to the standard energy source (220 / 230V) but transformed to the needed current. In this process, some energy is lost. This is a waste.

ES (electro stimulation) is not only a science but also a source of information for the future of health and mankind. We work with minimal current and frequencies to mimic nature at its best. The foreign intervention of the human body is as little as possible but creates a maximum result. The interaction machine / human body is studied to diminish the use of energy by most electrical equipment in hospitals.

Low energy equipment needs a smaller size, which makes it easier to transport, lighter in weight and portable. Using more portable equipment gives doctors and nurses more flexibility in practice. When we continue this development it is possible to fit a complete hospital in a container. Portable hospitals are lifesavers in case of an emergency such as disasters.

The above mentioned positive developments for the general healthcare is just but one aspect of ES. On the other side, there are also spectacular developments. With following points, which do not pretend to be a complete list of possibilities, I show some of the developments we can expect in the near future.

- ES is already a strong part in revalidation in injuries with trained professionals (ES certified) but it will become a strong prevention tool for top sport and Age Control. Equipment is used in the morning at raise up as a starter or motivator for the different groups. Muscles get stimulated and energy-loaded for the activities to come. The general and specific energy level is boosted for physical and mental use. It is expected to become a replacement for chemical energizers.
- ES will get a stronger influence in mental care of depression, psychological problems, bipolarity and other mental problems. Devices can and will be used on a temporary but also daily basis in a standby or portable size. Some ES machines can be carried all day or even implanted using the body as a source of energy.
- ES is improving physical fitness for all. Depending on the target ES is employed for a better body or higher achievement in sport. Specialist (ES certified) know with stimulation is used for the desired result.
- ES is employed for mobility. Growing older becomes easier when knowing and supported by ES machines assisting the muscles to move in the right direction, keeping correct balance or have the right toilet time.
- ES can be employed for sense development for people with autistic tendencies. The electrical impulses are useful to create awareness and alertness. These devices are combined with observation and communication tools (smartphones).

From therapy to home

Surprisingly I discovered a lack of interest and knowledge with many physiotherapists about the application of ES. The first reaction is a denial that the equipment has a positive result. Upon questioning them on their knowledge about the functioning I can to shocking results. Over 90% of the Physiotherapist and medical professionals had hardly any knowledge of the functioning or the application of ES in practical, easy to measure situations.

ES products seemed to be particular of interest in sport, self-help and in private situations. The applications are numerous and the results are astonishing. But the not-licensed professionals are in full denial. I did encounter the same situation in the 80's and 90's when trying to introduce physical therapy in the same group. They refused the fact that active therapy, this implies the training with weights and body-weight, had the best results. Most, over 90%, did stick to passive therapy such as red lamps, massage, and some warmth treatments. Their results were virtually zero and customers kept coming back with the same problems.

In the last years of the 90's suddenly a Physiotherapist guru stepped up and preached the physical therapy as the only way to treat customers. Suddenly the mood did change and the therapist started to exercise their patients. Most without proper knowledge or ability. They copied Body Building but did not get the essence of training recuperation. Until today many customers get injured because of the wrong use of power training by untrained (physio)therapist.

The same is happening with ES products. In the 80's and 90's many (physio)therapist did use ES in a passive way. Again due to not knowing how to apply the products in the right way. This moved a working product into a home situation. People started to apply the products at home. Mostly for the wrong reasons. The products were promoted for losing weight, skin toning, and sexual performances. I have to admit that it did surprise me and my team that the application of ES as sex toys was such a big market.

In 2015 some pioneers started to explore the combination of the active use of ES and exercise. The first "studio's" did open under different names advertising a 20-minute program. This program, as the advertising mentioned, replaced a 3-hour workout. This is not true. There are many reasons to explain that it is factual, not true but the concept to combine exercise and ES was right. The effects on healthy individuals were clear from the start. Many people did join the concept to feel the effect of ES on their body. And effect they got.

Active application of ES stimulates the full body as the muscular contractions are deeper and stronger. When active during the impulses the reaction of the muscles goes up strongly. Many people experienced muscle fatigue, sourness, and pain after the first few sessions.

Most of the studio's do not have enough knowledge to get the maximum results from there, often high quality, products. A physiotherapist is in doubt of how to use the products and apply in active therapy. A combination of both and proper education can bring the right health therapy from hospital to home.

Changing attitudes

Independent living, personal preferences, flexibility, and employability are changing. People live longer single or independent. The housing units are smaller and more efficiently decorated. Time has become a special commodity which to some is flexible while others have a chronic lack of it. All these have a direct influence on health. ES is a perfect fit for all these circumstances. It can be employed anywhere and at any time.

Since 2015 many studios did open their door with as slogan “the perfect fast alternative for exercise”. The appealing fast result option attracts many people who want more activity but “cannot” make time for exercise. The attitude of easy and fast has not been changed since the ‘70’s. But ES also gets the attention of an active group of people who see the application of ES as a challenge to improve their personal core activity. By joining the studio training they get to know their muscles and nerves better. The electrical current shows them how to contract a muscle and also how to stimulate it to a maximum degree.

In (professional) sports environment it is normal to experiment with all possible products to enhance the performance. ES has been around since the early 60’s when Russian athletes started to use it as a performance enhancer. Little is known that they applied the combination ES / Supplements /Exercise. The combination of these three did the trick and performances got to a top level making Soviet athletes nearly unbeatable.

While doing my research I was wondering if and how we really did change in attitude since the ‘60’s. In these years most people had a physical job or at least had an active lifestyle. The TV was not well developed and going out to dance to meet people was a weekend normality. Social connections were stronger and interactions had a daily returning routine. The physical fitness of most people was reasonable to good.

From the ‘60’s until now, our lifestyle is changed from active to passive. The standard activity rate in the ‘60’s was around 54+%. Most people today have a less than 20% activity rate in their life.

Human Activity Rating System. (HARS)

- The rate is calculated over a 12 hour day period
- Each active hour stands for 9%
- Each part of the hour is 9/60=X %

It is possible to have a more than 100% activity rating by plus daily more hours.

The idea behind the marketing strategy of different ES studio promotion programs is to enhance your HARS by 27% by the suggestion that you can add a 3 hour training period to your activity level. But this is factual, not true. ES is highly beneficial but only when combined with the right other activities.

In the future, we have to change the attitude toward a plus+plus system. We add activity and combine them with a wholly pleasant experience. Activity needs to be enjoyable and with some sense of reward. Choosing ES to replace joyful activity is not a positive development. But adding ES to enhance your enjoyment, pleasure, and possibilities in life, is a long-term rewarding and positive development.

Self-help needed

ES is one of the few methods of self-help products that can hardly ever bring harm to the user. Unlike most electrical, chemical or medical products it can be easily used and understood at any time. Good and clear instructions, as given in this book, enables everybody to use it more or less frequently. The use of ES products rarely to never result in injury.

In another section of the book we show the nearly endless possibilities of application of ES products but here I would like to focus on self-help. It is advised to read the manual but also receives instructions of a (licensed) ES professional before using any of these instruments. Self-help is a need in a changing society where the medical help becomes very expensive, waiting list is long, professionals have a hard time listening to their patients (time pressure), individualization of treatments is drowning in standardization and recuperation is long. But for what can we use the products?

- Pain. Most people use TENS machines to limit pain experiences. The use of drugs is often addictive and sometimes dangerous. TENS support pain treatment when applied by professionals in the right way. The results are remarkable.
- Recuperation. Injuries can be painful and limiting. EMS is used for muscle activation, mobilization, stabilization, and recuperation. Depending on the right intensity and application one or more muscle groups can be targeted for treatment.
- Mobilization. People suffering from some form of immobility due to malfunction of their legs, back or other parts of their body can be assisted by TENS/FES/EMS activation. There are many different ways to use personalized products. We can distinguish between implants, external drives, wireless applications and body stickers.
- Maximization. Some EMS are made to stimulate muscle power, endurance or maximalization to enhance performance. These performances vary from athletic skills, fitness to power. With the right way to using it is possible to enhance flexibility and specific skills.
- ROM. Rang of motion capacity training. Some people have damaged or injured ligaments such as shoulders. Due to scar tissue, infections or calcification the range om motion of the arm is limited. By using ES it is possible to increase the ROM.
- SET. Sexual enhancement therapy. Many people experience unpleasant results before, during or after sexual activities. ES offers some solutions. Erectile malfunctioning, vaginal dryness, finishing capacities, pain during activities and many more possibilities.
- Mental stimulation. tDCS is a way of brain stimulation with an ultra-low level of electric stimulation. Stimulating the brain neural system increases endorphins and hormones which have a positive effect on wellbeing.

Control aging

ES products assist on a muscular and neural level. During the aging process, both functions degenerate if not activated often enough. Most people exercise to less, have little or no physical labor or activity. Lack of movement increases degeneration of all biological parts of the body. Slowly but steady the ability to move is fading away.

The use of ES products supports artificial exercise by contraction and stimulation of muscles and nerves. It cannot replace proper healthy exercise but enables the body to have a minimum of needed movement for use.

Muscles need a certain degree of contraction to keep functioning well. If muscles do not contract often enough they are considered useless and blood circulation slowly is reduced. A small reduction of blood implies less oxygen and energy. Muscles get to a point of "starvation" and start reducing not used fibers. These fibers are broken down and the waste is exported for cancellation.

ES can be used to activate the muscles and lifestyle. From a sedative way of living into a joyful participation in activities. One of the major advantages of ES is the flow of energy that re-activates the body. The "tickling " of the vibrating contractions give a special feeling in the body. This feeling activates more than the stimulated muscles. It creates a mental reflex with a desire for action.

During aging people feel a reduction of abilities. Joints do not function to optimal, muscles lose power and reflexes slow down. There are two ways to get along with this negative losing of abilities.

- Accept and feel the degradation day by day getting a grip on life and start ruling it
- Diminish the effect by activation and stimulation of all parts of the body

It is a personal choice. But a choice that is not influencing the individual only. By degrading abilities this individual must rely more and more on the help of others. But the "others" are less and less available. Losing abilities lead to loneliness and isolation.

Stimulation and activation is a challenge and not always easy. Getting older means that motivational power must stay the same or improve to live a healthy capable life. Some people need to use an ES for brain and muscle stimulation to continue a proper lifestyle. ES sessions can be combined with Virtual Reality, music sessions or learning activities.

More research is needed but stimulating the brain from an early stage, starting in the late 20's, can improve brain functions and mental activities. This form of stimulation may result in limitation of brain damage and function as an early warning for brain problems such as Alzheimer.

Improve activity

Using ES in the right way promotes motion and the will to move. A tickling of the muscles and nerves motivate the user to move and get out of a not active position. Depending on the power used the activation can be strong or weak.

Electricity is an integral part of our whole biology. From the smallest cell to the most complex organ, the heart, all is ruled by "electricity". The potential differences which occur in every cell of the body. Further on in the book, I explain the importance of potential differences.

The influence of electrostimulation on every part of the body is the energizing of tissue with a little more power than before. The external forces of electricity start to take part in the internal levels of energy and influencing the overall degree of activity.

It is currently not proven yet but the theory is that the externally added electricity becomes encapsulated in cell level structures. The “overload” of energy creates potential differences in the body which create an emerging level of hormones and endorphins. These natural stimulators enhance the overall metabolism which stirs up the ATP levels. When ATP levels go up the body becomes energized and must find ways to deactivate and release energy until an acceptable level is reached. Until that is done the body needs to become active.

Enhance performances

Active people want to enhance their performances by adding an extra stimulus to their program. ES has many possibilities to contract and stimulate muscles on a deeper or stronger level. Training or exercise becomes more fun and often with a higher result than ever before. Athletes use periodical ES stimulation for instance during traveling, recuperation of injuries or to maximize a range of movement.

During physical activity, we use different muscles. Each muscle receives information of contraction and duration of the contraction. Beside this, there is always an intensity of the contraction. Most activities do not need full or maximum contraction. During the competition, most muscles are never used in full range of motion due to needed speed or power actions.

When we apply ES it is possible to create a full ROM effect but also a maximum contraction level. Using different frequencies, power levels and wavelengths will influence the movement, flexibility, intensity, and power of any movement and side elements. The side elements are area’s which are not directly connected with the activity but involved on the side. A good sample is a balance or stability during a weight lift. Besides lifting the weight the body needs to be stabilized to bring the weight to the best position for a successful lift. In every part of the move, there are supportive muscles which assist the lifter to have a stable standing and a balanced lift of the weight.

With traditional training, a person has to go up to 80-90% of maximum performance to improve results in competition. It is not possible to reach this level at every training. When trying it even becomes dangerous. The possibility of injury is very high.

But when we apply ES during the exercise and increase the muscle contraction and intensity to a high level the chance of injury is decreased but the possibility of improvement is maximized. By using ES during training the level of injury goes down and the result goes up.

To transfer electric power into biological power needs a translation vehicle. Redox salts, neurotransmitters, polarity of aminoacids and the use of right combinations of pulse length, wide and frequencies. By using the tested combinations under the right conditions and for goal oriented reasons the results are very good. Professionality and knowledge is the key to superb results in business but also in customer experience.

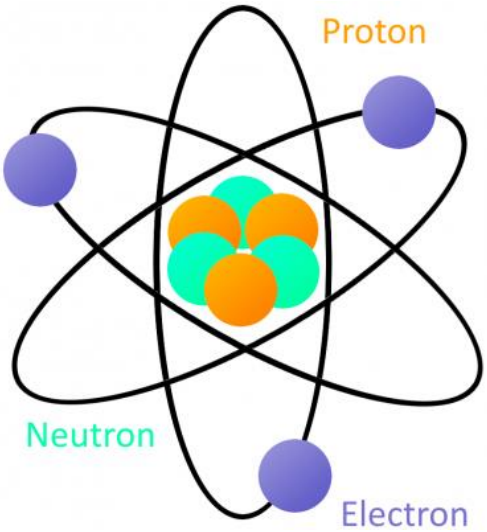
Beauty treatments

The skin is one of the first parts of the body that can be stimulated by ES to recuperate, regain elasticity, get stronger, more shiny and beautiful. Special ES programs assist the body to energize the skin.
Electrostimulation most of the time is applied through the skin. The pads are connected with the skin as the first contact with the body. Most of the electricity is transported through the skin into the muscles or nerves. But the skin is also a highly electrified organ. It is the largest organ of our body and highly sensitive to the outer world.
Our skin loses elasticity when getting older. Environmental influences do harm the skin in different ways. Sun, water, chemicals and external force are some of the ways our skin gets hurt. Sometimes it is damaged and broken. An open skin allows pathogens to enter the body and make us sick.
There is a saying; “beauty is only skin deep”. But it is not true. The skin is a reflection of the health of the body. When internal organs do not function well it is reflected in the color and constitution of the skin. All medical treatments use the skin as a way of diagnosis of disease. The receives a lot of signals from the inside of the body to communicate with the outside world. Many products from the inside are transported to the outside through the skin. But very little products are allowed to pass the skin barrier from outside to inside.
Most ES treatment specialist in the beauty industry combines different methods for a maximized result. Beside electricity, they apply vibration, light and different chemicals to treat it as best as possible.
The skin is a sensitive organ as mentioned and has many different levels of treatment and stimulation. Internal stimulation does occur in some treatments or enjoyments. Safety is always a priority.
Beside the skin we are aware of the shape of a person. The “looks” are important as the phrase “the first impression in the lasting impression” still counts. Electro Stimulation assist, next to an active lifestyle, to get a high muscular tonus, lifted posture and improved mood.

What is Electricity?

Electricity is a phenomenon that occurs throughout nature and takes many different forms. It is briefly defined as the **flow of electric charge**. To understand the fundamentals of electricity, we need to begin with the construction of atoms, the basic building blocks of everything. Atoms exist in different forms as chemical elements like hydrogen, carbon, oxygen, copper in total 118 different. When atoms combine to form molecules, they get a new function and characteristic. They do not lose identity but become part of the total.

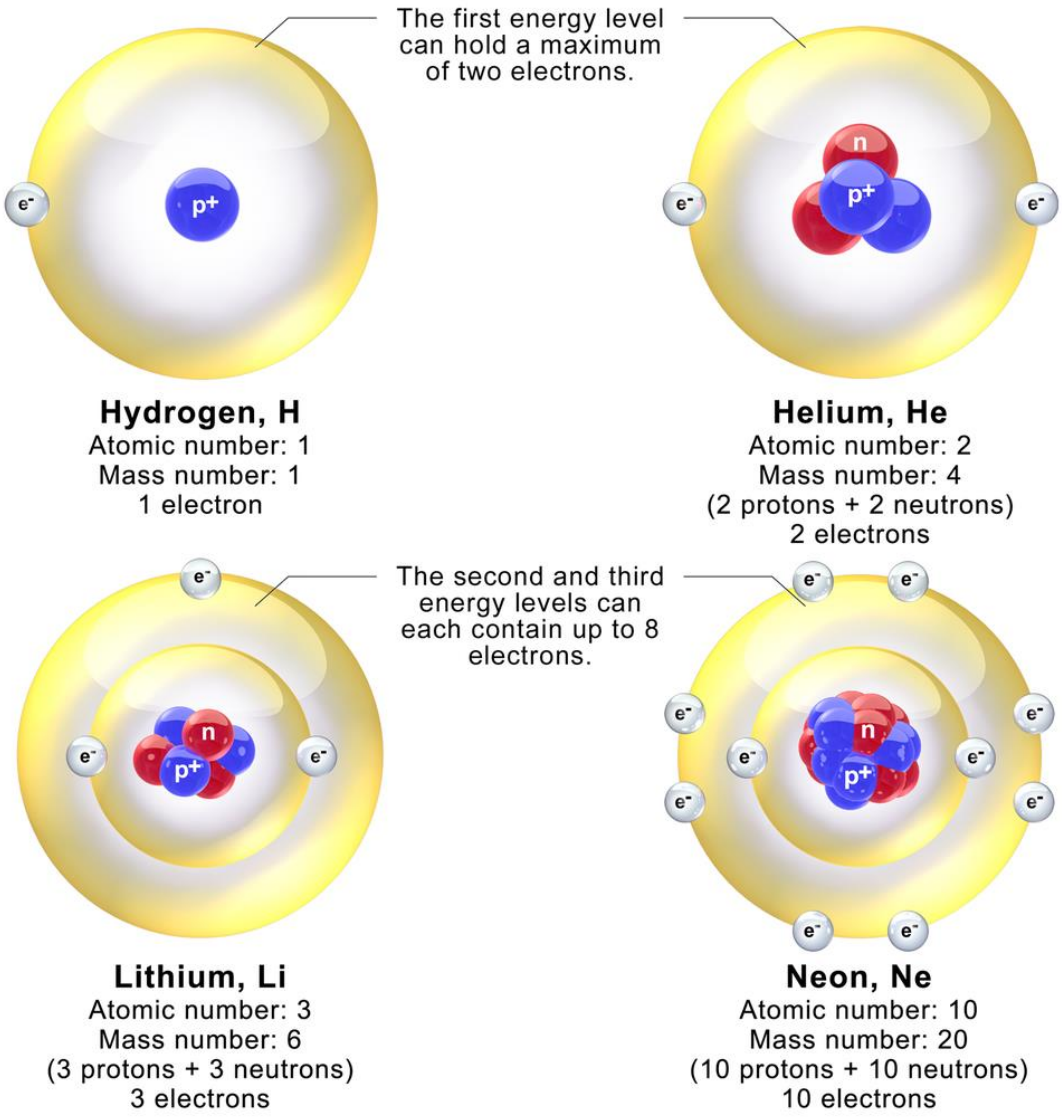
An atom is built from three particles: electrons, protons, and neutrons. Each atom has a central nucleus, where the protons and neutrons are packed together. Surrounding a nucleus are a group of orbiting electrons. Together they represent unique features for "that" specific element.



A model atom. The nucleus is made of protons and neutrons and surrounded by orbiting electrons.

Every atom has at least one proton in it. The number of protons in an atom defines what chemical element the atom represents. For example, an atom with just one proton is hydrogen, an atom with 29 protons is copper, and an atom with 94 protons is plutonium. This count of protons is called the atom's **atomic number**.

The protons are held at a place in the nucleus by neutrons which also determine the isotope of an atom.



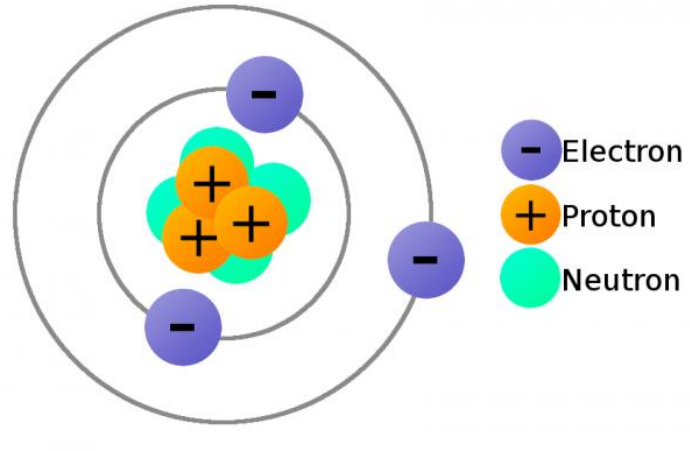
Electrons are essential to the workings of electricity. In its most balanced state, an atom has the same number of electrons as protons. In the Bohr atom model below, a nucleus with 29 protons (a copper atom) is surrounded by an equal number of electrons.

The Bohr model is a very useful atom model as we explore electricity. The atom's electrons aren't all forever bound to the atom. The electrons on the outer orbit of the atom are called valence electrons. With enough outside force, a valence electron can escape the orbit of the atom and become free. **Free electrons** allow us to move charge, which is what electricity is.

Flowing Charges

The charge is a part of matter–just like mass, volume, or density. It is measurable. As it is possible to quantify how much mass something has, you can measure how much charge it has. The key concept with charge is that it can come in two types: **positive (+) or negative (-)**.

In order to move charge, we need **charge carriers**. Electrons always carry a negative charge, while protons are always positively charged. Neutrons are neutral, they have no charge. Both electrons and protons carry the same **amount** of charge, just an opposite type.

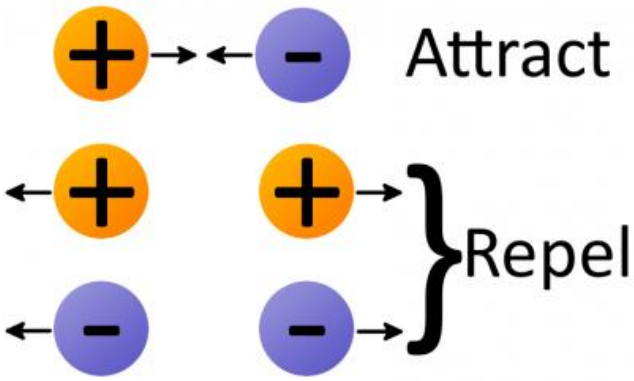


A lithium atom (3 protons) model with the charges labeled.

The charge of electrons and protons is important because it provides us the way to exert a force on them.

Electrostatic Force

Electrostatic force (also called Coulomb's law) is a force that operates between charges. It states that charges of the same type repel each other, while charges of opposite types are attracted together. **Opposites attract, and likes repel**.



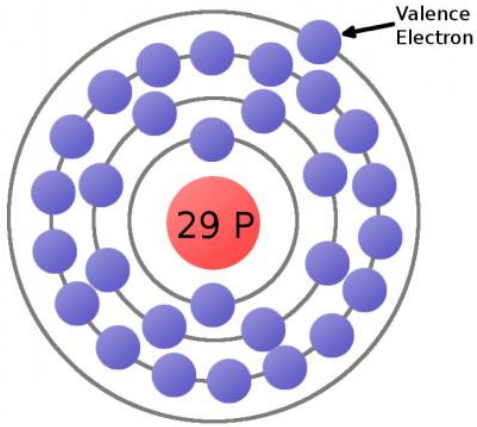
The **amount** of force acting on two charges depends on how far they are from each other. The closer two charges get, the greater the force (either pushing together or pulling away) becomes.

With electrostatic force, electrons push away other electrons and are attracted to protons. This force is part of the "force" that holds atoms together, it's the tool we need to make electrons (and charges) flow!

Making Charges Flow

Electrons in atoms can act as the **charge carrier**, every electron carries a negative charge. If we can free an electron from an atom and control it to move, we can create electricity.

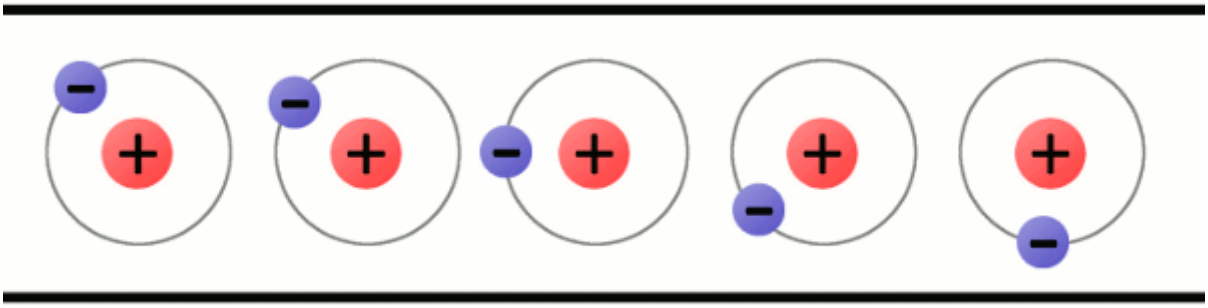
As copper is known as a great conductor we use the atomic model of a copper atom as a sample for charge flow. In its balanced state, copper has 29 protons and 35 neutrons in its nucleus and an equal number of 29 electrons orbiting around it. Electrons orbit at varying distances from the nucleus of the atom. Electrons closer to the nucleus have a stronger attraction to the center than those in distant orbits. The outermost electrons of an atom are called the **valence electrons**, these require the least amount of force to be freed from an atom.



This is a copper atom diagram: 29 protons in the nucleus, surrounded by bands of circling electrons. Electrons closer to the nucleus are hard to remove while the valence (outer ring) electron requires relatively little energy to be ejected from the atom.

Using enough electrostatic force on the valence electron– either pushing it with another negative charge or attracting it with a positive charge–we free the electron from orbit around the atom creating a free electron.

A copper wire is full of these "free" electrons. As the **free electron** is floating in a space between atoms, it's pulled and prodded by surrounding charges in that space. In this chaos the free electron seeks for a new atom to latch on to; in doing so, the negative charge of that electron ejects another valence electron from the atom. The "new" electron is drifting through free space looking to do the same. This chain effect can continue on and on to create a flow of electrons called an **electric current**.



A simplified model of charges flowing through atoms to make current.

Conductivity

Some elemental types of atoms are better than others at releasing their electrons. To get the best possible electron flow atoms with a weak electron binding at the valence side are needed for a flow of electricity. An element's conductivity measures how tightly bound an electron is to an atom.

Elements with high conductivity, which have very mobile electrons, are called **conductors**. These are the types of materials we want to use to make wires and other components which aid in electron flow. Metals like copper, silver, and gold are usually our top choices for good conductors.

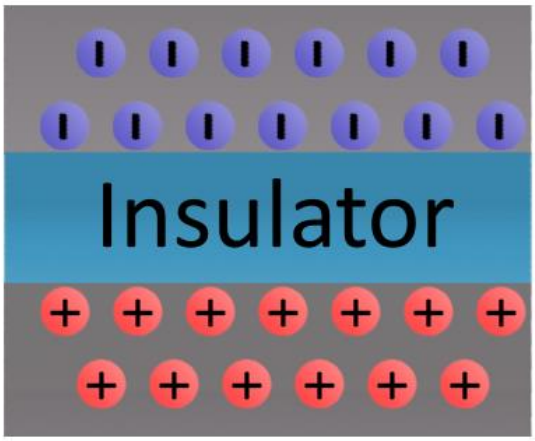
Elements with low conductivity are called **insulators**. Insulators serve a very important purpose: they prevent the flow of electrons. Popular insulators include glass, rubber, plastic, and air.

Static or Current Electricity

Before we move on, we need to distinguish the two forms electricity can take: static or current. In working with electronics, current electricity is much more common, but static electricity is important to understand as they influence each other's functioning.

Static Electricity

Static electricity exists when there is a build-up of opposite charges on objects separated by an insulator. Static (as in "at rest") electricity exists until the two groups of opposite charges can find a path between each other to balance the system out.



When the charges find a means of equalizing, a **static discharge** occurs. The attraction of the charges becomes so great that they can flow through even the best of insulators (air, glass, plastic, rubber, etc.). Static discharges can be harmful depending on what medium the charges travel through and to what surfaces the charges are transferring. Charges equalizing through an air gap can result in a visible shock as the traveling electrons collide with electrons in the air, which become excited and release energy in the form of light.

Spark gap igniters are used to create a controlled static discharge.
One of the most dramatic examples of static discharge is **lightning**. When a cloud system gathers enough charge relative to either another group of clouds or the earth's ground, the charges try to equalize. As the cloud discharges, massive quantities of positive (or sometimes negative) charges run through the air from the ground to cloud causing the visible effect if lightning.

Friction from rubbing different types of materials transfers electrons. The object losing electrons becomes positively charged, while the object gaining electrons becomes negatively charged. The two objects become attracted to each other until they can find a way to equalize. Preventative measures against static electricity include wearing ESD (electrostatic discharge) wrist straps or adding special components in circuits to protect against very high spikes of charge.

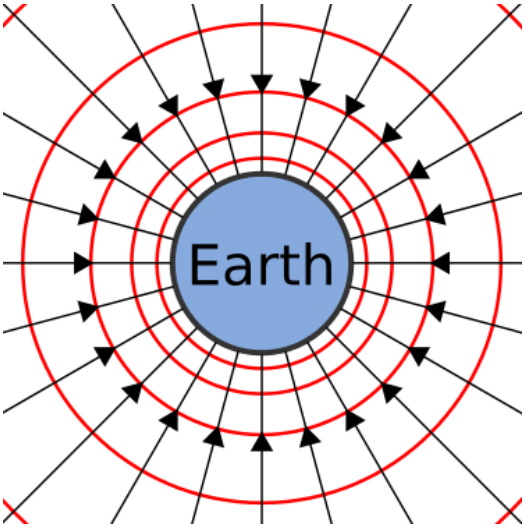
Current Electricity
This form of electricity exists when charges are able to **constantly flow**. In order to flow, current electricity requires a circuit: a closed, never-ending loop of conductive material. A circuit could be as simple as a conductive wire connected end-to-end, but useful circuits usually contain a mix of wire and other components which control the flow of electricity. The only rule when it comes to making circuits is they **can't have any insulating gaps** in them.

If you have a wire full of copper atoms and want to induce a flow of electrons through it, *all* free electrons need somewhere to flow in the same general direction. Copper is a great conductor, perfect for making charges flow. If a circuit of copper wire is broken, the charges can't flow through the air, which prevents any of the charges from going anywhere. On the other hand, if the wire were connected end-to-end, the electrons all have a neighboring atom and can all flow in the same general direction.

"Electric power" means "flow rate of electrical energy." If electrical energy was like water, then electric power would be the liters-per-second. Energy is measured in Joules, and when energy flows, the flow is measured in Joules per second. What is a watt? The word "Watt" is another way of saying "Joule per Second." Energy comes in Joules, while power comes in Joules per second. Power is a FLOW RATE of energy or a RATE OF USE of energy. We can store electrical energy, but electric power is not something that is ever stored.

Electric Fields
Most often the source of electron flow comes from an electric field. The concept of the electric field was introduced by Michael Faraday. A *field* is a tool we use to model physical interactions

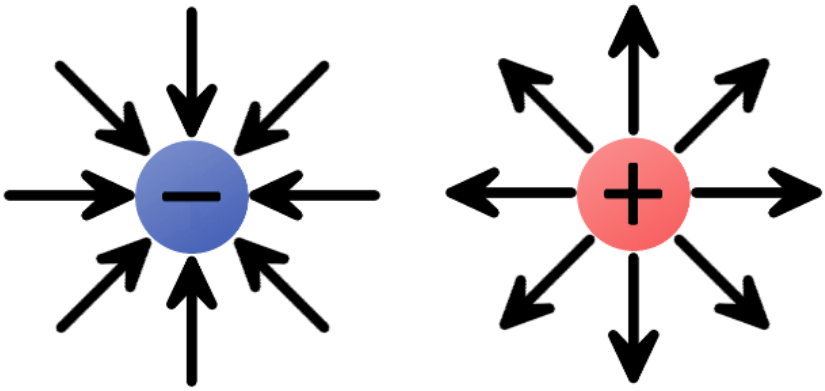
which **don't involve any observable contact**. Fields can't be seen as they don't have a physical appearance, but the effect they have is real.
We're all are familiar with Earth's gravitational field, the effect of a massive body attracting other bodies. Earth's gravitational field can be modeled with a set of vectors all pointing into the center of the planet; regardless of where you are on the surface, you'll feel the force pushing you towards it.



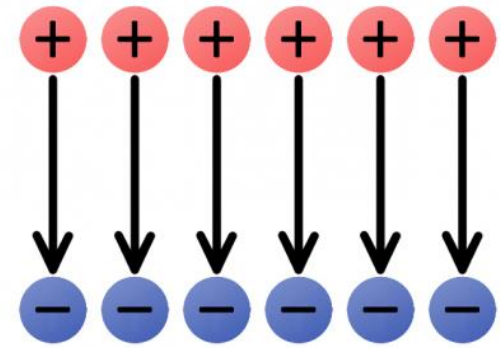
The strength or intensity of fields isn't uniform at all points in the field. The further you are away from the source of the field the less effect the field has. The magnitude of Earth's gravitational field decreases as you get further away from the center of the planet. Gravitational fields exert a force on objects of mass, and electric fields exert a force on objects of charge.

Electric Fields
Electric fields **describe the pulling or pushing force in a space between charges**. Compared to Earth's gravitational field, electric fields have one major difference: while Earth's field generally only attracts other objects of mass, electric fields push charges away just as often as the attract them.
The direction of electric fields is always defined as the **direction a positive test charge would move** if it was dropped in the field. The test charge has to be infinitely small, to keep its charge from influencing the field.

We begin by constructing electric fields for solitary positive and negative charges. If you drop a positive test charge near a negative charge, the test charge is attracted towards the **negative** charge. For a single negative charge, we draw the electric field arrows **pointing inward** at all directions. The same test charge dropped near another **positive** charge results in an outward repulsion, which means we draw **arrows going out** of the positive charge.



The electric fields of single charges. A negative charge has an inward electric field because it attracts positive charges. The positive charge has an outward electric field, pushing away like charges. **Groups of electric charges can be combined to make more complete electric fields**.



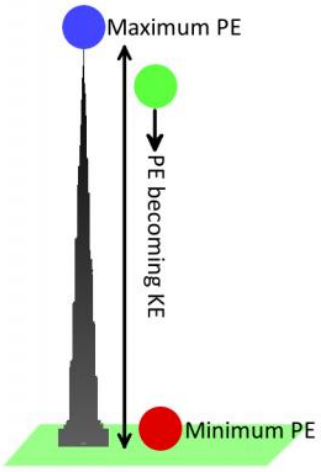
The uniform E-field above points away from the positive charges, towards the negatives. Imagine a tiny positive test charge dropped in the e-field; it should follow the direction of the arrows. As we've seen, electricity usually involves the flow of electrons–negative charges–which flow **against** electric fields.

Electric fields provide the pushing force needed to induce current flow. An electric field in a circuit is like an electron pump: a large source of negative charges that propels electrons, which flow through the circuit towards the positive lump of charges.

Potential Energy

Energy is defined as the ability of an object to do *work* on another object, which means moving that object some distance. Energy comes in **many forms**, some we see (like mechanical) and others we can't (like chemical or electrical). Regardless of what form it's in, energy exists in one of two **states**: kinetic or potential.

An object has **kinetic energy** when it's in motion. The amount of kinetic energy an object has depends on its mass and speed. **Potential energy**, on the other hand, is a **stored energy** when an object is at rest. It describes how much work the object could do if set into motion. It's an energy we can generally control. When an object is set into motion, its potential energy transforms into kinetic energy.

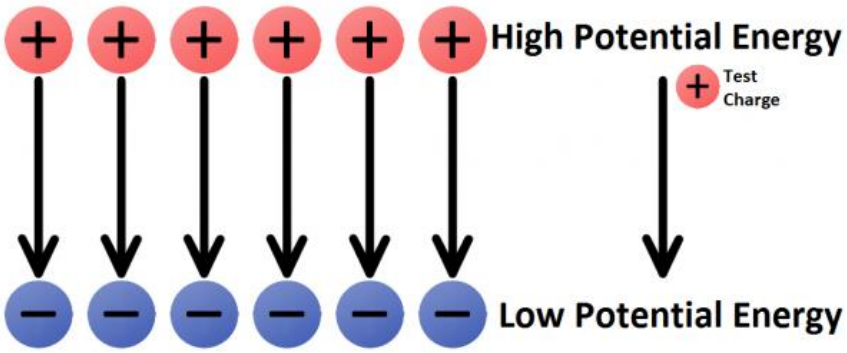


We use gravity as an example. A bowling ball lying motionless at the top of Khalifa tower has a lot of potential (stored) energy. Once dropped, the ball–pulled by the gravitational field–accelerates towards the ground. As the ball accelerates, potential energy is converted into kinetic energy (the energy from motion).

Eventually, all of the ball's energy is converted from potential to kinetic and then passed on to whatever it hits. When the ball is on the ground, it has a very low potential energy.

Electric Potential Energy

Just like mass in a gravitational field has gravitational potential energy, charges in an electric field have an **electric potential energy**. A charge's electric potential energy describes how much-stored energy it has when setting into motion by an electrostatic force, that energy can become kinetic, and the charge can do work.



Like a bowling ball lying at the top of a tower, a positive charge in close proximity to another positive charge has a high potential energy; left free to move, the charge would be repelled away from the like charge. A positive charge placed near a negative charge would have low potential energy, analogous to the bowling ball on the ground.

To instill anything with potential energy, we have to **work** by moving it over a distance. In the case of the bowling ball, the work comes from carrying it up 99 floors, against the field of gravity. Similarly, work must be done to push a positive charge against the arrows of an electric field (either towards another positive charge, or away from a negative charge). The further up the field the charge goes, the more work has to be done. Likewise, if trying to pull a negative charge *away* from a positive charge–against an electric field–it takes a lot of work.

For any charge located in an electric field, its electric potential energy depends on the type (positive or negative), amount of charge, and its position in the field. Electric potential energy is measured in units of joules (*J*).

Electric Potential

Electric potential builds upon electric potential *energy* to help define how much **energy is stored in electric fields**. It's another concept which helps to model the behavior of electric fields. Electric potential is *not* the same thing as electric potential energy!

At any point in an electric field, the electric potential is the **amount of electric potential energy divided by the amount of charge** at that point. It takes the charge quantity out of the equation and shows how much potential energy specific areas of the electric field may provide. Electric potential comes in units of joules per coulomb (*J/C*), which we define as a **volt** (V).

In an electric field, there are two points of electric potential. There's a point of high potential, where a positive charge would have the highest possible potential energy, and there's a point of low potential, where a charge would have the lowest possible potential energy.

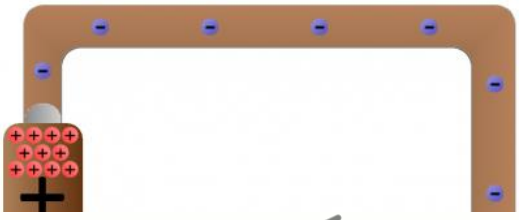
Voltage; A voltage is a difference in potential between two points in an electric field. Voltage explains how much pushing force an electric field has.

Electricity in Action!
The definition of electricity is the **flow of charge**. Usually, charges are carried by free-flowing electrons. Negatively-charged **electrons** are loosely held to atoms of conductive materials. With a little push to free electrons from atoms to get them to flow in a generally uniform direction.
A closed **circuit** of a conductive material provides a path for electrons to continuously flow.
The charges are propelled by an **electric field**. There is a source of electric potential (voltage), which pushes electrons from a point of low potential energy to higher potential energy.

A Short Circuit

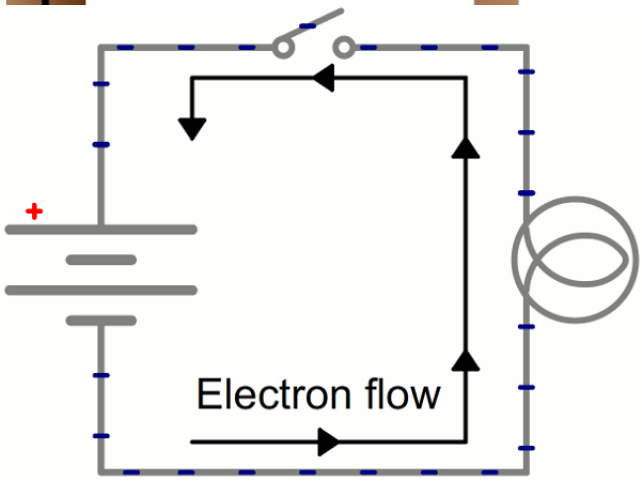
Batteries are energy sources which convert chemical energy into electrical energy. They have two terminals, which connect to the rest of the circuit. On one terminal there is an excess of negative charges, while all of the positive charges coalesce on the other. This is an electric potential difference just waiting to act!

If a wire is connected to a wire full of conductive copper atoms in the battery, that electric field influences the negatively-charged free electrons in the copper atoms. Simultaneously pushed by the negative terminal and pulled by the positive terminal, the electrons in the copper move from atom to atom creating the flow of charge we know as electricity.



Illuminating a Light Bulb

Generally, an electric circuit transfers electric energy into some other form–light, heat, motion, etc. When connecting a light bulb to the battery with wires in between, there is a functional circuit.



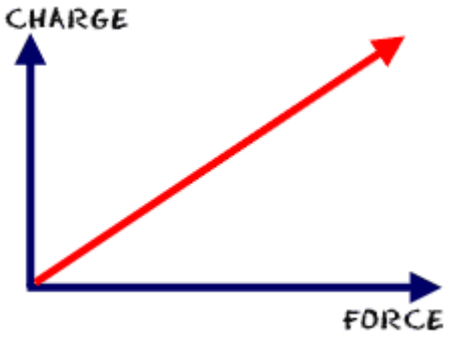
Schematic: A battery (left) connecting to a lightbulb (right), the circuit is completed when the switch (top) closes. With the circuit closed, electrons can flow, pushed from the negative terminal of the battery through the lightbulb, to the positive terminal.

While the electrons move, the electric field affects the entire circuit instantly. Electrons throughout the circuit, whether at the lowest potential, highest potential, or right next to the light bulb, are influenced by the electric field. When the switch closes and the electrons are subjected to the electric field, all electrons in the circuit start flowing at seemingly the same time. Those charges nearest the light bulb take one step through the circuit and start transforming energy from electrical to light (or heat).

When a charge is placed in a location with a non-zero electric field, a force will act on it. The magnitude of this force is given by Coulomb's law. If that charge were to move, the electric field is doing work on the electric charge. The electric potential at a certain point in space, which is equal to the work done by an external agent in carrying a unit of positive charge from an arbitrarily chosen reference point to that point without any acceleration and is typically measured in volts.

Coulomb: The Unit of Measurement of Charge

One of the first scientists to study charge transfer using scientific methods was Charles-Augustin de Coulomb in the mid-1700s. The study of interactions between charged objects, the standard unit of measurement of electric charge is named after him: the coulomb, abbreviated by the letter C.
A coulomb is related to other units of measurement commonly associated with electricity. For example, an electrical appliance that runs on 1 amp of electric current has exactly 1 coulomb of charge passing through its circuitry each second.
Coulomb Basics
The law looks at the forces created between two charged objects. As distance increases, the forces and electric fields decrease. This simple idea was converted into a relatively simple formula. The force between the objects can be positive or negative depending on whether the objects are attracted to each other or repelled.



Coulomb's Law
As charges increase, the forces increase. When you have two charged particles, an electric force is created. If you have larger charges, the forces will be larger.
F=kq1q2/r2

"F" is the resulting force between the two charges. The distance between the two charges is "r." The "r" actually stands for "radius of separation" but you just need to know it is a distance. The "q1" and "q2" value for the amount of charge in each of the particles. The constant of the equation is "k."

AMPERES

A quantity of charge is measured in units called COULOMBS, and the word Ampere means the same thing as "one Coulomb of charge flowing per second." If we were talking about water, then Coulombs would be like liters, and amperage would be like liters-per-second.

The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of the negligible circular cross-section, and placed one meter apart in vacuum, would produce between these conductors a force equal to $2\times10-7$ newtons per meter of length.
An ampere is a unit of measure of the rate of electron flow or current in an electrical conductor. One ampere of current represents one coulomb of electrical charge (6.24 x 1018 charge carriers) moving past a specific point in one second. Physicists consider current to flow from relatively positive points to relatively negative points; this is called conventional current or Franklin current.

Volt

Voltage is the pressure from an electrical circuit's power source that pushes charged electrons (current) through a conducting loop, enabling them to do work such as illuminating a light.

In brief, voltage = pressure, and it is measured in volts (V). The term recognizes Italian physicist Alessandro Volta (1745-1827), inventor of the voltaic pile—the forerunner of today's household battery. In electricity's early days, the voltage was known as electromotive force (emf). This is why in equations such as Ohm's Law, voltage is represented by the symbol E.

Faraday Basics

Faraday's law of induction is one of the important concepts of electricity. It looks at the way changing magnetic fields can cause current to flow in wires. Basically, it is a formula/concept that describes how potential difference (voltage difference) is created and how much is created. It's a huge concept to understand that the changing of a magnetic field can create voltage.

He discovered that the changes in the magnetic field and the size of the field were related to the amount of current created. Magnetic flux is a value that is the strength of the magnetic field multiplied by the surface area of the device.

Faraday's Law **E=dB/dt**

"E" is the value of voltage induced. The change in time for the experiment is "it". Time is measured in seconds. Last is "dB" which stands for the change in magnetic flux. The magnetic flux is the field lines of the magnetic field. The flux is equal to BA, where B is the magnetic field strength, and A is the area. This formula is a bit harder than those you may have seen before. The amount of voltage created is equal to the change in magnetic flux divided by the change in time. The bigger the change you have in the magnetic field, the greater amount of voltage.

OHMS (V = I x R)

Imagine a pressurized water tank. Connect a narrow hose to it and open the valve. You'll get a certain flow of water because the hose is a certain size and length. Now make the hose twice as long, and the flow of water decreases by exactly two times. The hose has "friction", by doubling its length, the friction is doubled. When the hose is longer the water flows slower (fewer liters per second,) make the hose shorter and the reduced friction lets the water flow faster (more liters per second.)

The water experiment is now changed into electricity. A thin wire is connected to a battery. The battery supplies its pressure ("voltage") and causes charge inside the thin wire and the charge within the battery to all start moving. The charge flows in a complete circle. Double the length of the wire, and double the friction. The extra friction cuts the charge flow (the amperes) in half. The friction is the "Ohms," it is the electrical resistance. To alter the charge-flow in a circle of wire changes the resistance of the wire by changing its length. Connect a long thin wire to a battery and the charge flow is slow (low amps.) Connect a shorter wire to the battery and the charge is faster (high amps.)

It is possible to change the flow by changing the pressure. Another battery is added to the series. Twice the pressure-difference applied to the ends of the wire circle, which doubles the flow. This is "Ohm's Law:" Ohm's law explains that the rate of charge flow is directly proportional to the pressure difference, and if the pressure goes up, the flow goes up in proportion. It also tells that the resistance affects the charge flow. If the resistance goes up while the pressure-difference stays the same, the flow gets LESS by an "inverse" proportional amount. The collisions between electrons and atoms in a

conductor cause resistance to the flow of charge. We measure that resistance in order to determine the effect that it has on current.

Resistance is also based on the resistivity of a material. The resistivity of material changes because of chemical makeup or the temperature. Copper is a better conductor than wood, copper has lower resistivity. That resistivity combines with (1) the distance and (2) the space that charges have to move in (thin vs. thick wires) to affect the "R" value. Greater length results in more resistance, and thick wires result in less. When people connect speakers, they usually use wires that are as short and thick as possible.

Nothing allows a perfect flow of current, not even superconductors. In metal, there are tiny flaws. Those imperfections cause the electrons to collide with the metal atoms. When they hit the metal, the electrons lose energy. Where does that energy go? It is usually turned into heat. Imperfections mean collisions; collisions mean heat.

Watts (W = V * I)

A watt is the base unit of power in electrical systems. It can also be used in mechanical systems. It measures how much energy is released per second in a system. In the battery diagram, the size of both the voltage and the current in the bulb determine how much energy is released.

In the diagram, the light bulb would get brighter as the power, measured in watts, increases.

It is possible to calculate the power released in the bulb, and of the electrical system as a whole, by multiplying the voltage by the current.

How to Calculate with Watts, Amps, Volts, and Ohms

If you want to do an electrical calculation involving voltage, current, resistance, or power, reference the formulae circle below.

Example Equations

1. What is the current in an electrical circuit with a voltage of 120V and 12Ω of resistance?

I = V/R

I = 120/12

I = 10A

The current in an electrical circuit with a voltage of 120V and 12Ω of resistance is 10A.

2. What is the voltage across an electrical circuit with a current of 10A and 200Ω of resistance?

V = I x R

V = 10 x 200

V = 2000V

The current in an electrical system with 10A and 200Ω of resistance is 2000V.

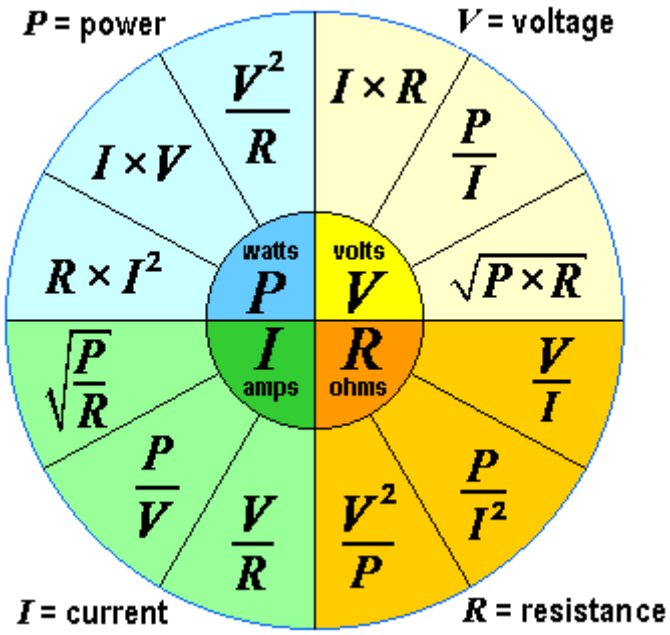
3. What is the resistance in an electrical system with a voltage of 230V and a current of 5A?

R = V/I

R = 230/5

R = 46Ω

The resistance in an electrical system with 230V and 50A is 46Ω.



The Formula Wheel of Electrical Engineering

V comes from "voltage" and E from "electromotive force (emf)".
E means also energy, so we choose V.
Energy = voltage × charge. E = V × Q.
Some like better to stick to E instead to V, so do it. For R take Z.

The 12 most important Formulas:
Voltage V = I × R = P / I = √(P × R) in volts V
Current I = V / R = P / V = √(P / R) in amperes A
Resistance R = V / I = P / I2 = V2 / P in ohms Ω
Power P = V × I = R × I2 = V2 / R in watts W

Power Formula 1 – Electrical power equation: Power P = I × V = R × I2 = V2 ⁄ R
where power P is in watts, voltage V is in volts and current I is in amperes (DC).
If there is AC, look also at the power factor PF = cos ϕ and ϕ = power factor angle (phase angle) between voltage and amperage.
Electric Energy is E = P × t – measured in watt-hours, or also in kWh. 1J = 1N×m = 1W×s

Power Formula 2 – Mechanical power equation: Power P = E ⁄ t where power P is in watts, Power P = work / time (W ⁄ t). Energy E is in joules, and time t is in seconds. 1 W = 1 J/s.
Power = force multiplied by displacement divided by time P = F × s / t or
Power = force multiplied by speed (velocity) P = F × v.

Electrical Measurement Definitions		
Quantity	**Name**	**Definition**
frequency *f*	hertz (Hz)	1/s
force *F*	newton (N)	kg·m/s²
pressure *p*	pascal (Pa) = N/m²	kg/m·s²
energy *E*	work joule (J) = N·m	kg·m²/s²
power *P*	watt (W) = J/s	kg·m²/s³
electric charge *Q*	coulomb (C) = A·s	A·s
voltage *V*	volt (V)= W/A	kg·m²/A·s³
current *I*	ampere (A) = Q/s	A
capacitance *C*	farad (F) = C/V = A·s/V = s/Ω	A²·s⁴/kg·m²
inductance *L*	henry (H) = Wb/A = V·s/A	kg·m²/A²·s²
resistance *R*	ohm (Ω) = V/A	kg·m²A²·s³
conductance *G*	siemens (S) = A/V	A²·s³/kg·m²
magnetic flux *Φ*	weber (Wb) = V·s	kg·m²/A·s²
flux density *B*	tesla (T) = Wb/m² = V·s/m²	kg/A·s²

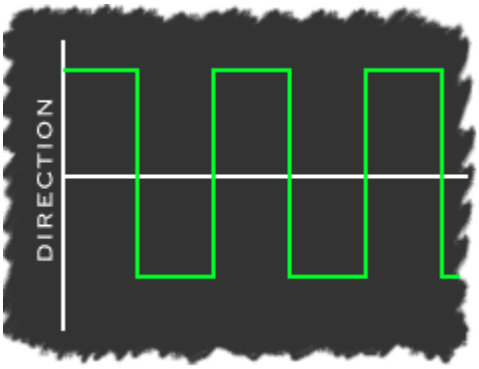
HOW ARE WATTS, OHMS AMPS, AND VOLTS RELATED?

Conductive objects are always full of movable electric charges, and the overall motion of these charges is called an 'electric current.' Voltage can cause electric currents because a difference in voltage acts like a difference in pressure which pushes the conductors' own charges along. A conductor offers a certain amount of electrical resistance or "friction," and the friction against the flowing charges heats up the resistive object. The flow-rate of the moving charges is measured in Amperes. The transfer of electrical energy (as well as the rate of heat output) is measured in Watts.

DC / AC

A Direct Current
Direct current flows in one direction. There are two main types of current in our world. One is direct current (DC) which is a constant stream of charges in one direction. The other is alternating current (AC) that is a stream of charges that reverses direction. Let's look at DC power which was refined by Thomas Edison in the 1800s.

Moving in One Direction
The current in DC circuits is moving in a constant direction. The amount of current can change, but it will always flow from one point to another. Physicists refer to conventional current as a flow from high potential/voltage (positive) to low potential/voltage (negative). Reminding that potential is like electrical height, this means that conventional current flows "downhill". The best example of direct current is a battery. Batteries have positive (+) and negative (-) terminals.



Current moves in the opposite direction of charged particles. Electrons move from areas where there are excess of negative charges to areas where there are a deficiency (or positive charge). Electrons move from "-" to "+", but the conventional current is considered to move in the other direction. When you set up a circuit, conventional current is considered to move from the "+" to the "-" side.

The idea about using positive charges in forming explanations comes from Benjamin Franklin. In Franklin's day, we didn't know about protons and electrons. Franklin believed that something moved through electrical wires, and he called these things "charge". He assumed there was only one kind of charge, and he logically assumed that charge would flow from a spot that had an excess (extra), to a spot that had a deficiency (too few). He called the spot with an excess "positive" and the spot with a deficiency "negative". So, for Franklin, charge flowed from positive to negative. We simply honor his achievements by continuing with this idea.

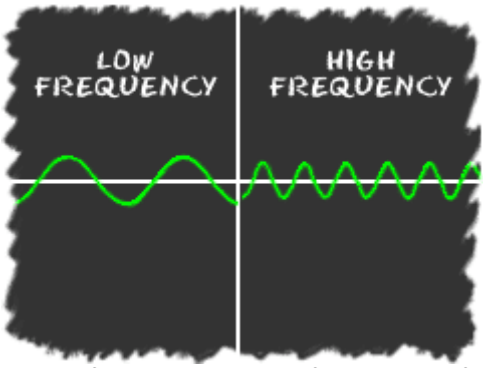
DC power is used all over the world. You probably use direct current power whenever you carry something around that uses electricity. Everything that uses batteries runs on DC power.

Electric wiring in your house is AC power and it is completely different than DC. There are machines that can convert DC to AC power. Those machines might be used to take a DC battery in a boat and convert the power to AC so that a refrigerator can use it.

Alternating Current (AC)

Alternating current switches direction while direct current only moves in one direction. Scientists such as Charles Proteus Steinmetz and Nikola Tesla made great advances when AC power was just a science experiment.

Flowing Back and Forth



Charges (electrons) must always be flowing to have a current. However, the flow of charges does not always have to be in one direction. In alternating current, the charges move in one direction for a very short time, and then they reverse direction. This happens over and over again.

Low frequency and high-frequency wavelengths. Scientists describe the cycle of switching directions as the frequency. Frequency is measured in Hertz (Hz). Currents that cycle more often during a specific amount of time are said to have a higher frequency. Most countries use AC frequencies at either 50 hertz or 60 Hertz.

Cheaper and Stronger

Why do we use AC power all over the world? It's cheaper and easier to make devices for AC power. It is less expensive because it is possible to increase and decrease the current for AC power easily. The power switches for AC power are less expensive to manufacture. One of the biggest advantages of AC is the possibility to use high voltages with small currents to reduce losses when transmitting power.

Sending power with DC loses a lot of energy. It takes much more effort into sending DC power over the same distance.

Water

Why water in an electricity section? In general water is the “enemy” of electricity. The reason is that water is a “super” conductor. In our work we need water as way to transfer electricity into the body. Most people do not know the incredible abilities of water. In next column there are some abilities mentioned.

Property of water	Function
Water is a solvent	The positive and negative parts of the water molecule attract other charged particles, such as ions and other polar molecules, such as glucose. Ions and polar molecules can dissolve in water. Non-polar molecules such as lipids do not dissolve in water.
Water as a transport medium	Blood is largely water and transports many dissolved substances around the body.
Chemical reactions take place in water	Transport of ions and polar molecules allows chemical reactions to take place when particles or molecules meet.
Water has a high specific heat capacity	A large amount of heat energy is needed to raise the temperature of water. This prevents large fluctuations in water temperature. This keeps the temperature of aquatic environments stable so that organisms do not have to endure extremes of temperature. This also allows enzymes within cells to work effectively.
Water has a high latent heat of vaporization	Due to cohesion between water molecules (caused by hydrogen bonding) a large amount of heat energy is needed to change water from a liquid to a vapor state (gas). This process of evaporation transfers heat energy and is a very effective way of cooling the body e.g. sweating or panting. Evaporation of water from a surface causes cooling.
Cohesion	The attraction between water molecules allows water to be transported over long distances.
Surface tension	At ordinary temperatures water has the highest surface tension of any liquid except mercury. In a pond the cohesion between water molecules supports organisms.
Density	Water has a maximum density at 4 Celsius ; ice is less dense and therefore floats on the surface and insulates the water beneath it. This reduces the tendency for

	large bodies of water to freeze completely allowing organisms to survive.

Water is very important in Electro Stimulation for many reasons.

WAVEFORM

Explain the shape, period, frequency and amplitude.

In electronic circuits, many different types, frequencies, and shapes of Waveforms are produced such as Square Waves, Rectangular Waves, Triangular Waves, Saw-toothed Waveforms and a variety of pulses and spikes. Each wave has specific characteristics and effects on the human body.
Electrical Waveforms are visual representations of the variation of a voltage or current over time.

This voltage (y-axis) or current variations set out on a graph paper against a base (x-axis) of time, (t) the resulting plot represent the shape of a Waveform. There are many different types of *electrical waveforms* and generally, they are broken down into two distinctive groups.

1. Uni-directional Waveforms – electrical waveforms are positive or negative in nature flowing in one forward direction only as they do not cross the zero axis point. Common unidirectional waveforms include Square-wave timing signals, Clock pulses, and Trigger pulses.
2. Bi-directional Waveforms – electrical waveforms (also called alternating waveforms) they alternate from a positive direction to a negative direction constantly crossing the zero axis point. Bi-directional waveforms go through periodic changes in amplitude.

Whether the waveform is uni-directional, bi-directional, periodic, non-periodic, symmetrical, non-symmetrical, simple or complex, all electrical waveforms include the following three common characteristics:

Period: – This is the length of time in seconds that the waveform takes to repeat itself from start to finish. This value can also be called the ***Periodic Time*, (T)** of the waveform for sine waves, or the ***Pulse Width*** for square waves.

Frequency: – This is the number of times the waveform repeats itself within a one second time period. **Frequency** is the reciprocal of the time period, (ƒ = 1/T) with the standard unit of the frequency being the ***Hertz*, (Hz).**

Amplitude: – This is the magnitude or intensity of the signal waveform measured in volts or amps.

Periodic Waveforms

Periodic waveforms are the most common of electrical waveforms. The AC (Alternating Current) is a sine wave which constantly alternates between a maximum value and a minimum value over time. The amount of time it takes between each individual repetition or cycle of a sinusoidal waveform is known as “periodic time” or *Period* of the waveform. It is the time it takes for the waveform to repeat itself.

This period varies with each waveform from fractions of a second to thousands of seconds as it depends on the frequency of the waveform. A sinusoidal waveform which takes one second to complete its cycle has a periodic time of one second. A sine wave which takes five seconds to complete has a periodic time of five seconds. It varies due to programming and setting.

The length of time it takes for the waveform to complete one full pattern or cycle before it repeats itself is called the “period of the wave” and is measured in seconds, the waveform is expressed as a period number per second denoted by the letter T.

The relationship between Frequency and Periodic Time

$$\text{Frequency} = \frac{1}{\text{Periodic time}} \quad \text{or} \quad f = \frac{1}{\text{T}} \text{ Hz}$$

$$\text{Periodic time} = \frac{1}{\text{Frequency}} \quad \text{or} \quad \text{T} = \frac{1}{f} \text{ sec}$$

ƒ is in Hertz and T is in Seconds.

One **Hertz** is exactly equal to one cycle per second. One hertz is a very small unit, prefixes are used that denotes the order of magnitude of the waveform such as **kHz**, **MHz,** and even **GHz**.

Prefix	Definition	Written as	Time Period
Kilo	Thousand	kHz	1ms
Mega	Million	MHz	1us
Giga	Billion	GHz	1ns
Tera	Trillion	THz	1ps

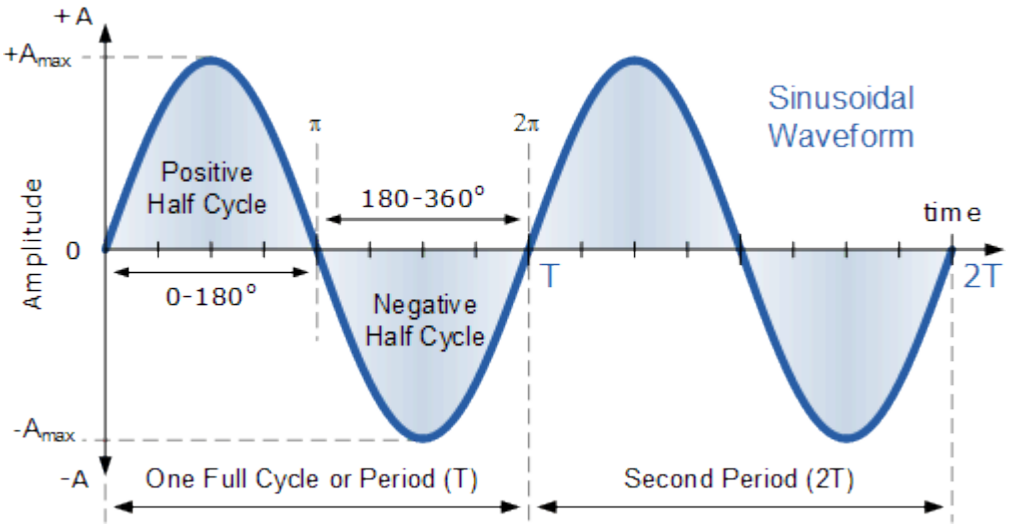
Square Wave Electrical Waveforms

Square-wave Waveforms are used extensively in circuits for clock and timing control signals as they are symmetrical waveforms of equal and square duration representing each half of a cycle and nearly all digital logic circuits use square wave waveforms on their input and output gates.

Unlike sine waves which have a smooth rise and fall waveform with rounded corners at their positive and negative peaks, square waves, on the other hand, have very steep almost vertically up and

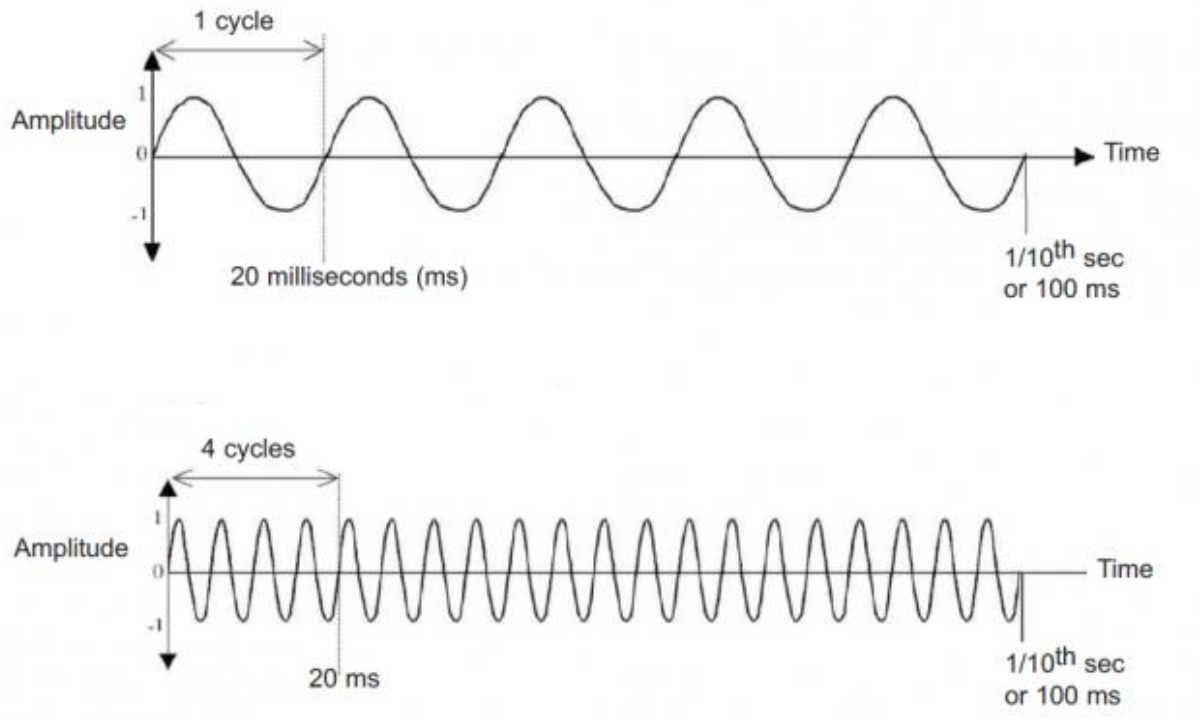
downsides with a flat top and bottom producing a waveform which matches its description, – "Square" as shown below.

A Sine Wave Waveform



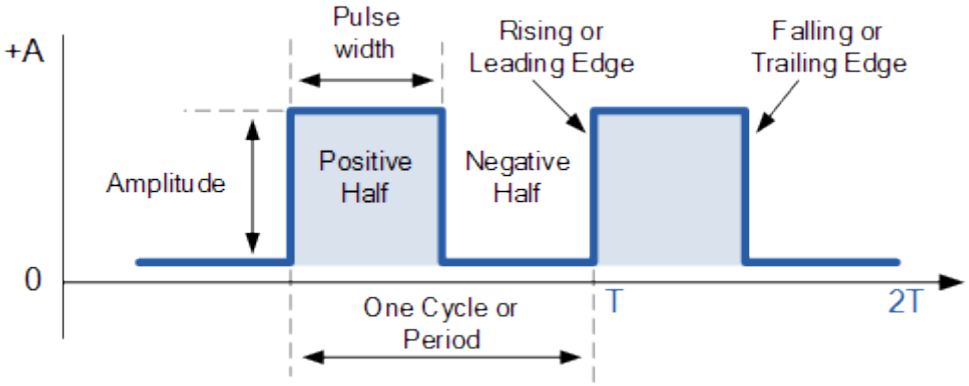
Units of periodic time, (T) include Seconds (s), milliseconds (ms) and microseconds (µs).
For sine wave waveforms only, the periodic time of the waveform in either degrees or radians, as one full cycle is equal to 360° (T = 360°) or in Radians as 2pi, 2π (T = 2π), 2π radians = 360°.

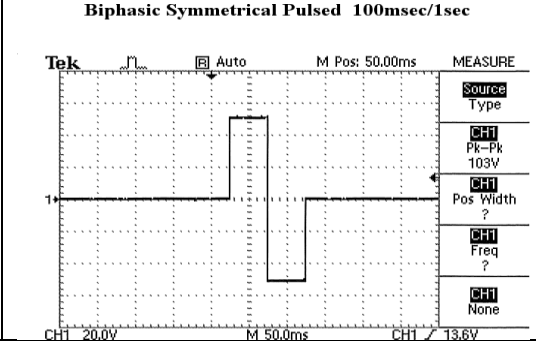
When taking the reciprocal of the period, (1/T) the number of times a period or cycle repeats itself in one second or cycles per second, is known as **Frequency** with units of **Hertz, (Hz)**. Hertz is defined as "cycles per second" (cps) and 1Hz is exactly equal to 1 cycle per second.



Both period and frequency are mathematical reciprocals of each other and as the periodic time of the waveform decreases, its frequency increases and vice versa with the relationship between *Periodic time* and *Frequency* given as.

A Square Wave Waveform



Symmetric Biphasic Rectangular pulse		Description	Alternate current with positive and negative rectangular pulses
		Pulse Frequency	1-200 Hz
		Phase duration	50-300 µsec
		Current, Amplitude	0-50 mA into 500 ohm
		Voltage, max	±60V Peak

		Waveform Duty Cycle	20% max
		Output Mode	Normal, Modulation, Burst
		Frequency Modulation	1.25-10KHz

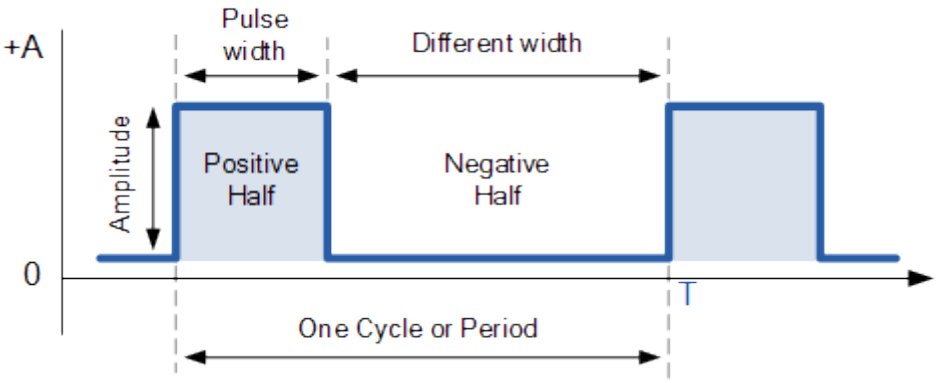
The square-shaped electrical waveforms are symmetrical in shape as each half of the cycle is identical, the time that the pulse width is positive must be equal to the time that the pulse width is negative or zero. When square wave waveforms are used as “clock” signals in digital circuits the time of the positive pulse width is known as the “Duty Cycle” of the period.
The square wave waveform positive side is “ON” time and equal to the negative or “OFF” time. The duty cycle must be 50%, (half of its period). As frequency is equal to the reciprocal of the period, (1/T) it defines the frequency of a square wave waveform as:

$$\text{Frequency} = \frac{1}{\text{"ON" time} + \text{"OFF" time}}$$

Rectangular Waveforms

Rectangular Waveforms are similar to the square wave waveform above, the difference being that the two pulse widths of the waveform are of an unequal time period. Rectangular waveforms are therefore classed as “Non-symmetrical” waveforms as shown below.

A Rectangular Waveform



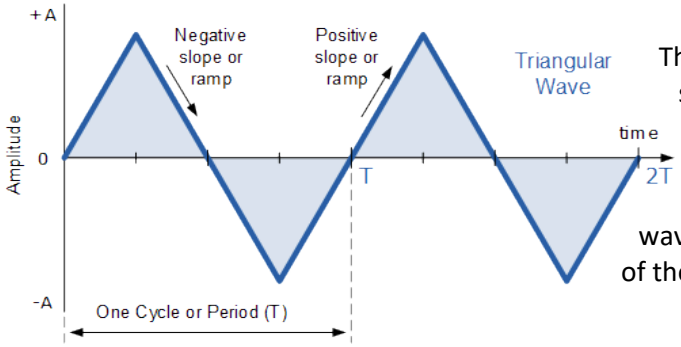
The example shows that the positive pulse width is shorter in time than the negative pulse width. Equally, the negative pulse width could be shorter than the positive pulse width, either way, the resulting waveform shape is a rectangular waveform.

Triangular Waveforms

Triangular Waveforms are generally bi-directional non-sinusoidal waveforms that oscillate between a positive and a negative peak value. Although called a triangular waveform, the triangular wave is actually more of a symmetrical linear ramp waveform because it is simply a slow rising and falling

voltage signal at a constant frequency or rate. The rate at which the voltage changes between each ramp direction is equal during both halves of the cycle as shown below.

A Triangular Waveform

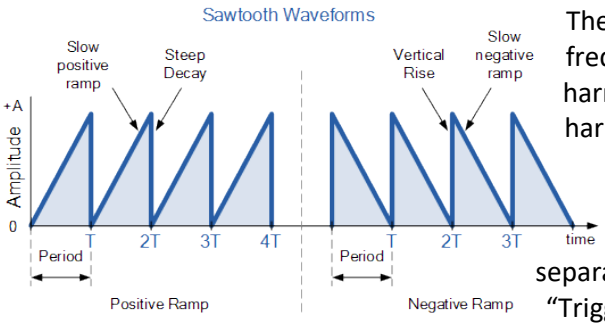


The positive-going ramp or slope (rise), is the same time duration as the negative-going ramp (decay) giving the triangular waveform a 50% duty cycle. Any given voltage amplitude, the frequency of the waveform determine the average voltage level of the wave.

Mark/Space Ratio is the ratio between HIGH (Mark) and LOW (Space) also "duty cycle". This control on the function generator changes the ratio of high voltage to low voltage time in a square wave signal, i.e. changing the waveform from a square wave with a 1:1 duty cycle to a pulse waveform, or a triangular waveform with equal rise and fall times to a sawtooth.

Sawtooth Waveforms

Sawtooth Waveforms the shape of the waveform resembles the teeth of a saw blade. Sawtoothed waveforms can have a mirror image of themselves, by having either a slow-rising but extremely steep decay, or an extremely steep almost vertical rise and a slow-decay as shown below.

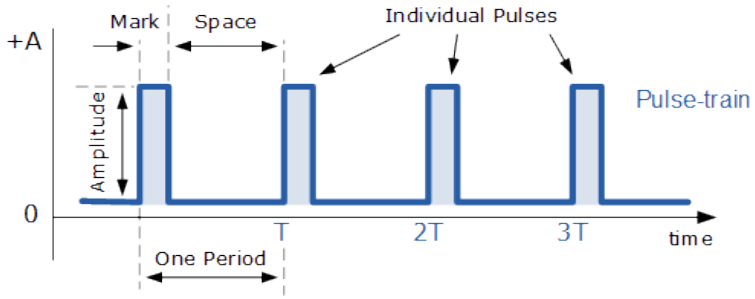


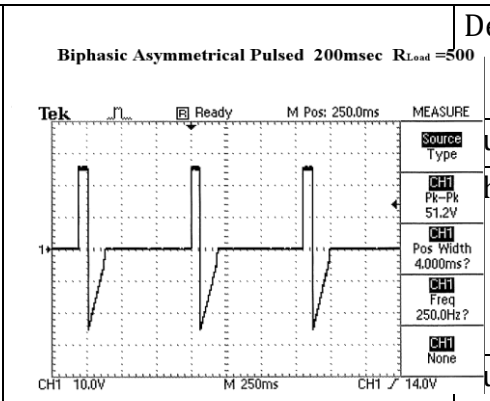
The Sawtooth waveform consists of a fundamental frequency (ƒ) and all its integer ratios of even harmonics only, 1/2, 1/4, 1/6 1/8 … 1/n etc. it is rich in harmonics.

Triggers and Pulses

Although technically **Triggers** and **Pulses** are two separate waveforms, when combined them as a "Trigger" it is basically a narrow "Pulse". The difference is that a trigger can be either positive or negative in direction whereas a pulse is only positive in direction.

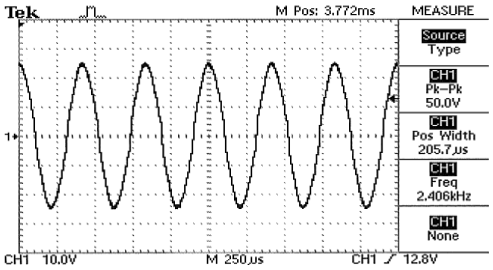
A **Pulse Waveform** or "Pulse-train" is a type of non-sinusoidal waveform that is similar to the Rectangular waveform. A **Pulse** is a waveform or signal in its own right. It has very different Mark-to-Space ratio compared to a high-frequency square wave clock signal or even a rectangular waveform. The purpose of a "Pulse" and that of a trigger is to produce a very short signal to control the time at which something happens.



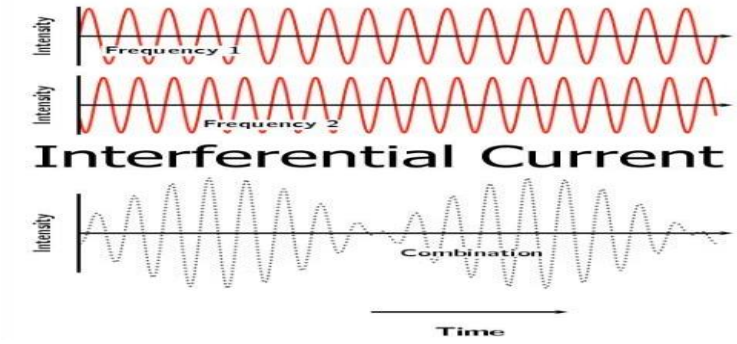
(*) Asymmetric Biphasic Pulse		Description	Alternate current with positive rectangular and negative triangular pulses
		ulse Frequency	1-300 Hz
		hase duration	Positive:(0.2-100)msec; Negative: (0.4-200)msec; negative duration/positive duration = 2
		urrent, Amplitude	0-50 mA into 500 ohm
		Voltage, max	±60V Peak
		Waveform Duty Cycle	20% max
		Ramp Up/Down	0-10 sec
		Output Mode	Normal, Modulation, Burst

Russian Current waveform

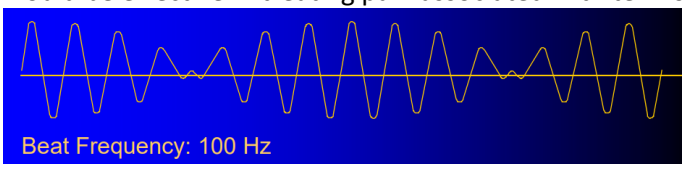
The **Russian Current waveform** delivers medium frequency current in alternating pulses or bursts of energy. This type of stimulation generates a motor response which can be used to strengthen muscles and muscular re-education. A study published in the International Journal of Rehabilitation and Science found that Russian current used in addition to physical therapy increased quadriceps strength in burn patients more than patients that received physical therapy alone. To add to its versatility, Russian Current can also be used to stimulate an analgesic effect in the muscles, making it effective in reducing pain as well as increasing muscular strength.

Russian Current		Description	Sine wave current
		Carrier Frequency	2500 Hz
		Burst Frequency	20-100 Hz
		Current, Amplitude	0-50 mA into 500 ohm
		Voltage (max);	±60V Peak
		Duty Cycle	10-33%
		Cycle Time	User-defined or continuous
		Ramp Up/Down	0-10 sec

Interferential Current **(also referred to as IFC)** is used to address chronic, post-surgical and post-trauma acute pain in patients. IFC works at a higher frequency meaning the energy crosses the skin with less stimulation. Because of its ease in reaching deep into pain sites and the increased tolerance for patients. Additionally, the IFC waveform offers deep tissue penetration over a larger volume of tissue.



Premodulated Current, also referred to as "period", With premod current, a single channel is used to mix the frequencies prior to delivery of the current through the electrode of the body (using two electrodes rather than four). This is beneficial when treating areas of the body that have less space available for electrode placement. This makes it the best choice to use on smaller muscle groups and joints such as the elbow, ankle, foot, and hands. For example, premodulated current would be effective in treating pain associated with tennis elbow.

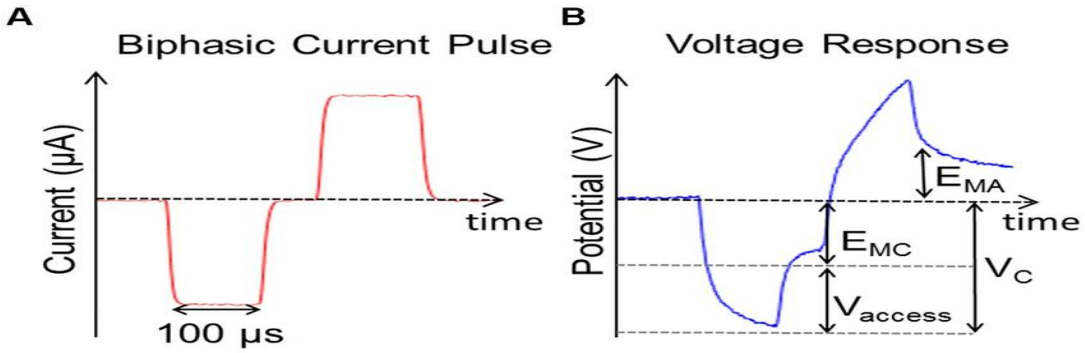


Biphasic Current

"Biphasic" refers to two phases, or pulses, of 2 different intensities alternating with each other during treatment. Biphasic current is considered the most versatile of the stimulation therapy waveforms because most devices feature settings that allow control of amplitude (intensity), stimulation (voltage), current, and duration of each pulse. Biphasic current e-stim can be used to:

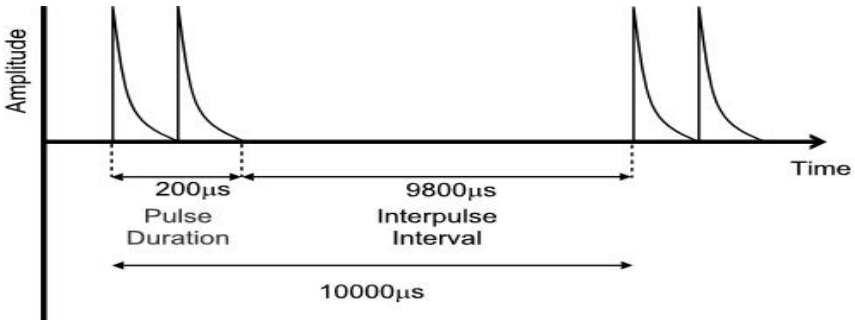
- strengthen muscles
- re-educate muscles
- increase circulation
- decrease swelling

Biphasic treatment is used to treat both acute and chronic pain, muscular and disc syndromes in the back and neck, arthritis, shoulder syndromes, neuropathies, etc.



High Voltage

High Voltage electrical stimulation uses polarity (positive or negative) to stimulate the tissue. This type of stimulation can be used to decrease pain, edema or facilitate in wound healing. Because of its ability to aid in circulation, High Voltage can be used to great effect in healing wounds in patients with circulatory issues such as diabetes. Additionally, this waveform can be used to relieve muscle spasms.



Microcurrent

Microcurrent utilizes micro-size, pulsating current to resonate with the body's own bio-electrical exchanges that take place at the cellular level. When microcurrent is applied, it triggers impulses to facilitate a chemical reaction to activate the release of adenosine triphosphate (ATP) at the cellular level, which is used to facilitate wound or tissue healing. Microcurrent is considered sub-sensory, implying that the intensity does not cause any visual jolting muscular movement, so it's more comfortable for patients.

Microcurrent	 MICROCURRENT	Description	A direct or alternate current with a rectangular pulse and low amplitude
		Beat Frequency	0.1-1000 Hz
		Current, Amplitude	10-1000 µA into 500 ohm
		Ramp Up/Down	1 sec (+/- only)
		Alternating Time	2.5 sec
		Polarity	(+), (-), (+/-)

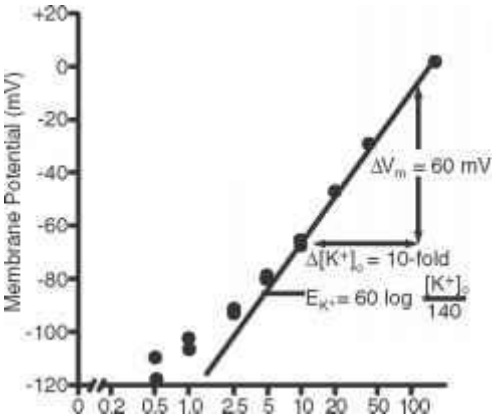
Ions = the biological energy

One of the barriers scientists have encountered when trying to link microelectronic devices with biological systems has to do with information flow. In biology, almost all activity is made possible by the transfer of molecules like glucose, epinephrine, cholesterol and insulin signaling between cells and tissues. Infecting bacteria secrete molecular toxins and attach to our skin using molecular receptors. To treat an injury or infection, we need to detect these molecules to identify the bacteria, discern their activities and determine how to respond. Microelectronic devices don't process information with molecules. A microelectronic device typically has silicon, gold, chemicals like boron or phosphorus and an energy source that provides electrons. By themselves, they're poorly suited to engage in molecular communication with living cells.
Free electrons don't exist in biological systems so there's almost no way to connect with microelectronics. There is, however, a small class of molecules that stably shuttle electrons. These are called "redox" molecules; they can transport electrons, sort of like wire does. The difference is that in wire, the electrons can flow freely to any location within; redox molecules must undergo chemical reactions – oxidation or reduction reactions – to "hand off" electrons. "Normal" Electricity as we use in our daily life to empower products is of a different "nature" than the electricity used in our body. The differences are:

Electron electricity	**Biological electricity**
Energy is based on electron flow	Energy is based on ion activity
Can use electrons of most materials	Is based on mainly inorganic elements
Can flow at all time	Depends on action potential
Can use a wide range of Volt / Ampere etc.	Has a small low active V / A / Ohm

How does biological electricity work?
Most of the information is based on Julius Bernstein (18 December 1839 – 6 February 1917). Bernstein speculated that cells have high K+ and low Na+ concentrations and that the extracellular fluid has low K+ and high Na+ concentrations. Another discovery was the fact that that cells were highly permeable to K+ but not very permeable to other ions.

Walther Hermann Nernst, (25 June 1864 – 18 November 1941) was a German chemist who is known for his work in thermodynamics; his formulation of the Nernst heat theorem helped pave the way for the third law of thermodynamics, for which he won the 1920 Nobel Prize in Chemistry. Nernst helped establish the modern field of physical chemistry and contributed to electrochemistry, thermodynamics and solid state physics. He is also known for developing the Nernst equation in 1887.

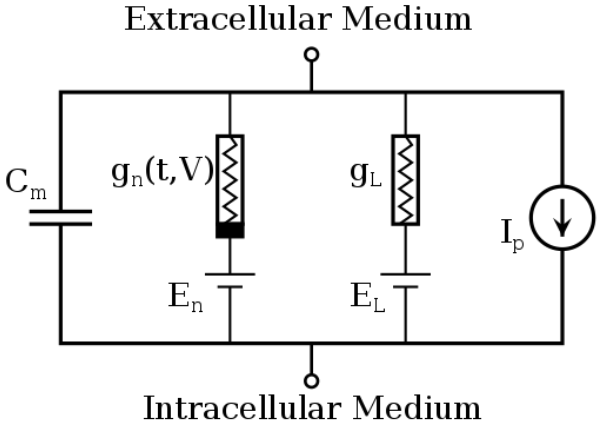


Potassium Concentration (mM)

Effects of altered extracellular concentrations of K+ on the membrane potential: (•), measured membrane potential at each of a variety of different concentrations of K+; the straight line is the potential predicted by the Nernst equation. The value of 140 in the Nernst equation is the estimated intracellular concentration of K+ for the cell used in the experiment. (Modified from Hodgkin AL, Horowicz P. J Physiol 1959; 148:127.) where Vm is the membrane potential and EK the potassium equilibrium potential.

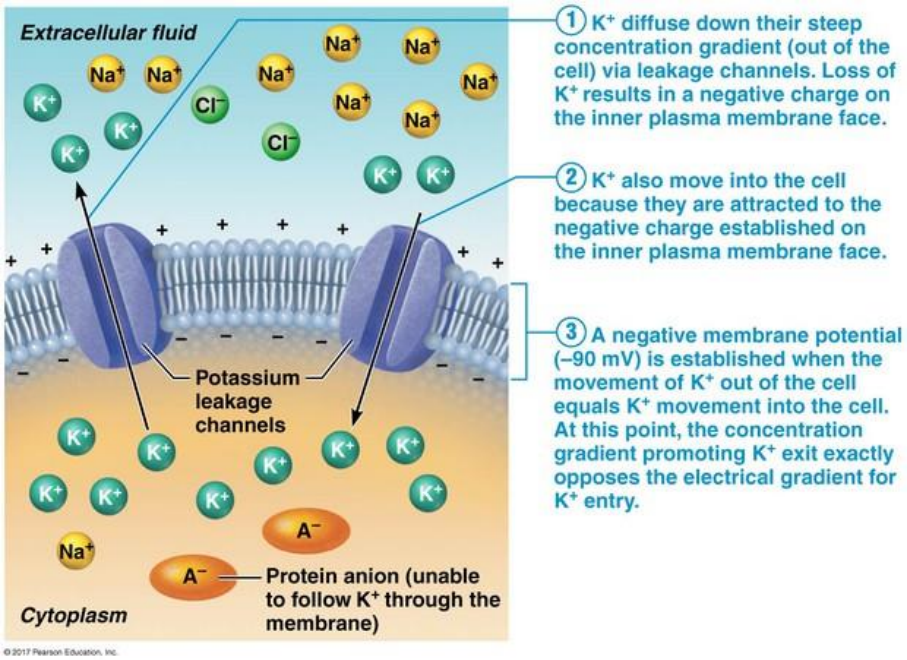
An action potential is the brief (about one-thousandth of a second) reversal of electric polarization of the membrane of a excited cells such as nerve cell (neuron), muscle cell, endocrine cell and so on. In neurons, an action potential happens when a neuron sends information down an axon, away from the cell body. In muscle cells, for example, an action potential produces the contraction required for all movement. Action potentials in neurons are also known as "nerve impulses" or "spikes", and the temporal sequence of action potentials generated by a neuron is called its "spike train". A neuron that emits an action potential is often said to "fire". Action potentials are generated by specific voltage-gated ion channels embedded in a cell's plasma membrane.

Until today these calculations are still standing and used in modulated forms, but the basic principles did not change. Cell have an action potential. Short outburst of energy transfers at which ion's are the main short of power. These powers occur in several types which are called excitable cells, a category of cell include neurons, muscle cells, and endocrine cells. Galvani coined the term *animal electricity* to describe the phenomenon. Galvani and contemporaries regarded muscle activation as resulting from an electrical fluid or substance in the nerves.



Alan Hodgkin and Andrew Huxley formed one of the most productive and influential collaborations in the history of physiology. Their work, both in the Physiological Laboratory in Cambridge and at the Laboratory of the Marine Biological Association in Plymouth, provided fundamental insights into nerve cell excitability.

The typical Hodgkin–Huxley model treats each component of an excitable cell as an electrical element (as shown in the figure). The lipid bilayer is represented as a capacitance (Cm). Voltage-gated ion channels are represented by electrical conductances (gn, where n is the specific ion channel) that depend on both voltage and time. Leak channels are represented by linear conductances (gL). The electrochemical gradients driving the flow of ions are represented by voltage sources (En) whose voltages are determined by the ratio of the intra- and extracellular concentrations of the ionic species of interest.

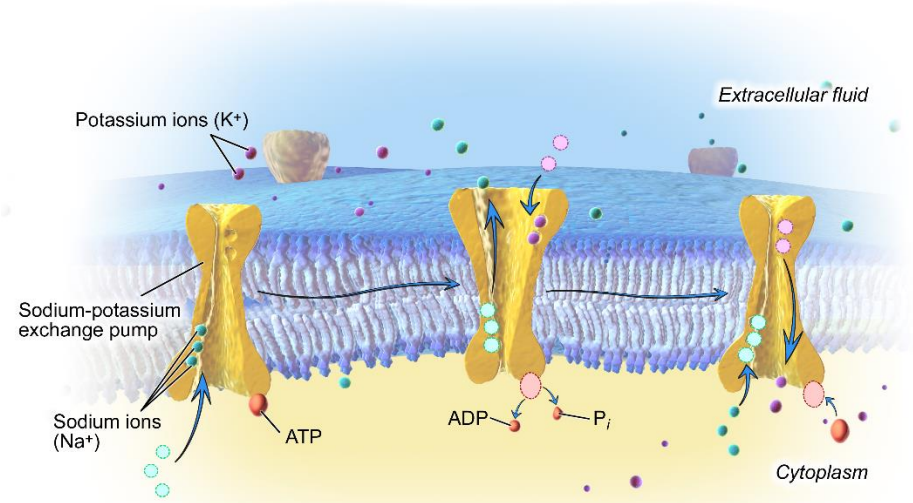


Finally, ion pumps are represented by current sources (Ip). The membrane potential is denoted by Vm. In voltage-gated ion channels, the channel conductance g_i is a function of both time and voltage ($g_n(t, V)$ in the figure), while in leak channels g_i is a constant (g_L in the figure). The current generated by ion pumps is dependent on the ionic species specific to that pump.

Membrane potential (also transmembrane potential or membrane voltage) is the difference in electric potential between the interior and the exterior of a biological cell. With respect to the exterior of the cell, typical values of membrane potential range from –40 mV to –80 mV.

Each living cell has a potential difference over the membrane of tensofthousands of Volt per sq.cm. The height of this difference is around 50 mV. It seems very small but when we calculate it back to other numbers it is an amazing amount. The cell membrane is 8-10 nanometer thick (1nm = 10 *-9 meter). This is equal to 50.000 Volt per centimeter.

In neurons, the factors that influence the membrane potential are diverse. They include numerous types of ion channels, some of which are chemically gated and some of which are voltage-gated. Because voltage-gated ion channels are controlled by the membrane potential, while the membrane potential itself is influenced by these same ion channels, feedback loops that allow for complex temporal dynamics arise, including oscillations and regenerative events such as action potentials.



The Sodium-Potassium Exchange Pump

There are active and passive transport elements in the cell membrane. The active transport ions from a lower concentration side to a higher concentration side. This active transport uses energy (ATP). Most of these pumps are enzymes such as H+-ATPasen, Ca2+-ATPasen, Na+/K+-ATPasen and others. ATP is supplied by the mitochondria. Most ion pumps are constantly active until an equilibrium is reached, which rarely happens.
On the other side there are Ionchannels which have a passive function in transport . In general these channels are closed until actively opened. Only after opening they become passive in actions. They allow ions to pass by without any interfering.

$$V_m = \frac{RT}{F} \ln\left(\frac{p_K[K^+]_o + p_{Na}[Na^+]_o + p_{Cl}[Cl^-]_i}{p_K[K^+]_i + p_{Na}[Na^+]_i + p_{Cl}[Cl^-]_o} \right)$$

- $\boldsymbol{V_m}$ is the membrane potential. This equation is used to determine the resting membrane potential in real cells, in which K^+, Na^+, and Cl^- are the major contributors to the membrane potential. Note that the unit of V_m is the Volt. However, the membrane potential is typically reported in millivolts (mV). If the channels for a given ion (Na^+, K^+, or Cl^-) are closed, then the corresponding relative permeability values can be set to zero. For example, if all Na^+ channels are closed, $p_{Na} = 0$.

- $\boldsymbol{R}$ is the universal gas constant (8.314 $J.K^{-1}.mol^{-1}$).
- $\boldsymbol{T}$ is the temperature in Kelvin (K = °C + 273.15).
- $\boldsymbol{F}$ is the Faraday's constant (96485 $C.mol^{-1}$).
- $\boldsymbol{p_K}$ is the membrane permeability for K^+. Normally, permeability values are reported as relative permeabilities with p_K having the reference value of one (because in most cells at rest p_K is larger than p_{Na} and p_{Cl}). For a typical neuron at rest, $p_K : p_{Na} : p_{Cl} = 1 : 0.05 : 0.45$. Note that because relative permeability values are reported, permeability values are unitless.
- $\boldsymbol{p_{Na}}$ is the relative membrane permeability for Na^+.
- $\boldsymbol{p_{Cl}}$ is the relative membrane permeability for Cl^-.
- $\boldsymbol{[K^+]_o}$ is the concentration of K^+ in the extracellular fluid. Note that the concentration units for all the ions must match.
- $\boldsymbol{[K^+]_i}$ is the concentration of K^+ in the intracellular fluid. Note that the concentration units for all the ions must match.

- **$[Na^+]_o$** is the concentration of Na^+ in the extracellular fluid. Note that the concentration units for all the ions must match.
- **$[Na^+]_i$** is the concentration of Na^+ in the intracellular fluid. Note that the concentration units for all the ions must match.
- **$[Cl^-]_o$** is the concentration of Cl^- in the extracellular fluid. Note that the concentration units for all the ions must match.
- **$[Cl^-]_i$** is the concentration of Cl^- in the intracellular fluid. Note that the concentration units for all the ions must match.

Leakage channels are the simplest type of ion channel, in that their permeability is more or less constant. The types of leakage channels that have the greatest significance in neurons are potassium and chloride channels.

Ligand-gated calcium channel in closed and open states are channels whose permeability is greatly increased when some type of chemical ligand binds to the protein structure. Animal cells contain hundreds, if not thousands, of types of these. A large subset function as neurotransmitter receptors—they occur at postsynaptic sites, and the chemical ligand that gates them is released by the presynaptic axon terminal. One example of this type is the AMPA receptor, a receptor for the neurotransmitter glutamate that when activated allows passage of sodium and potassium ions. Another example is the GABAA receptor, a receptor for the neurotransmitter GABA that when activated allows passage of chloride ions.

The importance of understanding the facts of energy potential differences in a biological electrical and a regular electrical environment is found in the active role of only a limited amount of chemicals. These chemicals have a direct effect on the cell membrane and its active potential. Important influencers of this system are neurotransmitters and hormones.

Voltage-gated ion channels, also known as voltage dependent ion channels, are channels whose permeability is influenced by the membrane potential. They form another very large group, with each member having a particular ion selectivity and a particular voltage dependence. Many are also time-dependent—in other words, they do not respond immediately to a voltage change but only after a delay.

Due to the constant polarization of the cell membrane it is not possible for most proteins and other “chemicals” to freely move between or even to go through cells. Polarization influences the transport of all chemicals through the body. This polarization influences the attraction and rejection of needed chemicals based on “local” demands. For instance if repair is needed, specific aminoacids will be attracted to be used.

It is important to understand that there is a difference between biological and standard electricity. This difference becomes even more clear when knowing that the effectiveness of Electro Stimulation can depend on the chemical constitution of the body part that we have to treat. External influence may be needed to have an effective treatment.

Anatomy & Physiology for ES

The skin

The skin is very important for all treatments. For a better understanding I divide the section "skin" in 3 segments; 1 / anatomy , 2 / conductor and 3 / treatment.

Anatomy of the Skin

The skin is a vital organ that covers the entire outside of the body, forming a gigantic protective barrier against pollution, pathogens and injuries. Some skin details are:
The skin has up to "five" layers of ectodermal tissue

- Stratum Corneum. Composed of dead cells called keratinocytes,
- Epidermis.
  - Stratum basale.
  - Stratum spinosum.
  - Stratum granulosum.
  - Stratum lucidum.
  - Stratum corneum.
- Dermal-Epidermal Junction.
- Dermis.
- Hypodermis.

The functions of the skin are:

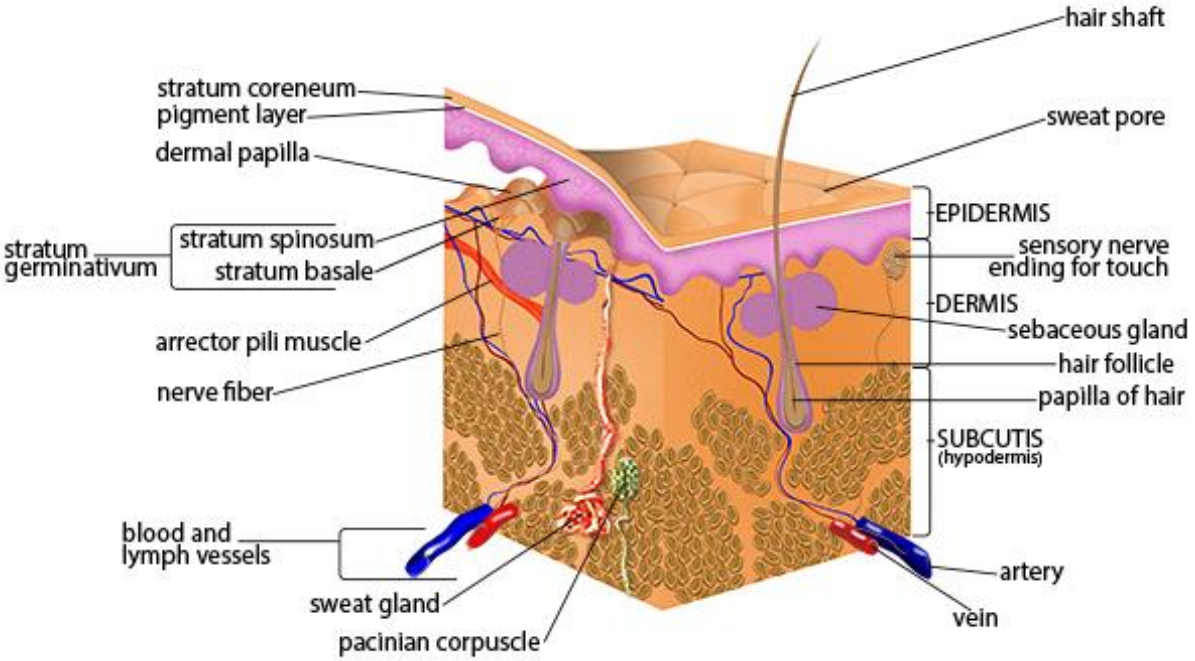
- insulation,
- temperature regulation,
- sensation,
- synthesis of vitamin D,
- protection of vitamin B folates.
- stores water, fat, and vitamin D,
- plays a role in the immune system protecting us from disease

Some need to know facts:

- The thickness of the skin varies considerably over all parts of the body, and between men and women and the young and the old.
- There are different types of sweat cells
- The average human skin cell is about 30 micrometers in diameter, but there are variants. A skin cell usually ranges from 25-40 micrometers (squared), depending on a variety of factors
- The skin is the body's second largest organ; covering the entire outside, it is about 2 mm thick and weighs approximately 3-4 kilo.

The color, thickness and texture of skin vary over the body and for everybody. There are two general types of skin; thin and hairy, which is more prevalent on the body, and thick and hairless, which is found on parts of the body that are used heavily and endure a large amount of friction, like the palms of the hands or the soles of the feet.

The epidermis is the outermost layer of the three layers of skin. Its thickness depends on where it is located on the body. For example, it's thinnest on the eyelids (half a millimeter). It's thickest on the palms of the hands and soles of the feet (1.5 millimeters).



The skin contains many specialized cells and structures:

- **Basket Cells**
  Basket cells surround the base of hair follicles and can sense pressure. They are evaluated when assessing overall nerve health and condition.
- **Blood Vessels**
  Blood vessels carry nutrients and oxygen-rich blood to the cells that make up the layers of skin and carry away waste products.
- **Hair Erector Muscle (Arrector Pili Muscle)**
  The arrector pili muscle is a muscle connected to each hair follicle and the skin. When it contracts it causes the hair to stand erect.
- **Hair Follicle**
  The hair follicle is a tube-shaped sheath that surrounds the part of the hair that is under the skin and nourishes the hair. It is located in the epidermis and the dermis.
- **Hair Shaft**
  The hair shaft is the part of the hair that is above the skin.
- **Langerhans Cells**
  These cells attach themselves to antigens that invade damaged skin and alert the immune system to their presence.
- **Melanocyte**
  A melanocyte is a cell that produces melanin, and is located in the basal layer of the epidermis.
- **Merkel Cells**
  Merkel cells are tactile cells of neuroectodermal origin located in the basal layer of the epidermis.

- **Pacinian Corpuscle**
  A pacinian corpuscle is a nerve receptor located in the subcutaneous fatty tissue that responds to pressure and vibration.
- **Sebaceous Gland**
  Sebaceous glands are small, sack-shaped glands which release an oily substance onto the hair follicle that coats and protects the hair shaft from becoming brittle. These glands are located in the dermis.
- **Sensory Nerves**
  These nerves sense and transmit heat, pain, and other noxious sensations. When they are not functioning properly sensations such as numbness, pins-and-needles, pain, tingling, or burning may be felt. When evaluating a skin biopsy, total number, contiguity, diameter, branching, swelling, and overall health of the sensory nerves are assessed.
- **Stratum Corneum**
  The stratum corneum is outermost layer of the epidermis, and is comprised of dead skin cells. It protects the living cells beneath it by providing a tough barrier between the environment and the lower layers of the skin. The stratum corneum is useful for diagnosis because in some conditions it will become thinner than normal.
- **Sweat Gland (Sudoriferous Gland)**
  These glands are located in the epidermis and produce moisture (sweat) that is secreted through tiny ducts onto the surface of the skin (stratum corneum). When sweat evaporates, skin temperature is lowered.

Type of skin:

1. Normal Skin Type
2. Dry Skin Type
3. Oily Skin Type
4. Combination Skin
5. Sensitive Skin

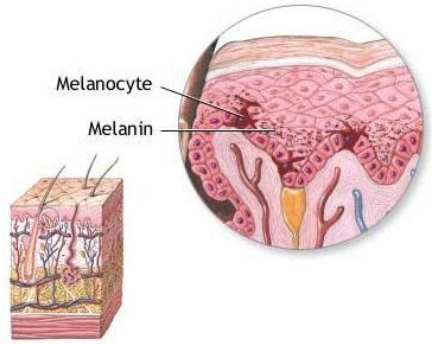
Layers of the Skin

The Epidermis

The epidermis is the outermost layer of the skin, and protects the body from the environment. The thickness of the epidermis varies in different types of skin; 0.05 mm thick on the eyelids, till 1.5 mm thick on the palms and the soles of the feet. The epidermis layer itself is made up of five sublayers that work together to continually rebuild the surface of the skin:

The Basal Cell Layer

The basal layer is the innermost layer of the epidermis, and contains small round cells called basal cells. The basal cells constantly divide, and new cells push older ones upward the surface of the skin, where they are eventually shed. The basal cell layer is known as the stratum germinativum due to the fact that it is constantly germinating (producing) new cells.



The basal cell layer contains cells called melanocytes. Melanocytes produce the skin coloring or pigment known as melanin, which gives skin its tan or brown color and helps protect the deeper layers of the skin from the effects of the sun. Sun exposure causes melanocytes to increase production of melanin to protect the skin from ultraviolet rays, producing a suntan. Patches of melanin in the skin cause birthmarks, freckles and age spots. Melanoma develops when melanocytes undergo malignant transformation.

Merkel cells, which are tactile cells of neuroectodermal origin, are located in the basal layer of the epidermis.

The Squamous Cell Layer / stratum spinosum

The squamous cell layer is located above the basal layer, and is also known as the stratum spinosum or "spiny layer" , the cells are held together with spiny projections. Within this layer are the basal cells that have been pushed upward, however these maturing cells are now called squamous cells, or keratinocytes. Keratinocytes produce keratin, a tough, protective protein that makes up the majority of the structure of the skin, hair, and nails. The squamous cell layer is the thickest layer of the epidermis, and is involved in the transfer of substances in and out of the body. *This is important to us for the transfer of products into the body with electro stimulation.* The squamous cell layer contains cells called Langerhans cells. These cells attach themselves to antigens that invade damaged skin and alert the immune system to their presence.

The Stratum Granulosum & the Stratum Lucidum

The keratinocytes from the squamous layer are then pushed up through two thin epidermal layers called the stratum granulosum and the stratum lucidum. As these cells move further towards the surface of the skin, they get bigger and flatter and adhere together, and then eventually become dehydrated and die. This process results in the cells fusing together into layers of tough, durable material, which continue to migrate up to the surface of the skin.

The Stratum Corneum

The stratum corneum is the outermost layer of the epidermis, and is made up of 10 to 30 thin layers of continually shedding, dead keratinocytes. The stratum corneum is known as the "horny layer". As the outermost cells age and wear down, they are replaced by new layers of strong, long-wearing cells. The stratum corneum is sloughed off continually as new cells take its place, this shedding process slows down with age. Complete cell turnover occurs every 28 to 30 days in young adults, while the same process takes 45 to 50 days in elderly adults.

The Dermis

The dermis is located beneath the epidermis and is the thickest of the three layers of the skin (1.5 to 4 mm thick), making up approximately 90 percent of the thickness of the skin. The main functions of the dermis are to regulate temperature and to supply the epidermis with nutrient-saturated blood.

Much of the body's water supply is stored within the dermis. This layer contains most of the skins' specialized cells and structures, including:

- **Blood Vessels**
  The blood vessels supply nutrients and oxygen to the skin and take away cell waste and cell products. The blood vessels transport the vitamin D produced in the skin back to the rest of the body.
- **Lymph Vessels**
  The lymph vessels provide the tissues of the skin with lymph, a milky substance that contains the infection-fighting cells of the immune system. These cells work to destroy any infection or invading organisms as the lymph circulates to the lymph nodes.
- **Hair Follicles**
  The hair follicle is a tube-shaped sheath that surrounds the part of the hair that is under the skin and nourishes the hair.
- **Sweat Glands**
  The average person has about 3 million sweat glands. Sweat glands are classified according to following types:
    1. Eccrine sweat glands : these are distributed all over the body in varying densities.
    2. Apocrine sweat glands : are limited to the axilla (armpit) and perianal (surrounding the anus) areas in humans.
    3. Ceruminous glands (ear wax) , mammary glands (milk) and ciliary glands (in eyelids) are modified apocrine sweat glands.
    4. Apoeccrine sweat glands : these have the characteristics of both eccrine and apocrine sweat glands. They are larger than eccrine glands but smaller than apocrine glands. These are mostly found in the armpits and perianal regions. They produce more sweat than both apocrine and eccrine glands, and play a large role in axillary sweating.
- **Sebaceous glands**
  Sebaceous, or oil, glands, are attached to hair follicles and can be found everywhere on the body except for the palms of the hands and the soles of the feet. These glands secrete oil that helps keep the skin smooth and supple. The oil helps to keep the skin waterproof and protects against an overgrowth of bacteria and fungi on the skin.
- **Nerve Endings**
  The dermis layer contains pain and touch receptors that transmit sensations of pain, itch, pressure and information regarding temperature to the brain.
- **Collagen and Elastin**
  The dermis is held together by a protein called collagen, made by fibroblasts. Fibroblasts are skin cells that give the skin its strength and resilience. Collagen is a tough, insoluble protein found throughout the body in the connective tissues that hold muscles and organs in place.. Elastin, allows the skin to spring back into place when stretched and keeps the skin flexible.

The dermis layer is made up of two sublayers:

Papillary Layer

This upper layer contains collagen fibers. The papillary layer supplies nutrients to the epidermis and regulates temperature. Constriction and expansion of blood vessels control temperature.

Reticular Layer

The lower layer is made of thick collagen fibers that are arranged in parallel to the surface of the skin. The reticular layer is denser than the papillary dermis, and it strengthens the skin, providing structure and elasticity. It supports other components of the skin, such as hair follicles, sweat glands, and sebaceous glands.

The Subcutis

The subcutis is known as the hypodermis or subcutaneous layer, and functions as both an insulator, conserving the body's heat, and as a shock-absorber, protecting the inner organs. It stores fat as an energy reserve for the body. The blood vessels, nerves, lymph vessels, and hair follicles cross through this layer. The thickness of the subcutis layer varies throughout the body and from person to person.

Type of skin

1. Normal Skin Type
2. Dry Skin Type
3. Oily Skin Type
4. Combination Skin
5. Sensitive Skin

Skin type is usually due to genetic predisposition, but there are habits that can exacerbate a skin condition. Knowing the skin type and understanding the ways to properly treat it can help to achieve, healthy-looking skin. Skin type selection is needed for cleaning and electrode placement.

Normal Skin Type

Not too dry and not too oily, normal skin has:

- No or few imperfections
- No severe sensitivity
- Barely visible pores
- A radiant complexion

Dry Skin Type

- Almost invisible pores
- Dull, rough complexion
- Red patches
- Your skin is less elastic
- More visible lines

What Causes Dry Skin?
Many assume that dry skin is due to a lack of moisture, but the water content of dry skin is generally found in similar levels to that of oily skin. Adding water to dry skin is actually counterproductive to treating this skin condition.

Avoid Harsh Cleansers
Those with dry skin are generally advised to avoid benzoyl peroxide treatments, as this further diminishes the amount of oil our glands produce. Sometimes dry skin is the indication of an underlying condition, so if you notice a great deal of redness, flaking, or irritation, it’s important to talk to a doctor or dermatologist.

Oily-Skin-Type

- Enlarged pores
- Dull or shiny, thick complexion
- Blackheads, pimples, or other blemishes

Those with oily skin tend to notice a great deal of shine on their face, and may deal with acne breakouts.

What Causes Oily Skin?
Oily skin is the result of both genetic factors and hormonal changes experienced in an individual's lifetime. Those with a genetic predisposition to active oil glands produce a higher amount of sebum, an oily substance created to help keep the skin soft and hydrated. This oil flows from inside the epidermis to the surface of the skin through pores and hair follicles. When the body experiences a fluctuation in hormone levels, it signals the production of androgens, a male hormone present in both men and women.

The production of androgens stimulates an increase in sebum production, but when an excess of this oil is produced, it can expand the size of the skin's pores and result in blockages that become pimples and other acne blemishes. Oily skin is more prone to acne breakouts, and may feature a plethora of blackheads, whiteheads, and pustules or papules. Pores may be more visible because of their size expansion, and the skin appears greasy throughout the day.

How to Care for Oily Skin
Lightly exfoliate (wash or rub with a granular substance to remove dead skin cells) oily skin, as the buildup of oil can cause dead skin cells to become trapped in the pores and lead to acne blemishes. Use products that contain gentle exfoliators, like the salicylic acid. Salicylic acid is a natural exfoliant that gently sloughs off the dead skin cells that may result in pore blockages.

Combination Skin

- Pores that look larger than normal, because they're more open
- Blackheads
- Shiny skin

Combination skin features two or more skin types on the face, and presents with dry and flaky skin on portions of the face, with excessive oil on others. Combination skin is the most common skin type. Exfoliating is essential for those with combination skin. Dead skin cells on the dry part of the face will be sloughed off, while clogged pores will be unblocked and cleared.

Sensitive Skin

- Redness
- Itching
- Burning
- Dryness

Sensitive skin types exhibit the characteristics of dry skin, oily skin, or combination skin, it deals with redness and irritation. Normal skin types may also have sensitive skin, but these generally don't overlap. Those with sensitive skin types should avoid harsh chemical-based skin care treatments, and can be caused by other skin conditions like rosacea or allergies. Sensitive skin is easily inflamed, it's important to choose the right natural skin care for sensitive skin to avoid any adverse reactions.

The skin as conductor

The goal of this part is to give an impression of the study we are performing worldwide skin condition, the optimal way of medicine delivery through the skin, Age Control of the skin, the use of the skin as conductor in Electro Stimulation. This chapter is not complete as it is an impression of the possibilities only.

Epidermis
The epidermis has a layered structure. The outer layer, the stratum corneum (SC), consists of a lipid-corneocyte matrix crossed by appendages like sweat glands or hair follicles. The SC has the highest resistance of about 105 Ωcm2 and a capacitance of ~0.03 μF/cm2 when small currents are applied.

Through electroporation, (this is a microbiology technique in which an electrical field is applied to cells to increase the permeability of the cell membrane, allowing chemicals, drugs, or DNA to be introduced into the cell.) a high increase in permeability of the cell membrane caused by an externally applied electrical field, the skin impedance drops significantly. The lipid matrix has about 70-100 lipid-corneocyte bilayers. Electroporation occurs when the voltage drop across each bilayer of about 300-400 mV is applied, which is a voltage drop through the SC of about 30 V. Lower voltage drops are too small for electroporation.

Inner layers of the epidermis have gradually lower impedances as they come closer to the stratum basale, the germinating layer where all epidermal cells arise. A fine meshed vascular network lies deep to the avascular epidermisin, the dermal cones and serves as nutrition source. The outer the layers the more they are dehydrated keratinize and peel off with sweat or bath. For the epidermis brick structured models are used. Appendages cross the skin and are preferred pathways for electrical current.

Dermis
The dermis is full of bundles of fibrous connective tissue, blood and lymphatic vessels, sensory receptors and related nerves and glands. The electric impedance of the dermis is lower than the dryer epidermis. It is modeled either as equipotential area or as homogeneous volume conductor with a resistivity of about the fat layer. In simplified models the epidermis and dermis are modeled as skin layer using a single volume conductor (e.g. conductivity ρ=300 Ωm; permittivity εr=6000).

The intrafollicular pathway: The amount of sebaceous glands on the total skin surface represents not more than 0.1%. Some scientists believe that this route is not a significant penetration pathway for most molecules. Others claim that the appendages can bypass the low diffusivity of the SC and may act as diffusional shunts. When the follicle is the site of action, such as in acne, scientists find ways to target a compound to this site, by developing delivery systems with specific physicochemical properties.

When considering these openings as a possible route for penetration, it is important to understand the variations in follicle distribution among different body locations. The highest hair follicle density and percentage of follicular orifices were found on the forehead. The highest average size of the follicular orifices is measured in the calf region. The forehead and the calf regions were found to exhibit the highest infundibular volume and therefore the highest potential for creation of a reservoir. The lowest values for all parameters were found on the forearm.

The plantar and palmar regions of the skin are the only sites completely devoid of sebaceous glands. Human skin appendages, hair follicles, and sebaceous glands, constitute a significant route for penetration of chemicals. Depending on the formulation and the compound's intrinsic properties,

certain compounds can enter faster into shunts than through a different route in the SC. It was demonstrated, for example, that microspheres with an optimal size of around 1.5 µm showed 55% penetration into hair follicles. Two types of liposomes (classic multilamellar vesicles and flexible ultradeformable liposomes) were found to contribute significantly to penetration through shunt routes.

The "polar pathway": This route is believed to be hydrophilic in nature. It is composed of aqueous regions surrounded by polar lipids that create the walls of microchannels. It is known to have a high penetration resistance to lipophilic compounds but low resistance to hydrophilic compounds. It is also thought to be the route by which water evaporates through the skin. The localization of the hydrophilic pores is unclear.
Enzymes: The approach of using enzymes to affect the barrier properties of the SC refers to either affecting activity of enzymes present in the skin, or to enzymes applied to it from the outside. For example, an application of papain, a proteolytic enzyme that was conjugated to SC-glucan revealed an enhancement of percutaneous absorption. This application triggered structural changes in the SC that led to an increase in thickness of the SC and the living epidermis.

Electrode Skin Care

1. Wash the area of skin where placing the electrodes, using mild soap and water before applying electrodes, and after taking them off. Be sure to rinse soap off thoroughly and dry skin well.
2. Excess hair may be clipped with scissors; do not shave stimulation area.
3. Wipe the area with the skin preparation. Let this dry. Apply electrodes as directed.
4. Many skin problems arise from the "pulling stress" from adhesive patches that are excessively stretched across the skin during application. To prevent this, apply electrodes from center outward; avoid stretching over the skin.
5. To minimize "pulling stress", tape extra lengths of lead wires to the skin in a loop to prevent tugging on electrodes.
6. When removing electrodes, always remove by pulling in the direction of hair growth.
7. It may be helpful to rub skin lotion on electrode placement area when not wearing electrodes.
8. Never apply electrodes over irritated or broken skin.
9. In some circumstances stretch bands with Velcro closure maybe a good alternative

Neural system

Nervous and muscle Anatomy (short version)
Our body is made of cells. Each cell must communicate with the others to be what we are, a living organism. The communication between cells is done in different ways. Cells communicate through chemical signals. Hormones, enzymes and neurotransmitters, are the sensors of the cells, the connection with the "outer world". Every cell has receptors that detect different signals. Signaling molecules come in multiple forms and shapes. Signaling happens in more than one way. It is within the cell itself and cells send messages to neighbors or other cells a distance away. The way these signals are transferred is:

- Chemical compounds (example: nutrients and toxins)
- Electrical impulses (example: neurotransmitters inducing electrical signals along nerves)
- Mechanical stimuli (example: stretching of the stomach to signal you are full)

Chemical Signaling
Chemical signaling is divided in four pathways, depending on the distance that need to be bridged.

Autocrine Signaling = Internal communication. In autocrine signaling, the cell releases a chemical signal that binds to a receptor within the cell transferring a specific message.
Paracrine Signaling = two cells communication. For example when signaling occurs across the gap between two neurons by a neurotransmitters.

Endocrine Signaling = send messages across long distances. Signals that originate in one part of the body and travel to their target through the bloodstream are called hormones. The hormone then sets specific cells or tissues into action.

Direct-Contact Signaling = Gap junctions are filled with water and allow small signaling molecules to travel across the channel. This is cell signaling through direct contact. It allows groups of cells to respond to a signal that only one cell received. It is not a typical human method

Electrical and Mechanical Signaling
Many cells respond to electrical or mechanical signals. Two examples of this are the regulating of the heart beat (electrical) and the signaling for muscle growth following exercise (mechanical).

The heart beats like a wave. This is a defined beating pattern, initiated and synchronized by electrical signals.

Mechanical signals in muscle cells lead to growth and strength gains. When muscle cells are stretched—otherwise deformed or damaged—calcium ions flood into the muscle cell. This flux of calcium ions is the intermediary, changing the mechanical signal into a chemical one. The presence of calcium ions signals a number of cell signaling pathways inside of the muscle, including hormones responsible for muscle growth. This is external energy transfer into biological energy (ion based).

How Cells Recognize and Respond to Signals
Proteins receptors help cells recognize received signals. Receptors are located both inside and outside the cell or situated into a cellular membrane. Signaling occurs when specific molecules bind to their receptors.

There are two classes of receptors: intracellular and cell-surface receptors.
Intracellular receptors are located inside the cell. Signal molecules travel through pores in the cell's membrane to reach this type of receptor and elicit a response.

Cell-surface receptors are embedded in the cell's membrane. They bind signaling molecules on the outside of the cell, and relay the message internally.

The central nervous system comprises the brain (cerebrum, cerebellum, and brainstem) and the spinal cord. There are over 100 trillion neural connections in the average human brain, though the number and location can vary. A synapse gives a command to the cell and the entire communication process typically takes only a fraction of a millisecond. Signals travel along an alpha motor neuron in the spinal cord 431 km/h the fastest transmission in the human

body. The peripheral nervous system includes sensory neurons, which link sensory receptors on the body surface and specialized receptor structures such as the ear, with processing circuits in the central nervous system.

Our nervous system is made up of two classes of cells: neurons and neuroglia.

Neurons

Neurons, or nerve cells, communicate by transmitting electrochemical signals. The duty of neurons are simplified in 3 functions;

- Receive messages
- Send messages
- Activate cells and tissue

The cell body of a neuron is the roundish part that contains the nucleus, mitochondria, and most of the cellular organelles. Dendrites extend from the cell body to communicate with other neurons, or sensory receptor cells. Axons send signals to other neurons or effector cells in the body.

There are 3 basic classes of neurons: afferent neurons, efferent neurons, and interneurons.

1. *Afferent neurons* = sensory neurons, afferent neurons transmit sensory signals to the central nervous system from receptors in the body.
2. *Efferent neurons* = motor neurons, they transmit signals from the central nervous system to effectors in the body such as muscles and glands.
3. *Interneuron = a* complex networks within the central nervous system to integrate information received from afferent neurons and activate.

Neurons have three basic parts:

1. Cell body: This part has a the nucleus (contains DNA), endoplasmic reticulum and ribosomes (for building proteins) and mitochondria (for making energy). Cell bodies are grouped together in clusters called ganglia, which are located in various parts of the brain and spinal cord.
2. Axons: These long, thin, cable-like cells send electrochemical messages (nerve impulses or action potentials) along the length of the cell. Depending upon the type of neuron, axons can be covered with a thin layer of myelin, like an insulated electrical wire. Myelin is made of fatty acids, which helps to speed transmission of a nerve impulse down the axon. Myelinated neurons are found in the peripheral nerves (sensory and motor neurons), while nonmyelinated neurons are found within the brain and spinal cord.
3. Dendrites or nerve endings: small, branchlike cellparts connect with other cells and allow the neuron to transfer its message to other cells or perceive the environment. Dendrites can be located on one or both ends of the cell.

Neuroglia

Neuroglia or glial cells, are assistant cells with numbers of 6 to 60 neuroglia that protect, feed, and insulate the neuron. Neuroglia are vital to maintaining a functional nervous system.

Spinal Cord

The spinal cord is a bundled cord of neurons for information transfer from the vertebral cavity of the spine beginning at the medulla oblongata of the brain on its ending to the lumbar region

of the spine. In the lumbar region and everything in between. The white matter of the spinal cord functions as the main conduit of nerve signals to the body from the brain. The grey matter of the spinal cord integrates reflexes to stimuli.

Nerves

Nerves are bundles of axons in the peripheral nervous system (PNS) to carry signals between the brain, spinal cord and the rest of the body. Individual axons of the nerve are bundled into groups called fascicles and are covered in a sheath called the perineurium. Bundles of fascicles are wrapped together in tissue called the epineurium to form a nerve. The multilayer protection covering is to increase speed in information transportation and limiting reaction time.

- *Afferent, Efferent, and Mixed Nerves*.
    - Afferent nerves carry information only one way to the central nervous system.
    - Efferent nerves, carry signals one way from the central nervous system to effectors as muscles and glands.
    - Mixed nerves contain both afferent and efferent axons. These have a 2-way function. Afferent axons heading toward the central nervous system and efferent axons heading away from the central nervous system.
- *Cranial Nerves*. Extending from the inferior side of the brain are 12 pairs of cranial nerves. Each cranial nerve pair is named by a Roman numeral I to XII based on location along the anterior-posterior axis of the brain. Each nerve has an additional name (e.g. olfactory, optic, etc.) that identifies its function or location. The cranial nerves provide a direct connection to the brain for the sense organs, muscles of the head, neck, and shoulders, the heart, and the GI tract.
- *Spinal Nerves*. Extending from the left and right sides of the spinal cord are 31 pairs of spinal nerves. The spinal nerves are mixed nerves that carry both sensory and motor signals between the spinal cord and specific regions of the body. The 31 spinal nerves are divided into 5 groups named for the 5 regions of the vertebral column. There are
    - 8 pairs of cervical nerves,
    - 12 pairs of thoracic nerves,
    - 5 pairs of lumbar nerves,
    - 5 pairs of sacral nerves, and
    - 1 pair of coccygeal nerves.

Each spinal nerve exits from the spinal cord through the intervertebral foramen between a pair of vertebrae or between the C1 vertebra and the occipital bone of the skull.

The nervous system has 3 main functions: sensory, integration, and motor.

1. *Sensory*. The sensory is collecting information from sensory receptors that monitor the body's internal and external conditions. These signals are passed on to the central nervous system (CNS) for further processing. Cause.
2. *Integration*. These signals are evaluated, compared, used for decision making, discarded or committed to memory as considered appropriate. Integration takes place in the gray matter of the brain and spinal cord.

3. *Motor*. Efferent neurons (also called motor neurons) carry signals from the gray matter of the CNS through the nerves of the peripheral nervous system to effector cells. The effector may be smooth, cardiac, or skeletal muscle tissue or glandular tissue. The effector releases a hormone or moves a part of the body to respond to the stimulus. Effect.

Central Nervous System = CNS

The brain and spinal cord together form the central nervous system, or CNS. The CNS acts as control center of the body by providing its processing, memory, and regulation systems. The CNS collects all conscious and subconscious sensory information from the body's receptors to be aware of the body's internal and external conditions.

With sensory information, the CNS makes decisions about conscious and subconscious actions to maintain the physical homeostasis and ensure survival. The CNS is responsible for the other functions of the nervous system as language, expression, emotions, and personality etc. The brain defines who we are and what we be.

Peripheral Nervous System

The peripheral nervous system (PNS) includes the nervous system outside of the brain and spinal cord. These parts include all the cranial and spinal nerves, ganglia, and sensory receptors.

Somatic Nervous System

The somatic nervous system (SNS) is a division of the PNS that includes all of the voluntary efferent neurons. The SNS is the only consciously controlled part of the PNS and is responsible for stimulating skeletal muscles in the body.

Autonomic Nervous System

The autonomic nervous system (ANS) is a division of the PNS that includes all of the involuntary efferent neurons. The ANS controls subconscious effectors such as visceral muscle tissue, cardiac muscle tissue, and glandular tissue. We do not have control but can influence by electric and chemical external impulses.

There are 2 segments of the autonomic nervous system in the body:

- *Sympathetic*. The automatic "fight or flight" response to stress, danger, excitement, exercise, emotions, and embarrassment. The sympathetic segment increases respiration, heart rate, releases adrenaline and other stress hormones, and decreases digestion to be ready for immediate action..
- *Parasympathetic*. Among other functions, the parasympathetic segment works to decrease respiration and heart rate, increase digestion, and permit the elimination of wastes.

Enteric Nervous System

- The enteric nervous system (ENS) is responsible for regulating digestion and the digestive organs. ENS receives signals from the CNS through both the sympathetic and parasympathetic segment of the autonomic nervous system to regulate its functions. The ENS mostly works independently of the CNS and continues to function without outside input. For this reason, the ENS is often called the "brain of the gut" or the body's "second brain." .

Action potential

Neurons function through the generation and propagation of electrochemical signals called action potentials (APs). An AP is created by the movement of sodium and potassium ions through the membrane of neurons. See Biological energy.

- *Resting Potential*. Neurons maintain a concentration of sodium ions outside the cell and potassium ions inside the cell. This concentration is maintained by the sodium-potassium pump of the cell membrane which pumps 3 sodium ions out of the cell for every 2 potassium ions pumped into the cell. The ion concentration results in a resting electrical potential of minus 70 millivolts (mV), which implies that the inside of the cell has a negative charge compared to its surroundings.
- *Threshold Potentia*l. If a stimulus permits enough positive ions to enter a part of the cell to cause it to reach -55 mV, that part of the cell opens its voltage-gated sodium channels and allow sodium ions to diffuse into the cell. -55 mV is called the threshold potential for neurons as this is considered the "trigger" voltage that they must reach to cross the threshold into forming an action potential.
- *Depolarization*. Sodium carries a positive charge that causes the cell to become depolarized (positively charged) compared to its normal negative charge. The voltage for depolarization of all neurons is +30 mV. The depolarization of the cell is the action potential (AP) that is transmitted by the neuron as a nerve signal. The positive ions spread into neighboring parts of the cell, initiating a new AP in those parts as they reach -55 mV. The AP continues to spread down the cell membrane of the neuron until it reaches the end of an axon.
- *Repolarization*. After the depolarization voltage of +30 mV is reached, voltage-gated potassium ion channels open, allowing positive potassium ions to diffuse out of the cell. The loss of potassium along with the pumping of sodium ions back out of the cell through the sodium-potassium pump restores the cell to the -55 mV resting potential. At this point the neuron is ready to start a new action potential.

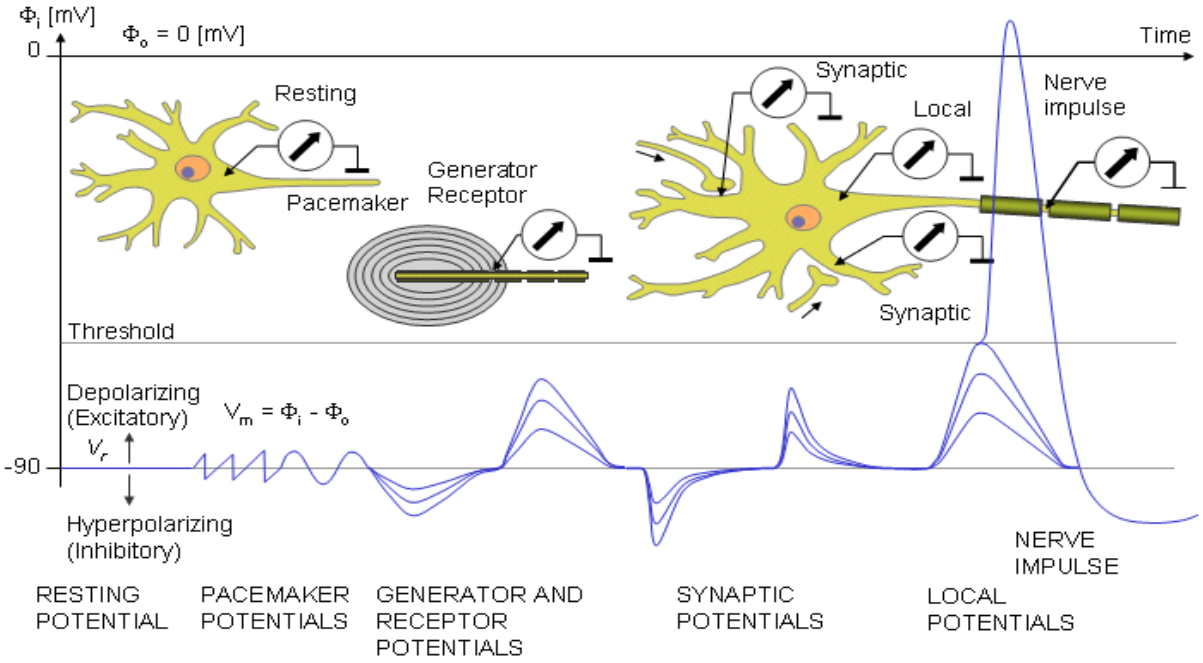
Bioelectric function of the nerve cell

The *membrane voltage (transmembrane voltage)* (V_m) of an excitable cell is defined as the potential at the inner surface (Φ_i) relative to that at the outer (Φ_o) surface of the membrane, i.e. $V_m = (\Phi_i) - (\Phi_o)$. This definition is independent of the cause of the potential, and whether the membrane voltage is constant, periodic, or nonperiodic in behavior. Fluctuations in the membrane potential can be classified according to their nature in many different ways. The classification for nerve cells is developed by Theodore Holmes Bullock (1959). According to Bullock, the transmembrane potentials can be resolved into a resting potential and potential changes due to activity. They can be classified into three different types:

1. *Pacemaker potentials*: the intrinsic activity of the cell which occurs without external excitation.

2. *Transducer potentials* across the membrane, due to external events. These include *generator potentials* caused by receptors or *synaptic potential* changes arising at synapses. Both subtypes can be inhibitory or excitatory.

3. As a consequence of transducer potentials, further response arises. If the magnitude does not exceed the threshold, the response is *nonpropagating (electric)*. If the response is enough, a *nerve impulse (action potential impulse)* is produced which obeys the all-or-nothing law (see below) and proceeds unattenuated along the axon or fiber.



Transmembrane potentials according to Theodore H. Bullock.

Synapse

A synapse is the junction between a neuron and another cell. Synapses can form between 2 neurons or between a neuron and an effector cell. There are two types of synapses found in the body:

Chemical synapses. At the end of a neuron's axon is an enlarged region of the axon known as the axon terminal. The axon terminal is separated from the next cell by a small gap known as the synaptic cleft. When an action potential reaches the axon terminal, it opens voltage-gated calcium ion channels. Calcium ions cause vesicles containing neurotransmitters (NT) to release their contents by exocytosis into the synaptic cleft. The NT molecules cross the synaptic cleft and bind to receptor molecules on the cell, forming a synapse with the neuron. These receptor molecules open ion channels that may either stimulate the receptor cell to form a new action potential or may inhibit the

cell from forming an action potential when stimulated by another neuron. Classes of Neurotransmitters:

Acetylcholine
Biogenic amines (contains one or more amine groups)
Dopamina, Norepinephrine, and epinephrine
Serotonin
Histamine
Amino acids
GABA (gamma-aminobutyric acid)
Glutamate
Glycerine
Peptides
Endorphins and enkephalins
Somatostatin

- *Electrical synapses*. Electrical synapses are formed when 2 neurons are connected by small holes called gap junctions. The gap junctions allow electric current to pass from one neuron to the other, so that an AP in one cell is passed directly on to the other cell through the synapse.

In reference to the aging process it is understandable that the neural system is the weak link. Many **things can go and do go wrong. The first steps are the training in childhood. Coordination is programming the neural system in where to react. Precision training is how to do it. Slowly we build a movement that includes coordination, speed and accuracy. Through training of repetition reflexes are built. With reflexes more room for other movement is created. The most important part of reflexes are the unconscious reaction to programmed and suspected events. This programming gives space for other movements. By programming a complete personal movement and reaction sequences is created. Within this, due to the multifunctional neural actions, fear and joy are imbedded. Emotions become a part of the neural system and have influence on personality and movement.**

The neural system is fragile and it is possible to disrupted it. The following options of disruption do happen:

- Delayed transmission. Nerves need to be kept in a good condition. One of the major ways to keep nerves active is to feed them with different impulses and speed levels. Nerves must be "played" with to keep active and "young". When nerves serve the same speed day in and day out they become "lazy" . Like a routine person does things without thinking a nerve act the same. But when this routines happen too often a nerve also get slower and sometimes obstructed. Using the same pathway leaves traces of energy in the neural shield (ganglia) which can create "false" energy and disrupt a signal (wear and tear principle). When transmission is delayed all following procedures are delayed. This simple delay has a domino effect on all reactions following.
- Obstructed delay. As mentioned before obstruction can be caused by pollution of the passages but also by injury or defects. Most of the time it is possible the neural system creates alternative routes but not always. A neural obstruction in a chain creates delays or fall out of next steps.
- Fall out or complete removal. Amputation is a clear sample of a malfunctioning neural system. The system continues to send and "receive" ghost messages to not-existing parts of the body.

- Chemical disturbances. The use of drugs and medicines can disrupt the neural system by or take over the function of neurotransmitters with a different signal but “identical” chemistry or block the transmission completely for a period of time.
- Malfunctioning. Through a disease or otherwise the nerves transmit parts of a wrong message. This malfunction can lead to a change in cell information (cancer) or even destruction of cells and tissue.

The sensitivity of the neural system is known but not yet recognized as one of the major causes of aging. Keeping the system healthy and productive is a need. Stimulation a must. Neurex is still one of the only – if not the only – exercises to keep the neural system in a good condition until high age.

In every part of the neural system we see the combination of chemical and electrical action s return. The electrical transfer difference between ions and electrons is often bridged by some less known factors. For a transfer of external electric impulses into the biological system there is a need for a converter mechanism. This mechanism is a combination of redox salts, neurotransmitters, amino acids, some minerals and vitamins. It supports the transfer and makes treatment more effective. Customer gets this combination before every treatment in a drink which takes around 10-15 minutes to reach blood and location levels.

Muscles

Muscular Anatomy

There are three types of muscle tissue: Visceral, cardiac, and skeletal.

Visceral Muscle

Visceral muscle is located inside the organs such as the stomach, intestines, and blood vessels. Visceral muscle moves organs to contract and move substances through the organ. Visceral muscle is known as involuntary muscle. The structure is different from other muscles.

Cardiac Muscle

Cardiac muscle, found in the heart, is responsible for pumping blood throughout the body. Cardiac is an involuntary muscle. Signals from the brain influences the rate of contraction but cardiac muscle stimulates itself to contract.

Cells of cardiac muscle tissue are striated—they show light and dark stripes under a microscope. The protein fibers inside of the cells causes these light and dark bands. Cardiac Muscles are very strong and have a great endurance.

Skeletal Muscle

Every physical action that a person consciously performs (e.g. speaking, walking, or writing) requires skeletal muscle. The function of skeletal muscle is to contract. Most skeletal muscles are attached to two bones across a joint, the muscle serves to move parts of those bones closer to each other. Skeletal muscles can be trained unlike the others.

Most skeletal muscles are attached to two bones through tendons. Tendons are tough bands of dense regular connective tissue whose strong collagen fibers firmly attach muscles to bones. Tendons are under specific levels of stress when muscles pull on them, they are strong and are woven into the coverings of both muscles and bones.

Muscles move by contraction which shortens their length, pulling on tendons, and moving bones. One of the bones is pulled towards the other bone, which remains stationary. The place on the stationary bone that is connected through tendons to the muscle is called the origin while the moving bone is called the insertion. The belly of the muscle is the fleshy part of the muscle in between the tendons that does the contraction.

Skeletal muscles rarely work alone to achieve movements in the body. Most of the time they work in groups to produce movements. The muscle that produces any particular movement is known as an agonist. The agonist always pairs with an antagonist muscle that produces the opposite effect on the same bones. For example, the biceps brachii muscle flexes the arm at the elbow. The antagonist for this motion, the triceps brachii muscle extends the arm at the elbow. When the triceps is extending the arm, the biceps is the antagonist.

The agonist/antagonist pairing does not work alone, other muscles support the movements of the agonist. Synergists are(smaller) muscles that assist to stabilize movement and reduce extraneous movements. They are found in segments near the agonist and often connect to the same bones.

Histology

Skeletal muscle fibers differ from other tissues of the body due to their specialized functions. Many of the organelles that make up muscle fibers are unique to this type of cell. Sarcolemma is the cell membrane of muscle fibers.

The sarcolemma acts as a conductor for electrochemical signals that stimulate muscle cells. Connected to the sarcolemma are transverse tubules (T-tubules) that help carry these electrochemical signals into the middle of the muscle fiber. The sarcoplasmic reticulum serves as a storage facility for calcium ions (Ca2+) that are vital to muscle contraction.

Mitochondria, break down sugars and provide energy in the form of ATP to active muscles. Most of the muscle fiber's structure is made up of myofibrils, which are the contractile structures of the cell. Myofibrils are constructed of many proteins fibers arranged into repeating subunits called sarcomeres. The sarcomere is the functional unit of muscle fibers.

Structure of sarcomere

Sarcomeres are made of two types of protein fibers: thick filaments and thin filaments.

- *Thick filaments*. Thick filaments are made of many bonded units of the protein myosin. Myosin is the protein that causes muscles to contract.
- *Thin filaments*. Thin filaments are made of three proteins:
    1. *Actin*. Actin forms a helical structure which is the bulk of the thin filament mass. Actin contains myosin-binding sites that allow myosin to connect to and move actin during muscle contraction.

2. *Tropomyosin*. Tropomyosin are long protein fibers that wrap around actin and cover the myosin binding sites on actin.
3. *Troponin*. Bound very tightly to tropomyosin, troponin moves tropomyosin away from myosin binding sites during muscle contraction.

Function

The main function of the muscular system is movement. Muscles has the ability to contract and therefore move other parts of the body. The second function is maintenance of posture and body position. Muscles contract to hold the body still or in a particular position rather than to cause movement. The muscles responsible for the body's posture have the greatest endurance of all muscles in the body—they hold up the body throughout the day without becoming tired.

The third function is the movement of substances inside the body. Cardiac and visceral muscles are primarily responsible for transporting substances like blood or food from one part of the body to another.

Fourth function of muscle tissue is the generation of body heat. As a result of the high metabolic rate of contracting muscle, the muscular system produces "waste" heat. Many small muscle contractions within the body produce the natural body heat. When we exert more than normal, the extra muscle contractions lead to a rise in body temperature and eventually to sweating.

Motor units

Each motor neuron controls several muscle cells in a group known as a motor unit. When a motor neuron receives a signal from the brain, it stimulates all of the muscles cells in its motor unit at the same time. The size of motor units varies throughout the body, depending on the function of a muscle. Muscles that perform fine movements—like those of the eyes or fingers—have very few muscle fibers in each motor unit to improve the precision of the brain's control over these structures. Muscles that need strength to perform their function—like leg or arm muscles—have many muscle cells in each motor unit. One of the ways that the body can control the strength of each muscle is by determining how many motor units to activate for a given function. This explains why the same muscles that are used to pick up a pencil are also used to pick up a dumbbell.

The way of contraction

Muscles contract when stimulated by signals from motor neurons, this happens at a point called the Neuromuscular Junction (NMJ). Motor neurons release neurotransmitters at the NMJ that bond to a special part of the sarcolemma known as the motor end plate. The motor end plate contains many ion channels that open in response to neurotransmitters and allow positive ions to enter the muscle fiber. The positive ions form an electrochemical gradient to form inside of the cell, which spreads throughout the sarcolemma and the T-tubules by opening even more ion channels.

When the positive ions reach the sarcoplasmic reticulum, Ca^{2+} ions are released and allowed to flow into the myofibrils. Ca^{2+} ions bind to troponin, which causes the troponin molecule to change shape and move nearby molecules of tropomyosin. Tropomyosin is moved away from myosin binding sites on actin molecules, allowing actin and myosin to bind together.

ATP molecules power myosin proteins in the thick filaments to bend and pull on actin molecules in the thin filaments. As the thin filaments are pulled together, the sarcomere shortens and contracts. Myofibrils of muscle fibers are made of many sarcomeres in a row, when all of the sarcomeres contract, the muscle cells shortens with a force relative to its size.

Muscles continue contraction as long as they are stimulated. When a motor neuron stops the release of the neurotransmitter, the process of contraction reverses. Calcium returns to the sarcoplasmic reticulum; troponin and tropomyosin return to their resting positions; and actin and myosin are prevented from binding. Sarcomeres return to their elongated resting state once the force of myosin pulling on actin has stopped.

Muscle contraction

The strength of a muscle's contraction is controlled by two factors: the number of activated motor units involved in contraction and the amount of stimulus from the nervous system. A single nerve impulse of a motor neuron causes a motor unit to contract briefly before relaxing. This small contraction is known as a twitch contraction. If the motor neuron provides several signals within a short period of time, the strength and duration of the muscle contraction increases. If the motor neuron provides many nerve impulses in rapid succession, the muscle may enter the state of tetanus, or complete and lasting contraction. A muscle remains in tetanus until the nerve signal rate slows or until the muscle becomes too fatigued to maintain the tetanus.

Not all muscle contractions produce movement. Isometric contractions are light contractions that increase the tension in the muscle without exerting enough force to move a body part. When people tense their bodies due to stress, they are performing an isometric contraction. Holding an object still and maintaining posture are the result of isometric contractions. A contraction that does produce movement is an isotonic contraction.

Muscle tone is a condition in which a skeletal muscle stays partially contracted at all times. Muscle tone provides a slight tension on the muscle to prevent damage to the muscle and joints from sudden movements, this helps to maintain the body's posture. All muscles maintain some amount of muscle tone at all times (think of gravity and airpressure as working powers on the body).

Muscular fiber types

Skeletal muscle fibers can be divided into two types based on how they produce and use energy: Type I and Type II.

1. Type I fibers are slow in their contractions. They are resistant to fatigue because they use aerobic respiration to produce energy from glucose. Type I fibers are found in muscles throughout the body for stamina and posture. Near the spine and neck regions, high concentrations of Type I fibers hold the body up throughout the day.
2. Type II fibers are broken down into two subgroups: Type II A and Type II B.
    - Type II A fibers are faster and stronger than Type I fibers, but do not have as much endurance. Type II A fibers are found throughout the body, but especially in the legs where they work to support the body throughout a long day of walking and standing.

- Type II B fibers are faster and stronger than Type II A, but have less endurance. Type II B fibers are lighter in color than Type I and Type II A due to their lack of myoglobin, an oxygen-storing pigment. Type II B fibers are found throughout the body, but particularly in the upper body where they give speed and strength to the arms and chest at the expense of stamina.

Metabolism and fatigue

Muscles use aerobic respiration when needed to produce a low to moderate level of force. Aerobic respiration requires oxygen to produce about 36-38 ATP molecules from a molecule of glucose. Aerobic respiration is efficient, and can continue as long as a muscle receives adequate amounts of oxygen and glucose to keep contracting. When using muscles to produce a high level of force, they become so tightly contracted that oxygen carrying blood cannot enter the muscle. This condition causes the muscle to create energy using lactic acid fermentation, a form of anaerobic respiration. Anaerobic respiration is less efficient than aerobic respiration—only 2 ATP are produced for each molecule of glucose. Muscles quickly tire as they burn through their energy reserves under anaerobic respiration.

Myoglobin, a red pigment found in muscles, contains iron and stores oxygen in a manner similar to hemoglobin in the blood. The oxygen from myoglobin allows muscles to continue aerobic respiration in the absence of oxygen. Another chemical that helps to keep muscles working is creatine phosphate. Muscles use energy in the form of ATP, converting ATP to ADP to release its energy. Creatine phosphate donates its phosphate group to ADP to turn it back into ATP in order to provide extra energy to the muscle. Finally, muscle fibers contain energy-storing glycogen, a large macromolecule made of many linked glucoses. Active muscles break glucoses off of glycogen molecules to provide an internal fuel supply.

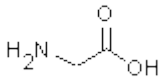
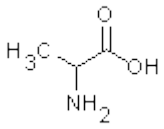
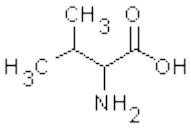
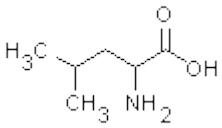
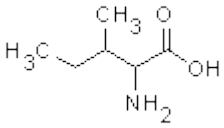
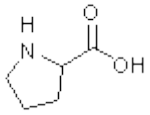
When muscles run out of energy during either aerobic or anaerobic respiration, the muscle quickly tires and loses its ability to contract. This condition is known as muscle fatigue. A fatigued muscle contains very little or no oxygen, glucose or ATP, but instead has waste products from respiration, like lactic acid and ADP. The body must take in extra oxygen after exertion to replace the oxygen that was stored in myoglobin in the muscle fiber as well as to power the aerobic respiration that rebuilds the energy supplies inside of the cell. Oxygen debt (or recovery oxygen uptake) is the name for the extra oxygen that the body must take in to restore the muscle cells to their resting state.

Physical reactions

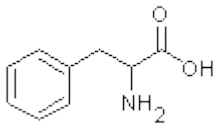
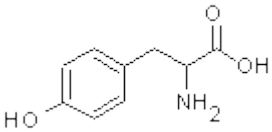
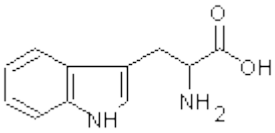
Amino acids

Aminoacids are the building blocks of proteins. There are 20(+) aminoacids.

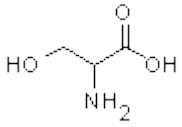
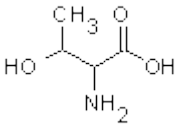
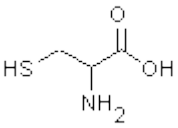
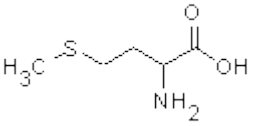
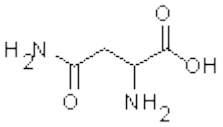
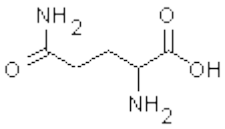
non-polar, aliphatic residues

Glycine	**Gly**	**G-2**		**GGU GGC GGA GGG**
Alanine	**Ala**	**A-3**		**GCU GCC GCA GCG**
Valine	**Val**	**V-1**		**GUU GUC GUA GUG**
Leucine	**Leu**	**L-1**		**UUA UUG CUU CUC CUA CUG**
Isoleucine	**Ile**	**I-1**		**AUU AUC AUA**
Proline	**Pro**	**P-2**		**CCU CCC CCA CCG**

aromatic residues

Phenylalanine	**Phe**	**F-1**		**UUU UUC**
Tyrosine	**Tyr**	**Y-2**		**UAU UAC**
Tryptophan	**Trp**	**W-1**		**UGG**

polar, non-charged residues

Serine	**Ser**	**S-3**		**UCU UCC UCA UCG AGU AGC**
Threonine	**Thr**	**T-1**		**ACU ACC ACA ACG**
Cysteine	**Cys**	**C-2**		**UGU UGC**
Methionine	**Met**	**M-1**		**AUG**
Asparagine	**Asn**	**N-3**		**AAU AAC**
Glutamine	**Gln**	**Q-2**		**CAA CAG**

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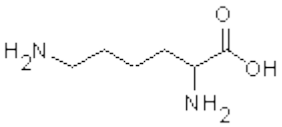
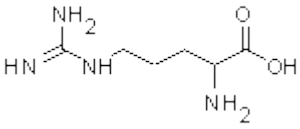
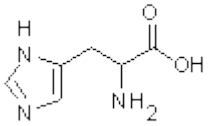
positively charged residues

Lysine	**Lys**	**K-1**		**AAA AAG**
Arginine	**Arg**	**R-2**		**CGU CGC CGA CGG AGA AGG**
Histidine	**His**	**H-1**		**CAU CAC**

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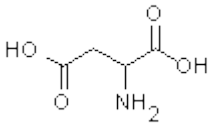
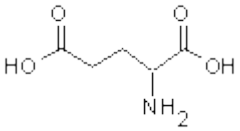
negatively charged residues

Aspartate	**Asp**	**D-3**		**GAU GAC**
Glutamate	**Glu**	**E-3**		**GAA GAG**

1 = essential amino acid
2 = conditional essential amino acid
3 = non-essential amino acid

These building blocks have a common feature that sets them apart of other biological chemicals. Most important are the amino and carboxyl groups, amino acids have a side chain or R group attached to the α-carbon. A way to separate them is to look at their level and way of activity. Technically, any organic compound with an amine (-NH2) and a carboxylic acid (-COOH) functional group is an amino acid.

Nonpolar Side Chains
There are six / eight (there is dispute about this number) amino acids with nonpolar side chains. Glycine, alanine, and proline have small, nonpolar side chains and are all weakly hydrophobic. *Phenylalanine**, valine, leucine, isoleucine and *methionine** have larger side chains and are more hydrophobic. * there is discussion about their place in this part.

Aromatic amino acids
Aromatic amino acids are relatively nonpolar. To different degrees, aromatic amino acids absorb ultraviolet light. Tyrosine and tryptophan absorb more than do phenylalanine; tryptophan is responsible for most of the absorbance of ultraviolet light (ca. 280 nm) by proteins. Tyrosine is the only one of the aromatic amino acids with an ionizable side chain.

Polar, Uncharged Side Chains
There are six amino acids with polar, uncharged side chains. Serine and threonine have hydroxyl groups. Asparagine and glutamine have amide groups. Cysteine has a sulfhydryl group.

Charged Side Chains
There are three amino acids with charged side chains. Arginine and lysine have side chains with amino groups. Their side chains are fully protonated at pH 7.4. Histidine, has as a positively charged imidazole functional group.

Negatively charged residues
Aspatate is under physiological conditions (pH 7.4) usually occurs as the negatively charged aspartate form, −COO− . Glutamic acid in highly alkaline solutions the doubly negative anion −OOC-CH(NH2)-(CH2)2-COO− prevails.

Building Blocks Of Proteins
The most simple amino acid is called glycine (glyco, “sugar”). In the mid-1950s scientists agreed that 20 amino acids (called standard or common amino acids) were the essential building blocks of proteins.

Acid-Base Properties
Another important feature of amino acids is the existence of both a basic and an acidic group at the α-carbon. Compounds such as amino acids that can act as either an acid or a base are called amphoteric. The basic amino group typically has a pKa between 9 and 10, while the acidic α-carboxyl group has a pKa that is usually close to 2 (a very low value for carboxyls). The pKa of a group is the pH value at which the concentration of the protonated group equals that of the unprotonated group.

Meaning, at physiological pH (about 7–7.4), the free amino acids exist largely as dipolar ions or “zwitterions” (German for “hybrid ions”; a zwitterion carries an equal number of positively and

negatively charged groups). Any free amino acid and likewise any protein will, at some specific pH, exist in the form of a zwitterion.

All amino acids and all proteins, when subjected to changes in pH, pass through a state at which there is an equal number of positive and negative charges on the molecule. The pH at which this occurs is known as the isoelectric point (or isoelectric pH) and is denoted as (pI, pH(I), IEP).

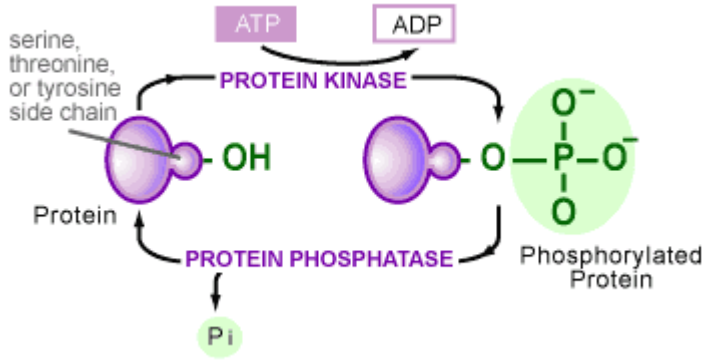
When dissolved in water, all amino acids and all proteins are present predominantly in their isoelectric form. Stated another way, there is a pH (the isoelectric point) at which the molecule has a net zero charge (equal number of positive and negative charges), but there is no pH at which the molecule has an absolute zero charge (complete absence of positive and negative charges). Amino acids and proteins are always in the form of ions; they always carry charged groups. This fact is vitally important in considering further the biochemistry of amino acids and proteins.

Peptide bond

Amino acids can be linked by a condensation reaction in which an −OH is lost from the carboxyl group of one amino acid along with a hydrogen from the amino group of a second, forming a molecule of water and leaving the two amino acids linked via an amide—called, in this case, a peptide bond. When individual amino acids are combined to form proteins, their carboxyl and amino groups are no longer able to act as acids or bases, since they have reacted to form the peptide bond. The acid-base properties of proteins are dependent upon the overall ionization characteristics of the individual R groups of the component amino acids. Amino acids joined by a series of peptide bonds constitute a peptide.

In summary, it is the sequence of amino acids that determines the shape and biological function of a protein as well as its physical and chemical properties.

Several α-amino acids (or their derivatives) act as chemical messengers. For example, γ-aminobutyric acid (gamma-aminobutyric acid, or GABA; a derivative of glutamic acid), serotonin and melatonin (derivatives of tryptophan), and histamine (synthesized from histidine) are neurotransmitters. Thyroxine (a tyrosine derivative produced in the thyroid gland of animals) and indole acetic acid (a tryptophan derivative found in plants) are examples of hormones.

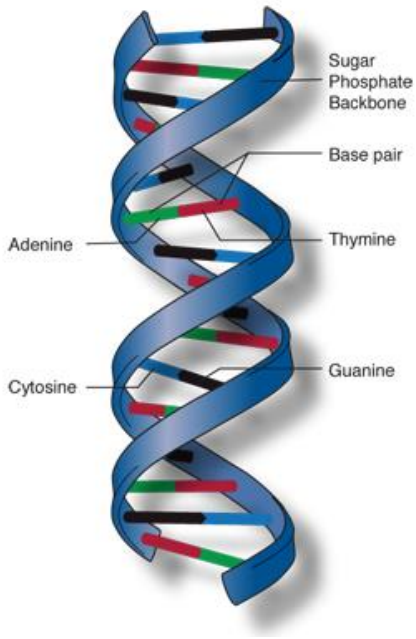


Amino acids are used therapeutically for nutritional and pharmaceutical purposes. For example, patients are often infused with amino acids to supply these nutrients before and after surgical procedures. Treatments with single amino acids are part of the medical approach to control certain disease states.

DNA structure and amino acids

Exploring a DNA chain is a need to understand our fundaments of live. The backbone of DNA is based on a repeated pattern of a sugar- and a phosphate group. The full name of DNA, deoxyribonucleic acid, shows the name of the sugar - deoxyribose. Deoxyribose is a modified form of ribose. Ribose is the sugar in the backbone of RNA, ribonucleic acid.

The complete DNA instruction book, or genome, for a human contains about 3 billion bases and about 20,000 genes on 23 pairs of chromosomes.



REMARK; protein supplementation is overall easily available but must be critically approached. Supplies are often of questionable sources. Protein supplementation has a large filling property, meaning that digesting a "meal" of protein rich food stops most people from eating their normal food. This is not good as the digestive track is based on solid foods and will decay if the foods are liquid. The use of protein as supplement is a matter of professional judgement and not one of simple trial and error if concerning a weak health person. The following information is important to check and supply to people in your care.

- Proteins for human consumption must undergo a number of treatments before ready to use.
    - Hydrolyze takes care of the size of the protein and makes it solvable and digestible. Most supplements also undergo an enzymatic treatment for better digestion.
    - There are proteins available for industrial purpose. These proteins are relatively cheap and to be used in chemical processes. The proteins of this segment are not for a consumer market. These proteins are even dangerous for individual use. But these proteins are widely used on the internet and budget supplement market with sell inferior products for low price. Be aware of this.
    - As mentioned before some proteins must be checked on health contaminations such as bacteria, virus or others. Especially bovine and egg are under suspicion.

Proteins are the building blocks of our body and the cornerstones of life. One of the major important protein based structures in our bodies are the enzymes. Enzymes go before hormones (this seems to be a highly disputed statement but all hormones only come to activity by undergo a change by enzymes) and we should pay attention to the function and health benefits. Enzymes are vital

important to our health and also highly vulnerable for toxics and health (=environmental) changes. During aging most of these enzymes decrease in strength and activity.

Protein based Hormones

TISSUE (ORGAN)	HORMONE
Hypothalamus	Thyrotropin releasing hormone (TRH)
Hypothalamus	Growth hormone Releasing hormone (GHRH)
Anterior pituitary	Thyrotropin stimulating hormone
Anterior pituitary	Corticotropin (ACTH)
Anterior pituitary	Growth hormone (GH)
Posterior pituitary	Vasopressin
Pancreas	Insulin

Peptide hormones can't pass through the cell membrane because cell membranes consist of fatty compounds called phospholipids, and protein-based hormones are water-soluble, not fat-soluble. Peptide hormones bind to receptors on the outside of cells, this triggers a response inside the cell. Examples of short chain hormones are vasopressin and oxytocin.
Peptide hormones are synthesized in endoplasmic reticulum, transferred to the Golgi and packaged into secretory vesicles for export.

They can be secreted by one of two pathways:

- Regulated secretion: The cell stores hormone in secretory granules and releases them in "bursts" when stimulated. This is the most commonly used pathway and allows cells to secrete a large amount of hormone over a short period of time.
- Constitutive secretion: The cell does not store hormone, but secretes it from secretory vesicles as it is synthesized.

Most peptide hormones circulate unbound to other proteins. In general, the half-life of circulating peptide hormones is only a few minutes.

Peptide / protein hormones have different functions which all are equally important.

Hormonal

An example of a hormonal protein is insulin, which is secreted by the pancreas to regulate the levels of blood sugar in your body.

Enzymatic

Enzymatic proteins accelerate metabolic processes in cells, including liver functions, stomach digestion, blood clotting and converting glycogen to glucose.

Structural
Also known as fibrous proteins, structural proteins are necessary components of your body. They include collagen, keratin and elastin. Collagen forms the connective framework of your muscles, bones, tendons, skin and cartilage. Keratin is the main structural component in hair, nails, teeth and skin.

Defensive
Antibodies, or immunoglobulin, are a core part of your immune system, keeping diseases under control. Antibodies are formed in the white blood cells and attack bacteria, viruses and other harmful microorganisms, rendering them inactive.

Storage
Storage proteins mainly store mineral ions such as potassium in your body. Iron, for example, is an ion required for the formation of hemoglobin, the main structural component of red blood cells. Ferritin -- a storage protein -- regulates and guards against the adverse effects of excess iron in your body. Ovalbumin and casein are storage proteins found in breast milk and egg whites, that play a huge role in embryonic development.

Transport
Transport proteins carry vital materials to the cells. Hemoglobin, for example, carries oxygen to body tissues from the lungs. Serum albumin carries fats in your bloodstream, while myoglobin absorbs oxygen from hemoglobin and then releases it to the muscles. Calbindin is another transport protein that facilitates the absorption of calcium from the intestinal walls.

Receptor
Located on the outer part of the cells, receptor proteins control the substances that enter and leave the cells, including water and nutrients. Some receptors activate enzymes, while others stimulate endocrine glands to secrete epinephrine and insulin to regulate blood sugar levels.

Contractile
Also known as motor proteins, contractile proteins regulate the strength and speed of heart and muscle contractions. These proteins are actin and myosin. Contractile proteins can cause heart complications if they produce severe contractions.

Vitamins and minerals

It is important to understand the difference between vitamins and minerals for an overall functional oversight.

	Vitamins	**Minerals**
Chemical composition	Organic substance	Inorganic substance
Source	Plants and animals	Soil and rock
Vulnerability	Easily destroyed by heat, chemical reaction or environment	Not sensitive to external factors
Nutritional requirement	Necessary for proper function of the body	Not all are required and amount often are very little

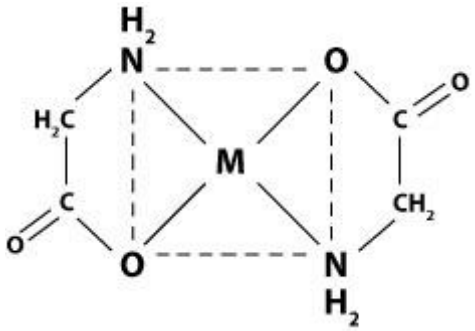
VITAMIN	BENEFITS	GOOD FOOD SOURCES
RETINOIDS AND CAROTENE (vitamin A; includes retinol, retinal, retinyl esters,	Essential for vision Keeps tissues and skin healthy. Plays an important role in bone growth and in the immune system. Carotenoids act as antioxidants.	**Sources of retinoids:**beef liver, eggs, shrimp, fish, fortified milk, butter, cheddar cheese, Swiss cheese **Sources of beta carotene:**sweet potatoes, carrots, pumpkins, squash, spinach, mangoes, turnip greens
THIAMIN (vitamin B_1)	Helps convert food into energy. Needed for healthy skin, hair, muscles, and brain and is critical for nerve function.	Pork chops, brown rice, ham, soymilk, watermelons, acorn squash
RIBOFLAVIN(vitamin B_2)	Helps convert food into energy. Needed for healthy skin, hair, blood, and brain	Milk, eggs, yogurt, cheese, meats, green leafy vegetables, whole and enriched grains and cereals.
NIACIN (vitamin B_3, nicotinic acid)	Helps convert food into energy. Essential for healthy skin, blood cells, brain, and nervous system	Meat, poultry, fish, fortified and whole grains, mushrooms, potatoes, peanut butter
PANTOTHENIC ACID (vitamin B_5)	Helps convert food into energy. Helps make lipids (fats), neurotransmitters, steroid hormones, and hemoglobin	Wide variety of nutritious foods, including chicken, egg yolk, whole grains, broccoli, mushrooms, avocados, tomato products
PYRIDOXINE (vitamin B_6, pyridoxal, pyridoxine, pyridoxamine)	Aids in lowering homocysteine levels. Helps convert tryptophan to niacin and serotonin, a neurotransmitter that plays key roles in sleep, appetite, and moods. Helps make red blood cells Influences cognitive abilities and immune function	Meat, fish, poultry, legumes, tofu and other soy products, potatoes, non-citrus fruits such as bananas and watermelons
COBALAMIN (vitamin B_{12})	Aids in lowering homocysteine levels. Assists in making new cells and breaking down some fatty acids and amino acids. Protects nerve cells and encourages their normal growth	Meat, poultry, fish, milk, cheese, eggs, fortified cereals, fortified soymilk

	Helps make red blood cells and DNA	
BIOTIN	Helps convert food into energy and synthesize glucose. Helps make and break down some fatty acids. Needed for healthy bones and hair	Many foods, including whole grains, organ meats, egg yolks, soybeans, and fish
ASCORBIC ACID (vitamin C)	Helps make collagen and supports blood vessel walls. Helps make the neurotransmitters serotonin and norepinephrine Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Bolsters the immune system	Fruits and fruit juices (especially citrus), potatoes, broccoli, bell peppers, spinach, strawberries, tomatoes, Brussels sprouts
CHOLINE	Helps make and release the neurotransmitter acetylcholine, which aids in many nerve and brain activities. Plays a role in metabolizing and transporting fats	Many foods, especially milk, eggs, liver, salmon, and peanuts
CALCIFEROL (vitamin D)	Helps maintain normal blood levels of calcium and phosphorus, which strengthen bones. Helps form teeth and bones.	Fortified milk or margarine, fortified cereals, fatty fish
ALPHA-TOCOPHEROL (vitamin E)	Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Protects vitamin A and certain lipids from damage.	Wide variety of foods, including vegetable oils, salad dressings and margarines made with vegetable oils, wheat germ, leafy green vegetables, whole grains, nuts
FOLIC ACID(vitamin B_9, folate, folacin)	Vital for new cell creation.	Fortified grains and cereals, asparagus, okra, spinach, turnip greens, broccoli, legumes like black-eyed peas and chickpeas, orange juice, tomato juice
PHYLLOQUINONE, MENADIONE (vitamin K)	Activates proteins and calcium essential to blood clotting.	Cabbage, liver, eggs, milk, spinach, broccoli, sprouts, kale, collards, and other green vegetables

Available minerals

Minerals are important for our body. But only in very small amounts. Beside the amount the shape of delivery is important. Our body is not able to consume minerals when not chelated. CHELATION is a natural process. The word chelate derives from the Greek word "chel", meaning a crab's claw, and refers to the pincer-like manner in which the metal is bound. Chemically, a chelate is a compound from complexing of cations with organic compounds resulting in a ring structure.

Minerals have the ability and need to interact as soon as possible. Incapsulating or inactivating chemical reactions when entering the biological entity. The best chelating partners are: Hydroxamate Siderophores, Organic Acids and Amino Acids. Organic acids and amino acids such as citric acid and glycine are naturally occurring chelating agents. Glycine is the simplest amino acid with a molecular weight of 75. The chelates usually contain 2 moles of ligand (glycine) and one mole of metal as demonstrated in the following figure.



Citric acid is one of the organic acids commonly used as chelating agents. Other naturally occurring organic acids such as malonic acid and gluconic acid also play an important role in plant mineral nutrition.

Why is chelation important for nature and the human being?

1. Increase the availability of nutrients.
2. Prevent mineral nutrients from forming insoluble precipitates.

MINERAL	BENEFITS	GOOD FOOD SOURCES
CALCIUM	Builds and protects bones and teeth. Helps with muscle contractions and relaxation, blood clotting, and nerve impulse transmission. Plays a role in hormone secretion and enzyme activation. Helps maintain healthy blood pressure	Yogurt, cheese, milk, tofu, sardines, salmon, fortified juices, leafy green vegetables, such as broccoli and kale (but not spinach or Swiss chard, which have binders that lessen absorption)
CHLORIDE	Balances fluids in the body. A component of stomach acid, essential to digestion	Salt (sodium chloride), soy sauce, processed foods
CHROMIUM	Enhances the activity of insulin, helps maintain normal blood glucose levels, and is needed to free energy from glucose	Meat, poultry, fish, eggs, potatoes, some cereals, nuts, cheese

COPPER	Plays an important role in iron metabolism and immune system. Helps make red blood cells	Liver, shellfish, nuts, seeds, whole-grain products, beans, prunes, cocoa, black pepper
FLUORIDE	Encourages strong bone formation. Keeps dental cavities from starting or worsening	Water that is fluoridated, toothpaste with fluoride, marine fish, teas
IODINE	Part of thyroid hormone, which helps set body temperature and influences nerve and muscle function, reproduction, and growth. Prevents goiter and a congenital thyroid disorder	Iodized salt, processed foods, seafood
IRON	Helps hemoglobin in red blood cells and myoglobin in muscle cells ferry oxygen throughout the body. Needed for chemical reactions in the body and for making amino acids, collagen, neurotransmitters, and hormones	Red meat, poultry, eggs, fruits, green vegetables, fortified bread and grain products
MAGNESIUM	Needed for many chemical reactions in the body Works with calcium in muscle contraction, blood clotting, and regulation of blood pressure. Helps build bones and teeth	Green vegetables such as spinach and broccoli, legumes, cashews, sunflower seeds and other seeds, halibut, whole-wheat bread, milk
MANGANESE	Helps form bones. Helps metabolize amino acids, cholesterol, and carbohydrates	Fish, nuts, legumes, whole grains, tea
MOLYBDENUM	Part of several enzymes, one of which helps ward off a form of severe neurological damage in infants that can lead to early death	Legumes, nuts, grain products, milk
PHOSPHORUS	Helps build and protect bones and teeth. Part of DNA and RNA. Helps convert food into energy. Part of phospholipids, which carry lipids in blood and help shuttle nutrients into and out of cells	Wide variety of foods, including milk and dairy products, meat, fish, poultry, eggs, liver, green peas, broccoli, potatoes, almonds
POTASSIUM	Balances fluids in the body. Helps maintain steady heartbeat and send nerve impulses. Needed for muscle contractions. A diet rich in potassium seems to lower blood pressure. Getting enough potassium from your diet may benefit bones	Meat, milk, fruits, vegetables, grains, legumes
SELENIUM	Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Helps regulate thyroid hormone activity	Organ meats, seafood, walnuts, sometimes plants (depends on soil content), grain products
SODIUM	Balances fluids in the body. Helps send nerve impulses. Needed for muscle	Salt, soy sauce, processed foods, vegetables

	contractions. Impacts blood pressure; even modest reductions in salt consumption can lower blood pressure	
SULFUR	Helps form bridges that shape and stabilize some protein structures. Needed for healthy hair, skin, and nails	Protein-rich foods, such as meats, fish, poultry, nuts, legumes
ZINC	Helps form many enzymes and proteins and create new cells. Frees vitamin A from storage in the liver. Needed for immune system, taste, smell, and wound healing. When taken with certain antioxidants, zinc may delay the progression of age-related macular degeneration	Red meat, poultry, oysters and some other seafood, fortified cereals, beans, nuts

Hormones and enzymes

Vital to all physiological processes in the body is the functioning of hormones and enzymes. We may consider both the keys to vital living and the core of cell health. Keeping both in an optimal condition is the first task of health aging. But before we can move into the optimization it is important to understand functioning and production. In enclosed tables an short oversight of major functions is given.

List of some Hormones and their Functions in human body

HORMONE	FUNCTION	ENDOCRINE GLAND SECRETING
Thyrotropin-releasing hormone (TRH)	Stimulates thyroid gland to synthesize T3 & T4 hormones	Hypothalamus (HYP)
Growth hormone inhibitory hormone (GHIH) (somatostatin)	Inhibits release of growth hormone, TSH, insulin	(HYP)
Dopamine or prolactin-inhibiting factor (PIF)	Inhibits prolactin secretion.	(HYP)
Growth hormone	Stimulates growth of the body	Anterior pituitary (AP)
Prolactin	Stimulates milk formation	(AP)
Follicle-stimulating hormone (FSH)	Stimulates to form sperms in male and Ova in female.	(AP)
Luteinizing hormone (LH)	Formation of ova in females & production of testosterone	(AP)

HORMONE	FUNCTION	ENDOCRINE GLAND SECRETING
Antidiuretic hormone (ADH) (also called vasopressin)	Limit water expulsion by kidney. It also constricts blood vessels and rise blood pressure	Posterior pituitary
Calcitonin	Reduces blood calcium. by enhanced deposition in bone, decrease in intestinal absorption and expulsion by kidney.	Thyroid
Cortisol	Increases blood sugar levels and suppress immune system	Adrenal cortex
Norepinephrine	Also called noradrenaline, mobilize the brain and body for action, promotes vasoconstriction, increase blood glucose levels and levels of circulating free fatty acids	Adrenal medulla, locus coeruleus (brain)
Epinephrine	Also known as Adrenaline, increase in heart rate, muscle strength, blood pressure, and sugar metabolism, causes smooth muscle relaxation in the airways but causes contraction of the smooth muscle that lines most arterioles	Adrenal medulla
Insulin (β cells)	Helps absorb glucose from blood to tissue and also release from liver	Pancreas
Testosterone	Builds muscles, give muscline character and also stimulate formation of sperms	Testes
Estrogens	Development of female reproductive system.	Ovaries & Placenta
Progesterone	Menstruation, Aids zygote implantation, Lactation & sexual drive	Ovaries & Placenta
Leptin	Regulates energy balance. Inhibits hunger if needed	adipose cells

HORMONE	FUNCTION	ENDOCRINE GLAND SECRETING
Ghrelin	Stimulates hunger	Gastro intestine

Amino Acid-Derived Hormones
The amino acid-derived hormones are relatively small molecules that are derived from the amino acids tyrosine and tryptophan. Its chemical name end in “-ine”. Examples include epinephrine and norepinephrine, thyroxine and melatonin.

Peptide Hormones
Peptide hormones include molecules that are short polypeptide chains, such as antidiuretic hormone and oxytocin produced in the brain and released into the blood. This class also includes small proteins, like growth hormones and large glycoproteins such as follicle-stimulating hormone produced by the pituitary. Amino acid-derived and polypeptide hormones are water-soluble and insoluble in lipids.

Lipid-Derived Hormones (or Lipid-soluble Hormones)
Most lipid hormones are derived from cholesterol and thus are structurally similar to it. The primary class of lipid hormones in humans is the steroid hormones. Chemically, these hormones are usually ketones or alcohols; their chemical names will end in “-ol” for alcohols or “-one” for ketones. Examples of steroid hormones include estradiol and testosterone. Other steroid hormones include aldosterone and cortisol, which are released by the adrenal glands along with some other types of androgens. Steroid hormones are insoluble in water, and transported by transport proteins in blood.

Eicosanoids

Eicosanoids also called 'local hormones' as they act on cells close to their site of production. Eicosanoids have a short lifespan and break down fast.

Both, enzymes and hormones, have specific functions in the body and often interact with each other. The Pancreas produces both enzymes and hormones which are both active on the same channel but on a different angle. Amylase breaks down carbohydrate containing food into solvable nutrients. After entering the blood system Insulin assist to get the glucose (carbohydrates) into the cell. Here we see an important additional effect of enzyme / hormone.

Hormones have specific interaction levels at target cells:
Permissiveness – one hormone cannot function without the assistance of another hormone. This teamwork is needed for a full functioning of the reaction

Synergism – more than one hormone produces the same effect on a target cell. This avoids problems when a specific hormone shows a malfunction / error

Antogonism – one or more hormones opposes the action of another hormone. This is needed to end specific reactions and bring back to a neutral state.

ATP cycle

The ATP is used for many cell functions including transport substances across cell membranes. It is used for mechanical work, supplying energy needed for muscle contraction. It supplies energy to the heart muscle and skeletal muscle, to the chromosomes and flagella to enable them to carry out their functions. ATP is used as an on-off switch to control chemical reactions and send messages.
Any muscle contraction/force exertion is due to adenosine triphosphate (ATP). When an ATP molecule is in solvent state the phosphate groups splits and produces energy. The breakdown of ATP for muscle contraction results in adenosine diphosphate (ADP). Directly after this the recycling back to ATP is started.
The food we eat, in the form of carbohydrates, fats and proteins, is used as fuel for reactions in the body. To utilize fuels for muscle action, the body converts them to energy, adenosine tri-phosphate (ATP). There are two mechanisms for producing ATP, the aerobic and anaerobic pathways. 'Aerobic' implies combined with oxygen, while 'anaerobic' means without oxygen.
The energy is used by three systems that produce ATP:

- ATP-PC (high power, short duration),
- glycolytic (moderate power/short duration)
- oxidative (low power/long duration).

They are available and at all time at the onset of any activity.

The ATP-PC Energy System – High Power/Short Duration
ATP and phosphocreatine (PC) compose the ATP-PC system, also called the Phosphogen system. It functions without the use of oxygen. It allows for approximately 12 seconds (+ or -) of maximum power.
The Glycolytic System – Moderate Power/Moderate Duration
Blood glucose and stored glycogen is broken down to create ATP through the process of glycolysis. Hereby oxygen is not required for the process. This system acts as energy provider for the duration of 30-50 seconds but in most people cannot supply maximum power. During this process, pyruvic acid is converted to lactic acid and fatigue ensues quickly.
The Oxidative System – Low Power/Long Duration
The effort demand is low, but ATP in this system can be produced three ways:

- Krebs cycle
- Electron Transport Chain
- Beta Oxidation.

The aerobic system—which includes the Krebs cycle (also called the citric acid cycle or TCA cycle) and the electron transport chain—uses blood glucose, glycogen and fat as fuels to resynthesize ATP in the mitochondria of muscle cells. When using carbohydrate, glucose and glycogen are metabolized through glycolysis, with the resulting pyruvate used to form acetyl-CoA, which enters the Krebs cycle. The electrons produced in the Krebs cycle are then transported through the electron transport chain, where ATP and water are produced. Thus, the aerobic system produces 18 times more ATP than the anaerobic glycolysis from each glucose molecule.

Available instruments

Product

Electro Stimulation products come in great variety. Product names and groups segmentation are brought onto the market suggesting a complete different approach but can be brought back to a more simplified origin. Because of the sheer endless list of names and products I decided to list most of them here. The list of names may not be complete but the actual application of product is. The variation of product is due to the practical proven and verified application:

- Muscular stimulation
- Neural stimulation
- Brain stimulation
- Sexual stimulation

This section mention all kind of different products without explicit trademarks or advises. It is my vision to display most products without a critical vision or evidence. Each product has a general explanation which I extend during training and lectures.

The use of each product depends on personal goals, targets in business or healthcare/prevention, financial resources and desire for quality. It is my personal vision and experience that choosing a product need to be a combination of needs and future vision.

If setting up a healthcare/prevention or commercial enterprise the need for professional advise on product and supplier is important in decision making. Budget, available space, core business, goals and long term planning must be considered. Electro Stimulation is a highly profitable business if employed with a vision, knowledge and care.

During the ‘70’s and 80’s ES came onto the market without a strong planning. Physiotherapist and other professionals applied the products without complete knowledge. Slowly ES disappeared from the professional floor to resurface again and again. ES as a singular treatment, method is not advised. It is most effect tive in the right combination as a strong supporting supplement. It is most effective with in the right combination.

The international standard on the basic safety of medical nerve and muscle stimulators advises “that stimulation should not be applied across or through the head, directly on the eyes, covering the mouth, on the front of the neck, (especially the carotid sinus), or from electrodes placed on the chest and the upper back or crossing over the heart”. The standard also notes that “any electrodes that have current densities exceeding 2 mA/cm² may require the special attention of the operator”. It imposes the following limits on the output parameters of stimulators (for therapeutic purposes):

with a load resistance of 500 Ω, the output current shall not exceed
80 mA at DC
50 mA below 400 Hz pulse frequency
80 mA at 400–1500 Hz
100 mA above 1500 Hz
for pulse durations less than 0.1 s, the pulse energy into a 500 Ω load shall not exceed 300 mJ per pulse, for longer pulses the above DC limit applies the output shall not exceed a peak voltage of 500 V when measured under open-circuit condition.

NOTE: this is a product description in general setting. To create this section I have used different product descriptions as handed by manufacturers, physiotherapists, professionals, healthcare workers and others. I have tried to write an usuful and readable description of each.

EMS – Electro Myo Stimulation

EMS - Electrical Muscle Stimulation is known as Electromyostimulation and as neuromuscular electrical stimulation. Electric impulses are generated by an electrical device and transmitted to the skin through electrodes. The electrodes may be gel based, rubber based, or specially designed. The impulses generated by the device are designed to mimic signals from the central nervous system – which causes muscles to contract and relax.

EMS can be used for the following applications:

- Muscular contractions
- Relaxation
- Treatment of spasms
- Activation of injured / operated / not used muscles
- Prevent retard atrophy
- Increase / improve / maintain Range Of Motion (ROM)
- Increasing local circulation
- Helping to relieve and manage chronic pain
- Acute pain post surgery, post-traumatic acute pain, and immediate post-surgical stimulation
- Prevent venous thrombosis
- Recovery after a workout or exercise
- Treatment of neuromuscular dysfunction
- Pain management
- Tissue repair
- Acute and chronic edema
- Peripheral blood flow

ES follows a practical process which activates nitric oxide which helps dilate blood vessels in the muscles. It increases the Venous Pump and Lymphatic Flow – improves circulation and stimulates oxygen bearing blood to the muscles and pulling toxins away. This decreases the time it takes for the muscles to recover and helps improving condition of the muscles. Using electrical stimulation for muscle recovery is part of an over-all solution for fast muscle recovery from working out, and can play a key component in retaining muscles, strength, and balance as we age.

How does it work?

Muscles contract by electrical stimulation impulses from the brain. The muscle receives a contraction order through the nerves from neurotransmitters (acetylcholine), the “action potential' moves at great speed throughout the motor nerve, slowly inverting the polarity of the cells which it goes through. Electrical stimulation of a motor neuron requires much less current than is needed for direct stimulation of the muscle fiber and, the surface excitation effect achieved by using the nerve to distribute the current to all muscle fibers transmits the flow deep into the muscle. The physiology of the contraction and the muscle metabolism provides with precise data of different types of myofibers (slow, fast, intermediate). Through research the details of the specific muscle metabolism corresponding with the development of specific types of muscle efficiency have been discovered.

The frequency of repetition of the electrical impulses, the duration of each contraction, the rest period between contractions, and the duration of each training program, allow athletes to adapt their muscles to the type of work which best suit their objectives. EMS influences the capacity of the muscle fibers to consume oxygen which is brought by the blood .

One of the characteristic differences between slow and fast twitch fibers is the greater quantity of oxidative enzymes of the slow fibers. With the use of oxygen, these fibers obtain energy from fatty acids and from carbohydrates. The improvement in oxygen consumption by the stimulated fibers can be explained by their concentration of oxidative enzymes.

The anaerobic threshold, is the intensity of maximum effort below which the level of lactate does not exceed 4 milimol/liter. When carrying an effort beyond this threshold, the level of lactate explodes and the intensity of the effort can be sustained only for a while. A trained athlete is able to extend this threshold until up to 80-90% of the VO2max.

With EMS there is no mental fatigue, athletes can train their muscles on a competitative level. Athletes can recruit fast twitch fibers preferentially. In voluntary training, to recruit fast twitch fibers it is necessary to gather slow and mixed fibers before getting to the fast fibers. With high frequency EMS training, it is possible to gather 90 - 100% of the fast fibers from the beginning of the session.

Explosive Strength programs allow athletes to increase speed. Active Recovery programs stimulate an elimination of lactic acid and other toxins; improved oxygenation contributes to recovery of the muscular tissues; the increased endorphin ptoduction effect reduce pains associated with training; finally relaxation after tension. Recovery sessions allows athletes to face the next training session in optimum conditions, therefore maximizing their time and better assimilating.

WB-EMS – Whole Body EMS

Prof. Wolfgang Kemmler: In the case of WB-EMS, stimulation current is applied to the muscles akin to the well-known local EMS technology. The new aspect with WB-EMS is that it not only activates one individual body area but is able to simultaneously stimulate all major muscle groups, but with varying regional intensity. All in all, this pertains to up to twelve body regions with a surface area measuring approximately 2,800 square centimeters.

WB-EMS is primarily used in preventive medicine, particularly in the case of systemic diseases. In older people, for example, this pertains to so-called sarcopenia, the loss of muscle tissue as part of the aging process. Having said that, EMS or WB-EMS can also be used in the fitness or competitive sports realm. In competitive sports, it is less used to facilitate improvements in specific disciplines but rather to help strengthen and maintain the back muscles. This applies to runners or cyclists, who don’t want to invest time in preventive back muscle exercises for example. On the whole, there are many different areas of application.

WB-EMS should primarily be recognized as a strength oriented training technology, that is to say, as long as the training goals are not too specific, WB-EMS can be seen as a time-efficient option to a strength training program. Existing research shows that the effect of WB-EMS on muscle mass and hypertrophy is comparable. However, it produces a somewhat lesser effect on functional abilities like muscle strength or performance.

Sarcopenia is a disease associated with the aging process characterized by a considerable loss of muscle mass and a dramatic functional decline. Many people are no longer able to live independently. Oftentimes, sarcopenia is accompanied by obesity. This combination is called

sarcopenic obesity. Physical activity would be a treatment option in this case but many aging adults who have not done any sports up to this point don't want or are unable to get on board with it. This is a case where WB-EMS provides a relatively low-threshold, joint-friendly and individualized training option. The emphasis here is on maintaining or increasing muscle mass. The function of muscles, strength, walking speed and a lower body fat percentage are also key training objectives.

Kemmler: This was a randomized controlled trial with three arms. One group was administered Vitamin D and protein, the second group was supplied with protein, Vitamin D, and WB-EMS, while the third group was only administered Vitamin D as a control group. We conducted a final measurement after 16 weeks where we measured the same parameters we assessed at the beginning of the study.

One classic parameter of sarcopenia is a loss of muscle mass in the arms and legs. There was a significant muscle mass increase in both the EMS&Protein and the Protein group. Both groups also showed a reduction in the total and abdominal body fat percentage. Abdominal body fat, in particular, is an elevated cardiometabolic risk factor. Strength and walking speed only increased in the combined WB-EMS&Protein group. The 'normal' walking speed is an important fitness parameter because it is closely connected to autonomy and mortality. Incidentally, the control group did not exhibit any changes in body composition or functional ability despite the administration of Vitamin D.

Kemmler: people who are able to and like to do "sports" should continue to do so. Having said that, WB-EMS can be an alternative to time-consuming strength training for endurance athletes suffering from erector spinae muscle pain for example. In fact, WB-EMS is a very time-efficient technology. Especially for people who lack the motivation or the time to do sports, EMS is a great option to implement strength oriented training goals such as increasing muscle mass, strength, stabilization but also fat reduction. As is the case with traditional strength training, the effects on endurance performance tend to be slight. Another important aspect is the fact that WB-EMS should be implemented as part of a personal training regimen, meaning the close interaction between trainer and client, to ensure safety and effectiveness. In doing so, the client has the trainer's constant attention and care plus gets feedback and motivation. This is definitely a key factor for successful training.

The interview was conducted by Julia Unverzagt and translated from German by Elena O'Meara. MEDICA-tradefair.com

The effectiveness of the devices for sports has been clearly demonstrated in scientific research, but is not as fully extended practice. The technique is used in the professional field and less in the amateur, one of the main reasons being that commercial companies advertises tended to inflate the truth about these miracle machines. Claims that a person can achieve an amazing body shape with very little work or time prove unconvincing. Indeed they have the opposite effect amongst those who know that it is only with time and effort that to achieve results. Electro stimulation requires time and planning and can prove very effective when used properly.

EMG – electromyogram

An electromyograph detects the electric potential generated by muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect medical abnormalities, activation level, or recruitment order, or to analyze the biomechanics of human or animal movement.

How do muscles move?

The process starts in the brain. To be more precise in the motor cortex, where neural activity (a series of action potentials) signals to the spinal cord, and the information about the movement is send to the relevant muscle via motor neurons. This begins with upper motor neurons, that carry the signal to lower motor neurons.

The lower motor neurons are the actual instigators of muscle movement, they innervate the muscle directly at the neuromuscular junction. This innervation causes the release of Calcium ions within the muscle, ultimately creating a mechanical change in the tension of the muscle. This process involves depolarization (a change in the electrochemical gradient), the difference in current can be detected by EMG.

EMG activity (measured in microvolts) is linearly related to the amount of muscle contraction and the number of contracted muscles . Stronger muscle contractions and higher the numbers of activated muscles, show a higher recording of voltage amplitude. EMG is used in understanding how people move, fEMG (facial electromyography, in which EMG signals are recorded from the muscles of the face), can provide information about facial expressions. On an even more detailed scale of measuring there is as eye tracking or GSR (galvanic skin response), allowing to see where someone looks, and their level of emotional arousal, as well as the direction of those emotions.

There are two kinds of EMG: surface EMG and intramuscular EMG. Surface EMG assesses muscle function by recording muscle activity from the surface above the muscle on the skin. Surface electrodes are able to provide only a limited assessment of the muscle activity. Surface EMG can be recorded by a pair of electrodes or by a more complex array of multiple electrodes. More than one electrode is needed because EMG recordings display the potential difference (voltage difference) between two separate electrodes. Limitations of this approach are the fact that surface electrode recordings are restricted to superficial muscles, are influenced by the depth of the subcutaneous tissue at the site of the recording which can be highly variable depending of the weight of a patient, and cannot reliably discriminate between the discharges of adjacent muscles.

One basic function of EMG is to see how well a muscle can be activated. The most common way that can be determined is by performing a maximal voluntary contraction (MVC) of the muscle that is being tested. Muscle force, which is measured mechanically, typically correlates highly with measures of EMG activation of muscle. Most commonly this is assessed with surface electrodes, but it should be recognized that these typically only record from muscle fibers in close approximation to the surface.

EMG can also be used for indicating the amount of fatigue in a muscle. The following changes in the EMG signal can signify muscle fatigue: an increase in the mean absolute value of the signal, increase in the amplitude and duration of the muscle action potential and an overall shift to lower frequencies. Monitoring the changes of different frequency changes the most common way of using EMG to determine levels of fatigue. The lower conduction velocities enable the slower motor neurons to remain active.

A motor unit is defined as one motor neuron and all of the muscle fibers it innervates. When a motor unit fires, the impulse (called an action potential) is carried down the motor neuron to the muscle. The area where the nerve contacts the muscle is called the neuromuscular junction, or the motor end plate. After the action potential is transmitted across the neuromuscular junction, an action potential is elicited in all of the innervated muscle fibers of that particular motor unit. The sum of all this electrical activity is known as a motor unit action potential (MUAP). This electrophysiologic activity from multiple motor units is the signal typically evaluated during an EMG. The composition of

the motor unit, the number of muscle fibres per motor unit, the metabolic type of muscle fibres and many other factors affect the shape of the motor unit potentials in the myogram.

Nerve conduction testing is also often done at the same time as an EMG to diagnose neurological diseases.

EMG signals are essentially made up of superimposed motor unit action potentials (MUAPs) from several motor units. For a thorough analysis, the measured EMG signals can be decomposed into their constituent MUAPs. MUAPs from different motor units tend to have different characteristic shapes, while MUAPs recorded by the same electrode from the same motor unit are typically similar. Notably MUAP size and shape depend on where the electrode is located with respect to the fibers and so can appear to be different if the electrode moves position. EMG decomposition is non-trivial, although many methods have been proposed.

EMG signal processing
Rectification is the translation of the raw EMG signal to a signal with a single polarity, usually positive. The purpose of rectifying the signal is to ensure the signal does not average to zero, due to the raw EMG signal having positive and negative components. Two types of rectification are used: full-wave and half-wave rectification.[18] Full-wave rectification adds the EMG signal below the baseline to the signal above the baseline to make a conditioned signal that is all positive. If the baseline is zero, this is equivalent to taking the absolute value of the signal.[19][20] This is the preferred method of rectification because it conserves all of the signal energy for analysis. Half-wave rectification discards the portion of the EMG signal that is below the baseline. In doing so, the average of the data is no longer zero therefore it can be used in statistical analyses.

The electrical source is the muscle membrane potential of about –90 mV.[22] Measured EMG potentials range between less than 50 µV and up to 20 to 30 mV, depending on the muscle under observation.

Typical repetition rate of muscle motor unit firing is about 7–20 Hz, depending on the size of the muscle (eye muscles versus seat (gluteal) muscles), previous axonal damage and other factors. Damage to motor units can be expected at ranges between 450 and 780 mV

In general EMG and nearly all related procedures of equipment mentioned in this book:

- Fasting is not required before the test. In some cases, cigarettes and caffeinated beverages, such as coffee, tea, and cola may be restricted two to three hours before testing.
- Notify therapist of all medications (prescribed and over-the-counter) and herbal supplements that you are taking.
- Notify therapist if you have a pacemaker.
- Dress in clothes that permit access to the area to be tested or that are easily removed.
- Stop using lotions or oils on your skin for a few days before your procedure, or at least stop using them on the day of the exam.
- Based on your medical condition, therapist may request other specific preparation.

Generally, an EMG procedure follows this process:

- Customer is requested to remove any clothing, jewelry, hairpins, eyeglasses, hearing aids, or other metal objects that may interfere with the procedure. Depending on place and agreement customer may be given alternative clothing or covering for the duration of treatment.

- In most cases customer is requested to sit or lie down for the test. Specific cases demand activity and participation.

- A therpaist locates the muscle(s) to be studied.

- The skin is cleansed with an antiseptic solution. Next, a fine, sterile needle could be inserted into the muscle. A ground electrode is positioned under the arm or leg. Insertions only are allowed by registered qualified licensed medical therapists. All others are only allowed to work with external pads.

- (Only allowed by doctor or medical therapist) Five or more needle insertions may be necessary for the test. Customer may experience slight pain with the insertion of the electrode, but it is usually painless.

- If the test is painful customer is requested to tell the examiner because this can interfere with the results.

- Customer is asked to relax and perform slight or full-strength muscle contractions.

- The electrical activity from the working muscle is measured and displayed on the oscilloscope.

An audio amplifier may be used so that both the appearance and sound of the electrical potentials can be evaluated. If the recorder is attached to an audio amplifier, people may hear a sound like hail on a tin roof when contracting the muscle.

After the procedure:
Some muscle soreness may persist for a day or so following the procedure. Notify the doctor if experiencing increasing pain, tenderness, swelling, or pus at the needle insertion sites.A physician may give additional or alternate instructions after the procedure, depending on the particular situation.

TENS - Transcutaneous electrical nerve stimulation

Transcutaneous electrical nerve stimulation (TENS) therapy involves the use of low-voltage electric currents to treat pain. Electrodes are placed on the body to deliver electricity that travels through the nerve fibers. The electric currents block the pain receptors from being sent from the nerves to the brain.

TENS therapy can be used to treat both chronic (long lasting) and acute (short-term) pain. The most common conditions that TENS therapy is used to treat are:
Osteoporosis-related joint, bone, or muscle problems
Fibromyalgia-related joint, bone, or muscle problems
Tendinitis (muscle tissue inflammation)
Bursitis (inflammation of the fluid-filled pads that cushion the joints)
Neck pain
Labor pain
Cancer pain

Gate control theory

The gate control theory of pain asserts that non-painful input closes the "gates" to painful input, which prevents pain sensation from traveling to the central nervous system. Stimulation by non-noxious input is able to suppress pain.

Ronald Melzack and Patrick Wall proposed the theory in 1965, it offers a physiological explanation for the previously observed effect of psychology on pain perception. The gate control theory is considered to be one of the most influential theories of pain because it provided a neural basis which reconciled the specificity and pattern theories and ultimately revolutionized pain research.

Willem Noordenbos (1910–1990), a Dutch researcher at the University of Amsterdam, was the first one to propose a model with an interaction between small (unmyelinated) and thick (myelinated) fibers in 1959. The fast (myelinated) fibers block the slow (unmyelinated) fibers, "fast blocks slow".

Proposed mechanisms
Ronald Melzack and Patrick Wall proposed that both thin (pain) and large diameter (touch, pressure, vibration) nerve fibers carry information from the site of injury to two destinations in the dorsal horn of the spinal cord: transmission cells that carry the pain signal up to the brain, and inhibitory interneurons that impede transmission cell activity. Activity in both thin and large diameter fibers excites transmission cells. Thin fiber activity impedes the inhibitory cells (tending to allow the transmission cell to fire) and large diameter fiber activity excites the inhibitory cells (tending to inhibit transmission cell activity).

When more large fiber (touch, pressure, vibration) activity relative to thin fiber activity at the inhibitory cell, the less pain is felt. The authors had drawn a neural "circuit diagram" to explain why we rub a smack. They pictured not only a signal traveling from the site of injury to the inhibitory and transmission cells and up the spinal cord to the brain, but also a signal traveling from the site of injury directly up the cord to the brain (bypassing the inhibitory and transmission cells) where, depending on the state of the brain, it may trigger a signal back down the spinal cord to modulate inhibitory cell activity (and so pain intensity).

The theory offered a physiological explanation for the previously observed effect of psychology on pain perception. The firing of the projection neuron determines pain. The inhibitory interneuron decreases the chances that the projection neuron will fire. Firing of C fibers inhibits the inhibitory interneuron (indirectly), increasing the chances that the projection neuron will fire. Firing of the Aβ fibers activates the inhibitory interneuron, reducing the chances that the projection neuron will fire, even in the presence of a firing nociceptive fiber.

Gate control theory asserts that activation of nerves which do not transmit pain signals, called nonnociceptive fibers, can interfere with signals from pain fibers, thereby inhibiting pain. Afferent pain-receptive nerves, those that bring signals to the brain, comprise at least two kinds of fibers - a fast, relatively thick, myelinated "Aδ" fiber that carries messages quickly with intense pain, and a small, unmyelinated, slow "C" fiber that carries the longer-term throbbing and chronic pain. Large-diameter Aβ fibers are nonnociceptive (do not transmit pain stimuli) and inhibit the effects of firing by Aδ and C fibers.

The peripheral nervous system has centers at which pain stimuli can be regulated. Some areas in the dorsal horn of the spinal cord that are involved in receiving pain stimuli from Aδ and C fibers, called laminae, also receive input from Aβ fibers. The nonnociceptive fibers indirectly inhibit the

effects of the pain fibers, 'closing a gate' to the transmission of their stimuli. In other parts of the laminae, pain fibers also inhibit the effects of nonnociceptive fibers, 'opening the gate'. This presynaptic inhibition of the dorsal nerve endings can occur through specific types of GABAA receptors (not through the α1 GABAA receptor and not through the activation of glycine receptors which are also absent from these types of terminals). Thus certain GABAA receptor subtypes but not glycine receptors can presynaptically regulate nociception and pain transmission.

An inhibitory connection may exist with Aβ and C fibers, which may form a synapse on the same projection neuron. The same neurons may form synapses with an inhibitory interneuron that synapses on the projection neuron, reducing the chance that the latter will fire and transmit pain stimuli to the brain. The inhibitory interneuron fires spontaneously. The C fiber's synapse would inhibit the inhibitory interneuron, indirectly increasing the projection neuron's chance of firing. The Aβ fiber, on the other hand, forms an excitatory connection with the inhibitory interneuron, thus decreasing the projection neuron's chance of firing (like the C fiber, the Aβ fiber has an excitatory connection on the projection neuron itself). Depending on the relative rates of firing of C and Aβ fibers, the firing of the nonnociceptive fiber may inhibit the firing of the projection neuron and the transmission of pain stimuli.

Gate control theory explains how stimulus that activates only nonnociceptive nerves can inhibit pain. The pain seems to be lessened when the area is rubbed because activation of nonnociceptive fibers inhibits the firing of nociceptive ones in the laminae. In transcutaneous electrical nerve stimulation (TENS), nonnociceptive fibers are selectively stimulated with electrodes in order to produce this effect and thereby lessen pain.

One area of the brain involved in reduction of pain sensation is the periaqueductal gray matter that surrounds the third ventricle and the cerebral aqueduct of the ventricular system. Stimulation of this area produces analgesia (but not total numbing) by activating descending pathways that directly and indirectly inhibit nociceptors in the laminae of the spinal cord. Descending pathways also activate opioid receptor-containing parts of the spinal cord.

Afferent pathways interfere with each other constructively, in a way that the brain can control the degree of pain that is perceived, based on which pain stimuli are to be ignored to pursue potential gains. The brain determines which stimuli are profitable to ignore over time. The brain controls the perception of pain quite directly, and can be "trained" to turn off forms of pain that are not "useful". This understanding led Melzack to assert that pain is in the brain.

TENS is a method of electrical stimulation which primarily aims to provide a degree of symptomatic pain relief by exciting sensory nerves and thereby stimulating either the pain gate mechanism and/or the opioid system. The different methods of applying TENS relate to these different physiological mechanisms. The effectiveness of TENS varies with the clinical pain being treated, but research would suggest that when used ‘well’ it provides significantly greater pain relief than a placebo intervention.

There is an extensive research base for TENS in both the clinical and laboratory settings. It is worth noting that the term TENS could represent the use of ANY electrical stimulation using skin surface electrodes which has the intention of stimulating nerves. In the clinical context, it is most commonly assumed to refer to the use of electrical stimulation with the specific intention of providing symptomatic pain relief.

TENS is most commonly delivered from small, hand held, battery powered devices. They can be purchased 'over the counter' in many (but not all) countries. In some locations, they need to be

'prescribed' by a therapist, doctor or other healthcare practitioner. Most multi-modal clinic based stimulators include TENS as an option, though its use in the clinic is less well supported than its use as a home based, patient delivered therapy.

It is interesting that in therapy practice, the majority of practitioners consider TENS as a treatment options in circumstances when a patient is experiencing CHRONIC pain. This is not a problem as there is a significant evidence base to support this mode of application. There is however, a significant and growing body of evidence that supports the use of TENS as a valid and effective intervention in a ACUTE pain conditions. Examples would include : Desantana et al (2009); Sbruzzi et al (2012); Silva et al (2012); Solak et al (2007) and Unterrainer et al (2010).

TENS as a treatment technique is non invasive and has few side effects when compared with drug therapy. The most common complaint is an allergic type skin reaction (about 2-3% of patients) and this is almost always due to the material of the electrodes, the conductive gel or the tape employed to hold the electrodes in place. Most TENS applications are now made using self adhesive, pre gelled electrodes which have several advantages including reduced cross infection risk, ease of application, lower allergy incidence rates and lower overall cost.

Digital TENS machines are widely available and extra features (like automated frequency sweeps and more complex stimulation patterns) are emerging, though there remains little clinical evidence for enhanced efficacy at the present time. Some of these devices do offer pre-programmed and/or automated treatment settings.

Transcutaneous electrical nerve stimulation (TENS) is a nonpharmacologic treatment for pain relief. Translational studies show mechanisms to prevent analgesic tolerance to repeated application of TENS. Clinical trials suggest that adequate dosing, particularly intensity, is critical to obtaining pain relief with TENS. Evidence continues to emerge from both basic science and clinical trials supporting the use of TENS for the treatment of a variety of painful conditions while identifying strategies to increase TENS effectiveness.

The use of TENS products should be instructed by a trained and licenced professional. Personal application in an “at home” situation is extremely useful but the user should be in contact are under control of the same professional for the best use of the product. It is strongly advised to use TENS in a professional setting under guidance and instruction.

PSFS / PNFS – Peripheral Subcutaneous Field Stimulation

Peripheral subcutaneous field stimulation (PSFS), also called peripheral nerve field stimulation (PNFS) or target field stimulation, is a form of neuromodulation that is intended to treat chronic neuropathic pain. Applications of PSFS being evaluated are craniofacial stimulation for headache/migraine, craniofacial pain or occipital neuralgia. PSFS is investigated for low back pain, neck and shoulder pain, inguinal and pelvic pain, thoracic pain, abdominal pain, fibromyalgia, and post-herpetic neuralgia.

Chronic, non-cancer pain is responsible for a high burden of illness. Common types of chronic pain include lumbar and cervical pain, chronic headaches and abdominal pain. All these conditions can be challenging to treat. Pharmacologic agents are typically the first-line treatment for chronic pain, and several classes of medications are available. These include analgesics (opioid and non-opioid), antidepressants, anticonvulsants, and muscle relaxants. There are a variety of non-pharmacologic treatments, including physical therapy, exercise, cognitive-behavioral interventions, acupuncture, chiropractic, and therapeutic massage.

Neuromodulation is another form of non-pharmacologic therapy that is usually targeted toward patients with chronic pain that is refractory to other modalities. Some forms of neuromodulation, such as transcutaneous electrical nerve stimulation (TENS) and spinal cord stimulation (SCS), are established methods of chronic pain treatment. Peripheral nerve stimulation, which involves placement of an electrical stimulator on the peripheral nerve, is used for neuropathic pain originating from peripheral nerves.

PSFS is a modification of peripheral nerve stimulation. In PSFS, leads are placed subcutaneously within the area of maximal pain. The objective is to stimulate the region of affected nerves, cutaneous afferents, or the dermatomal distribution of the nerves, which then converge back on the spinal cord. Combination spinal cord stimulation (SCS) plus PSFS is also being evaluated.

The mechanism of PSFS is unknown. Theories include an increase in endogenous endorphins and other opiate-like substances; modulation of smaller A delta and C nerve fibers by stimulated large diameter A beta fibers; local stimulation of nerve endings in the skin; local anti-inflammatory and membrane depolarizing effect; or a central action via antegrade activation of A beta nerve fibers. Complications of PSFS include lead migration or breakage and infection of the lead or neurostimulator.

Currently, there is no consensus regarding the indications for PSFS. Criteria for a PSFS trial may include a clearly defined, discrete focal area of pain with a neuropathic or combined somatic/neuropathic pain component with characteristics of burning and increased sensitivity, and failure to respond to other conservative treatments including medications, psychological therapies, physical therapies, surgery, and pain management programs.

Implantation of the PSFS is a two-step process, the electrode is temporarily implanted, allowing a trial period of stimulation. Once treatment effectiveness is confirmed from the trial stimulation which is defined as at least 50% reduction in pain, the electrodes and neurostimulator are then permanently implanted.

Applications of PSFS being evaluated are craniofacial stimulation for headache/migraine, craniofacial pain, or occipital neuralgia. PSFS is also being investigated for low back pain, neck and shoulder pain,

PNS – Peroneal Nerve Stimulation

As devices and technologies specifically designed for peripheral nerve stimulation (PNS) emerge, they promise a number of potential advantages over current PNS devices or SCS devices currently used for PNS applications. One emerging trend is the miniaturization of the PNS system. Small devices present several advantages over larger devices, such as decreased trauma from surgery, easier less invasive placement, the lack of extensive tunneling in some patients, and a reduced discomfort from the size and weight of the IPG once it has been implanted.

The miniaturization of the device may make it possible to treat conditions that have been untreated up to the present time because of the disadvantages or difficulties using existing systems. PNS devices are tested which use leads made from more flexible materials than traditional neurostimulation leads. Lead flexibility may decrease the chance of lead fracture or migration.

P-Stim – Auricular Stimulation

Auricular acupuncture is a distinct form of acupuncture. Electrical stimulation of acupoints (electroacupuncture) increases the effects of acupuncture. An auricular electroacupuncture device,

the P-Stim, is available. Clinical studies in outpatients have investigated the P-Stim in chronic musculoskeletal pain and its use for minor surgery. In chronic cervical or low back pain, auricular electroacupuncture is more effective than conventional auricular acupuncture. Auricular electroacupuncture reduced pain and remifentanil consumption during oocyte aspiration when compared with conventional auricular acupuncture or a sham treatment.

The P-Stim (Biegler GmbH, Mauerbach, Austria) is a portable auricular electroacupuncture stimulation device used for the treatment of pain. Compared to conventional acupuncture, it has the advantage of continuous auricular stimulation for up to 4 days. Its tolerability and efficacy has been demonstrated in studies involving European patients with chronic pain.

Pulsed Stimulated Treatment (P-STIM) is a pain treatment program blending conventional acupuncture therapy with contemporary scientific technology. P-STIM delivers effective, continuous pain relief to patients in a safe, personal and discreet device.

earP-STIM is a small, discreet device that is applied behind a patient's ear and weighs only seven grams. Once installed, P-STIM provides a steady current of low frequency electrical impulses to specific, targeted nerve endings located in the outer ear to relieve specific types of pain.

P-STIM KEY ADVANTAGES

- Natural, non-drug treatment for pain with little or no side-effects
- Non-addictive
- Performed in 15 minutes or less
- No anesthesia procedure
- Suitable for all ages and almost all physical conditions
- Percutaneously placed with little or no complication (no incision)
- No organ damage caused by medications
- Self contained, miniaturized, battery-powered, providing continuous stimulation
- Small, light and comfortable enough to wear behind the ear for 4 days
- Light weight (7g), allowing a patient to enjoy normal daily activities
- Patients have reported an improvement in their quality of life
- Most patients can return to completely normal or nearly normal activities immediately

HOW DOES P-STIM REDUCE PAIN?

Studies have shown that P-STIM enhances the release of natural endorphins by activating cranial nerves that result in physiological changes in functional brain activities, which has been confirmed with MRI.

While acute pain sufferers may experience total elimination of pain after one single treatment, chronic pain sufferers may require multiple sessions. Some patients, having solely relied upon narcotic drug therapies, have been able to discontinue the use of these conventional medicines.

Due to the fact that acute and chronic pain sufferers have different needs, P-STIM can be customized for individual patients. The initial application is designed to immediately mitigate pain and provide early relief. Additional treatments are then adapted toward addressing each patient's needs. Patients with post-operative pain have also benefited from reduced pain and less narcotic consumption and side effects. It is recommended that therapies be applied for up to nine weeks, as each treatment provides accumulated pain relief.

- Back Pain

- Cervical Pain (neck pain)
- Sciatic Pain (lower back and leg pain)
- Cancer Pain
- Headache - Migraine, Tension, Cluster, etc.
- Post-Operative Pain
- Rheumatoid Arthritis and Joint Pain
- Diabetic Neuropathy (diabetic nerve pain)
- Depression
- Insomnia
- Fibromyalgia
- Sports Injuries
- Shingles
- And many other indications

Contraindicationsdoc
Although the P-STIM pain relief treatment is designed to be minimally invasive with virtually no side effects, it is necessary to note advised contraindications where a physician would determine the feasibility of application and continued usage.

- Certain heart conditions may prevent usage – no clinical data available
- Recent organ transplants
- History of seizures
- Haemophilia Psoriasis vulgaris (an intact skin surface is required for use of P-STIM)

Relative Contraindications:

- Anti-coagulant therapy
- Recent transplant
- Site infection
- Pregnancy
- Pacemakers
- Contact dermatitis to adhesives (latex allergy)
- The occurrence of an MI (Myocardial Infraction) within the last 6 months

The P-STIM device produces flow of intermittent continuously, less frequency electrical pulses to the specific outlying nerves with last location in the ear removing many sorts of acute and chronic pain. These pulses are able to block afferent nerve pathways, which also include cervical, thoracic and lumbar nerve root origins. Stimulation with the periodic signals can happen over four days, alternating three hours of stimulation with three hours of rest. PSTIM might be placed up to the nice sessions a week apart, with increasing relief from pain during the series of treatments, and it depends on the level and length of the patient's pain. PSTIM can also be considered for post operative pain management.

In the treatment battery powered and controlled by a microchip, PSTIM is then applied quickly and with pain in few minutes. Once identifies the nerves access point's successfully, then a small and titanium acupuncture needles are installed to the device and kept on these access points.
After first assessment and placement visit, the recommendation is for nine extra weekly treatment with one week rest among weeks four and seven.
While each four day treatment, 1Hz of energy stimulation is taken to access points, and it increases the body's natural release of analgesic endorphins which are helpful for pain relief.

NMES - Neuromuscular electrical stimulation

Neuromuscular Electrical Stimulation or NMES uses a device that sends electrical impulses to nerves. This input causes muscles to contract. The electrical stimulation can increase strength and range of motion, and offset the effects of disuse. It is often used to “re-train” or “re-educate” a muscle to function and to build strength after a surgery or period of disuse.

Neuroprosthetics/Functional Electrical Stimulation refers to the use of electrical stimulation during a task. This can include walking or using an arm to reach. For example, “foot drop” is a common problem for a child with a neurological injury. The child has difficulty picking up his or her toes when walking. This may result in decreased walking speed, decreased step length, and tripping. FES can be applied to the muscles that lift the foot at the correct time during the walking cycle, which can help the child to lift and clear the foot when walking. This may result in increased strength of those muscles and increased range of motion at the ankle joint. FES can also improve safety, ease, and efficiency with walking.

Neuromuscular electrical stimulation (NMES) is the electrical stimulation of skeletal muscles through intact motor nerves to assist in the treatment of postural or movement disorders. The covered device is a two channel with two sets of leads allowing stimulation of two muscles or muscle groups.

NMES is intended to facilitate improved contraction of weakened muscles when the peripheral nerve supply to those muscles is intact. Electrical stimulation to muscles via NMES may be accomplished through electrodes placed on the skin (transcutaneous), with intramuscular placement (percutaneous), or with fully implanted devices. NMES may be viewed as a subset of functional electrical stimulation, which implies that electrical stimulation is applied during the performance of a functional movement or task.

NMES was the most frequently recommended treatment technique in the 2013 case-based survey of dysphagia therapies conducted by Carnaby and Harenberg. This result is a bit surprising in the face of conflicted evidence regarding the benefit of this modality. Several published studies have reported functional improvement in swallowing ability after dysphagia therapy with adjunctive NMES. These reports of functional gain are also reflected in a large national survey of electrical stimulation in dysphagia rehabilitation.

Results from that survey indicated that nearly 80% of responding clinicians believed more than half of the patients they treated with NMES showed swallowing improvement. The primary gains reported by these clinicians included advances in the oral diet, reduced aspiration, and reduced reliance on tube feedings. Conversely, other studies reported no significant differences between outcomes of dysphagia therapy with and without adjunctive NMES.

NMES is used as a treatment modality for disuse atrophy due to a condition such as limb casting or hip replacement surgery, where the nerve supply to the muscle is intact. The NMES device encompasses a portable stimulator with electrodes that are placed on the skin over targeted muscle or muscle group. The current passes through the electrodes into the body, and the motor nerves are stimulated, causing a muscle contraction. The intensity and frequency of stimulation can vary based on the level of muscular function and response to treatment.

TENS (transcutaneous electric nerve stimulators) versus NMES- TENS and NMES target different nerve groups of the body. TENS is specifically targets the sensory nerves, which are responsible for sending pain signals to the brain. NMES targets the muscle itself, specifically through the motor nerves. This allows the NMES machine to create a muscle contraction to recruit more muscle fibers when training; warming up or recovering. Sensory and motor nerves fire at different frequencies,

which is why NMES and TENS devices affect the body differently. TENS is not managed by this current policy.

The second type of NMES is FES (functional electrical stimulation), which is used to enhance functional activity in neurologically impaired patients. The objective of FES is to activate targeted muscle groups to facilitate performance of functional activities (e.g., grasping utensils for feeding) or movements (e.g., ambulation). The use of FES has primarily been proposed for individuals with neurological conditions such as spinal cord injury (SCI), multiple sclerosis, cerebrovascular accident (CVA), and cerebral palsy (CP).

FES - Functional Electrical Stimulation

Functional electrical stimulation (FES) is a technique that uses low energy electrical pulses to to generate muscle contraction in otherwise paralyzed / immobilized limbs to produce functions such as grasping, walking, bladder voiding and standing. This technology was originally used to develop neuroprostheses that were implemented to permanently substitute impaired functions in individuals with spinal cord injury (SCI), head injury, stroke and other neurological disorders.

In recent years FES technology has been used to deliver therapies to retrain voluntary motor functions such as grasping, reaching and walking. In this embodiment, FES is used as a short-term therapy, the objective of which is restoration of voluntary function and not lifelong dependence on the FES device, hence the name functional electrical stimulation therapy, FES therapy (FET or FEST). FEST is used as a short-term intervention to help the central nervous system of the consumer to re-learn how to execute impaired functions, instead of making the consumer dependent on neuroprostheses.

FES devices take advantage to electrically activate nerve cells, which then may go on to activate muscles or other nerves. Special care must be taken in designing safe FES devices, as passing electric current through tissue can lead to adverse effects such as decrease in excitability or cell death. This may be due to thermal damage, electroporation of the cell membrane, toxic products from electrochemical reactions at the electrode surface, or overexcitation of the targeted neutrons or muscles. Typically FES is concerned with stimulation of neurons and nerves. In some applications, FES can be used to directly stimulate muscles, if their peripheral nerves have been severed or damaged (i.e., denervated muscles). The majority of the FES systems used today stimulate the nerves or the points where the junction occurs between the nerve and the muscle. The stimulated nerve bundle includes motor nerves (efferent nerves—descending nerves from the central nervous system to muscles) and sensory nerves (afferent nerves—ascending nerves from sensory organs to the central nervous system).

Functional Electrical Stimulation - (a) The cell nucleus is responsible for synthesizing input from dendrites and deciding whether or not to generate signals. Following a stroke or spinal cord injury, muscles are impaired because motor neurons no longer receive sufficient input from the central nervous system. (b) A functional electrical stimulation system injects electrical current into the cell. (c) The intact but dormant axon receives the stimulus and propagates an action potential to (d) the neuromuscular junction. (e) The corresponding muscle fibers contract and generate (f) muscle force. (g) A train of negative pulses is produced. (h) Depolarization occurs where negative current enters the axon at the "active" electrode indicated.

Neurons are electrically active cells. In neurons, information is coded and transmitted as a series of electrical impulses called action potentials, which represent a brief change in cell electric potential of approximately 80–90 mV. Nerve signals are frequency modulated; i.e. the number of action

potentials that occur in a unit of time is proportional to the intensity of the transmitted signal. Typical action potential frequency is between 4 and 12 Hz. An electrical stimulation can artificially elicit this action potential by changing the electric potential across a nerve cell membrane (this also includes the nerve axon) by inducing electrical charge in the immediate vicinity of the outer membrane of the cell.

The electrical charge can stimulate both motor and sensory nerves. In some applications, the nerves are stimulated to generate localized muscle activity, i.e., the stimulation is aimed at generating direct muscle contraction. In other applications, stimulation is used to activate simple or complex reflexes. In other words, the afferent nerves are stimulated to evoke a reflex, which is typically expressed as a coordinated contraction of one or more muscles in response to the sensory nerve stimulation.

When a nerve is stimulated, i.e., when sufficient electrical charge is provided to a nerve cell, a localized depolarization of the cell wall occurs resulting in an action potential that propagates toward both ends of the axon. Typically, one "wave" of action potentials propagate along the axon towards the muscle (orthodromic propagation) and concurrently, the other "wave" of action potentials propagate towards the cell body in the central nervous system (antidromic propagation). While the direction of propagation in case of the antidromic stimulation and the sensory nerve stimulation is the same, i.e., towards the central nervous system, their end effects are very different. The antidromic stimulus has been considered an irrelevant side effect of FES. However, in recent years a hypothesis has been presented suggesting the potential role of the antidromic stimulation in neurorehabilitation. Typically, FES is concerned with orthodromic stimulation and uses it to generate coordinated muscle contractions.

In the case where sensory nerves are stimulated, the reflex arcs are triggered by the stimulation on sensory nerve axons at specific peripheral sites. The sensory nerve stimulation can be used to generate desired motor tasks or they to alter reflexes or the function of the central nervous system.

Nerves can be stimulated using either surface (transcutaneous) or subcutaneous (percutaneous or implanted) electrodes. The surface electrodes are placed on the skin surface above the nerve or muscle that needs to be "activated". They are noninvasive, easy to apply, and generally inexpensive. A limitation of the transcutaneous electrical stimulation is that some nerves, are too profound to be stimulated using surface electrodes. This limitation can be partly addressed by using arrays of electrodes, which can use several electrical contacts to increase selectivity.

Subcutaneous electrodes can be divided into percutaneous and implanted electrodes. The percutaneous electrodes consist of thin wires inserted through the skin and into muscular tissue close to the targeted nerve. These electrodes typically remain in place for a short period of time and are only considered for short-term FES interventions. One of the drawbacks of using the percutaneous electrodes is that they are prone to infection and special care has to be taken to prevent such events.

The other class of subcutaneous electrodes is implanted electrodes. These are permanently implanted in the consumer's body and remain in the body for the remainder of the consumer's life. Compared to surface stimulation electrodes, implanted and percutaneous electrodes potentially have higher stimulation selectivity, which is a desired characteristics of FES systems. To achieve higher selectivity while applying lower stimulation amplitudes, it is recommended that both cathode and anode are in the vicinity of the nerve that is stimulated. The drawbacks of the implanted electrodes are they require an invasive surgical procedure to install, and, as is the case with every surgical intervention, there exists a possibility of infection following implantation.

Typical stimulation protocols used in clinical FES involves trains of electric pulses. Biphasic, charged balanced pulses are employed as they improve the safety of electrical stimulation and minimize some of the adverse effects. Pulse duration, pulse amplitude and pulse frequency are the key parameters that are regulated by the FES devices. The FES devices can be current or voltage regulated. Current regulated FES systems always deliver the same charge to the tissue regardless of the skin/tissue resistance. Because of that, the current FES systems do not require frequent adjustments of the stimulation intensity. The voltage regulated devices may require more frequent adjustments of the stimulation intensity as the charge that they deliver changes as the skin/tissue resistance changes. The properties of the stimulation pulse trains and how many channels are used during stimulation define how complex and sophisticated FES-induced function is. The system can be as simple such as FES systems for muscle strengthening or they can be complex such as FES systems used to deliver simultaneous reaching and grasping, or bipedal locomotion.

How does FES work?
A FES device consists of a control box, about the size of a pack of cards, with a battery and electrodes. For foot drop, the device is usually worn in a cuff below the knee. This is where the electrodes can stimulate the nerve that goes to the muscle that would normally lift the front of your foot.

There is an initial assessment period that lasts for about an hour to see if you are suitable for treatment and if you respond to the FES stimulation. If you do respond then you can start the treatment process. A health professional set up the device with you and teach you how to use it. At first you may find it difficult and time consuming to put the device on and position the pads correctly, but this becomes easier with practice.

Follow up sessions might be necessary to adjust the electrode postion and the strength of the electrical stimulation. This can change as your muscles strengthen and your nerves get used to the level of stimulation.

What are the side effects of FES?
The electrical stimulation causes a tingling 'pins and needles' or buzzing sensation on the skin, much like a TENS machine. Ensuring that wires and pads are in the correct positions can help minimise some of these sensations. For most people this is not a problem, but you might find the effect uncomfortable and may not want to continue using the FES.

There are some risks associated with FES. Fracture of leg bones is possible due to loss of bone mineral density. Also, FES can trigger autonomic dysreflexia in upper-level injuries. People with severe spasticity, contractures, or osteoporosis are not good candidates. Physiotherapist may need to help to relearn specific movements.

Very occasionally people find that the stimulation or the electrodes causes irritation of their skin. Using hypoallergenic electrode patches or asking your health professional about changing the type of stimulation that is used can often solve these problems.

FES is commonly used for exercise, but also to assist with breathing, grasping, transferring, standing and walking. It can also lead to improved bladder and bowel function. There's even evidence that FES may reduce the frequency of pressure sores and urinary tract infections.

FES bikes
FES bikes allow people with little or no voluntary leg movement to pedal a stationary leg-cycle called an ergometer. Computer generated, low-level electrical pulses are transmitted through surface electrodes to the leg muscles. This causes coordinated contractions and the pedaling motion.

Each bike has a program cartridge set up for the specific needs of the rider, including run times, resistance, etc. A doctor's prescription is needed for FES cycling and the cartridge. For safety reasons, it's not recommended that FES bike riders use another's cartridge.

Bladder or bowel FES
Sacral stimulators are surgically implanted FES systems for on-demand control of the paralyzed bladder and bowel. The stimulator, called the Finetech-Brindley device, has a strong track record for improving bladder and bowel control in the vast majority of users.

Upper extremity
FES implant system to restore some hand and arm function to quadriplegics. The FreeHand system is an example of people living with paralysis gained significant function in grip, writing, eating, computer work, etc.

Are there different kinds of FES?
Yes, called functional neuromuscular stimulation and electrical stimulation. While the names are different, they all have the same goal, which is to stimulate muscle contraction. This may lead to more function, strength, and movement and less pain and spasticity (muscle tightness).

How many treatments are needed?
There's no set limit. Some people use FES for many years. To get the most benefits after stroke, a trial of FES may done (for example, for a month) to see if FES will help you.

Can I continue FES at home?
Yes, you can. If you have a home stimulator, family or friends will be shown how to help with treatments. NOTE: Make sure you speak with your therapist or doctor about the model of machine you use. They're not all the same.

Regarding the difference between FES and NMES. The parameters for FES will have a shorter pulse frequency if you look at pulse frequency being 20 to 60. In traditional NMES, there is a longer pulse frequency and you most likely have lower amplitude in FES as compared to traditional NMES. Again, the amplitude for FES only increase until I get the contraction and the movement that I need to accomplish the task versus NMES where you typically are going to have an amplitude that is as high as they can tolerate because your goal is generate a contraction that is between 60% to 70% of their max voluntary contraction. Amplitude is going to be lower and the pulse frequency will be a little bit lower for the FES protocol as compared to what you may have learned for traditional NMES.

tDCS - Transcranial Direct Current Stimulation

Transcranial direct current stimulation (tDCS) is a form of neurostimulation that uses constant, low direct current delivered via electrodes on the head; it can be contrasted with cranial electrotherapy stimulation which generally uses alternating current the same way.

It was originally developed to help patients with brain injuries or psychiatric conditions like major depressive disorder. tDCS appears to have some potential for treating depression. One of the aspects of tDCS is its ability to achieve cortical changes even after the stimulation is ended. The duration of

this change depends on the length of stimulation as well as the intensity of stimulation. The effects of stimulation increase as the duration of stimulation increases or the strength of the current increases. The way that the stimulation changes brain function is either by causing the neuron's resting membrane potential to depolarize or hyperpolarize. When positive stimulation (anodal tDCS) is delivered, the current causes a depolarization of the resting membrane potential, which increases neuronal excitability and allows for more spontaneous cell firing. When negative stimulation (cathodal tDCS) is delivered, the current causes a hyperpolarization of the resting membrane potential. This decreases neuron excitability due to the decreased spontaneous cell firing. tDCS has been proposed to promote both long term potentiation and long term depression.

Operation

Transcranial direct current stimulation works by sending constant, low direct current through the electrodes. When these electrodes are placed in the region of interest, the current induces intracerebral current flow. This current flow then either increases or decreases the neuronal excitability in the specific area being stimulated based on which type of stimulation is being used. This change of neuronal excitability leads to alteration of brain function, which can be used in various therapies as well as to provide more information about the functioning of the human brain.

Transcranial Direct-Current Stimulation (tDCS) is a contemporary, portable, non-invasive neuromodulatory technique that delivers a low electric current to the scalp. A fixed current between 1 and 2 mA is applied. tDCS works by a positive (anodal) or negative (cathodal) current via electrodes to an area, facilitating the depolarization or hyperpolarization of neurons, respectively. The positioning of the anode and cathode electrodes is used to influence how current flows, and where in the brain it does. The current delivered by tDCS is not considered strong enough to trigger an action potential in a neuron; its sub-threshold effect works by bringing the neurons closer to, or farther from firing. Plainly, tDCS augments the resting voltage of the neuronal membrane to prod a neuron's activity in a desired direction. In this way, tDCS may work by strengthening or weakening synaptic transmission between neurons by augmenting synaptic plasticity which is, in turn, the cellular basis of learning. tDCS is often combined with training. Training in itself produces learning (synaptic plasticity), and concurrent tDCS amplifies these effects (enhances synaptic plasticity). Some areas tDCS is currently being explored include: depression, schizophrenia, aphasia, addiction, epilepsy, chronic pain (migraine, fibromyalgia), attention, and motor rehabilitation.

What does the tDCS device look like?

tDCS devices are small battery powered devices. There is usually a control panel that allows to program the device (e.g., to set the duration and intensity of stimulation). Electrodes are placed on the head and held in place by headgear — usually an elastic strap. A cable connects each electrode to the stimulator. When the stimulator is turned on, current flows from the device to the electrode, and subsequently through the brain. Research and clinical grade stimulators have many features that help ensure stimulation is tolerable and reliable. This includes an impedance meter and a current meter.

What does tDCS feel like? What are the side-effects?

Research on the side-effects of tDCS is ongoing, but so far the established side-effects are minor, and restricted to the electrode location. They include temporary skin redness, itching, and tingling. Other suggested side-effects of tDCS include headache, nausea, and dizziness. It should be noted that these latter three side-effects have been illustrated to occur at nearly the same rate as sham stimulation (fake stimulation). When tDCS is applied inadequately, other side-effects can occur such as a phosphene which is a temporary, non-dangerous flash of light. This can occur if electrodes are placed

too close to the eye. Additionally, incorrect tDCS administration can elicit standard skin burns. There is no scientific evidence that demonstrates lasting injury or irreversible side-effects from tDCS. Nonetheless it should be noted that all of the tolerability and safety data on tDCS comes from controlled human trials using specialized equipment and strictly controlled protocols (e.g., limiting current duration, number of sessions).

What don't we know about tDCS?

While questions remain about the best applications for tDCS, there are decades of research denoting its implicated mechanism. Recent work suggests glial activation and the alteration of intracellular cAMP and calcium concentrations to largely contribute to tDCS's effects. It is also understood that the plasticity of the human brain can allow lasting excitability changes as a result of tDCS application, namely, long-term potentiation (LTP) and long-term depression (LTD).

How long do effects from tDCS last?
The immediate effects usually last anywhere from 5 to 90 minutes after the end of the stimulation session. Some research has shown that repetitive stimulation, for example on a daily basis for one week, can educe longer lasting, and more "ingrained" effects. Additionally, a study on depression found that the beneficial effects of tDCS stimulation were shown to be apparent an entire month after the treatment (link). Furthermore, one study (considered anecdotal, not yet confirmed) recorded a lasting cognitive enhancement effect resulting from Transcranial Direct Current Stimulation ONE YEAR after the initial stimulation study (link).

FNS or ENS – Functional Neuromuscular Stimulation or Electrical Neuromuscular Stimulation

What is Functional Neuromuscular Stimulation (FNS)?
FNS is the use of low-voltage electricity to elicit a skeletal muscle response. The electrical excitability of the nerves and muscle tissue provides the basis for its therapeutic use. Normally, movement of the extremities originates in the motor areas of the brain. For various reasons, such as trauma, stroke, neurological disease (e.g. multiple sclerosis), congenital deficiencies, or tumor, the neural pathway between the cerebral cortex and the muscles may be disrupted or damaged.

The basic premise of functional neuromuscular stimulation is that a viable muscle, even though atrophied, can still be activated and controlled by means of electrical stimulation applied below the level of injury.

In addition to eliciting contraction of skeletal muscles, electrical stimulation has also been employed in a variety of other applications, such as to contract the heart muscle (i.e., cardiac pacemakers), alleviate pain (TENS units), improve bladder control, control epileptic seizures, prevent the progress of scoliosis, promote bone strength, improve blood circulation in various parts of the body, control respiration, and stimulate the auditory nerve and visual cortex.

Physical therapists use FNS to facilitate activation and strengthening of paralyzed or weakened muscles following spinal cord injury, stroke, and brain injury. This tool is used along with other therapy interventions to increase functional muscle activity.

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HVPC / Galvanic- High-voltage pulsed current

What is High Voltage Pulsed Stimulation (HVPS)?
High voltage pulsed stimulation (HVPS) is a non-invasive method of applying high voltage, low amperage and direct current to a specific region of the body. HVPS has evolved as an electrotherapeutic agent being adopted to alleviate pain, stimulate blood flow, and promote wound healing. HVPS USES a very short pulse duration between 20-200µs, voltage greater than 100 volts in a therapeutic manner, stimulation range between 0-150Hz, and a twin peak monophasic waveform.

How does this electrotherapeutic modality differ from the others?
HVPS utilises a high voltage and direct current (DC), thus differentiating this device from transcutaneous electrical nerve stimulation (TENS) and neuromuscular electrical stimulation (NMES), which uses a low voltage and alternating current (AC). HVPS devices deliver more than 100V at microsecond pulse durations, and have features such as an adjustable pulse rate, positive or negative polarity switch, and alternating or synchronous stimulation.

When using a HVPS device a large 'dispersive' pad is needed to ground the current, and smaller 'active' pads are placed over the treatment site. With its constant unidirectional current flow HVPS's oppositely charged electrode pads are set up allowing the operator to switch the polarity of the output to generate a hot and cold sensation for the patient. The positive pad emits a cooling sensation, which tends to reduce circulation and decrease swelling in the region beneath the pad. In contrast, the negative pad emits warmth, promoting increased circulation and improves the overall rate of healing. There are methods available to objectively measure changes in temperature due to HVPS. At the cutaneous level you can use an infrared thermometer or a cutaneous thermistor.

High Voltage Pulsed Current (HVPC) has been used in therapy for many years (machines have been available since the 1940's), yet while in many countries it is highly popular, in other countries its use is minimal. By virtue of the fact that each pulse is very short, the current flow through the tissue will average to a very low level - thus the links with microcurrent type therapies. There is an evidence base for its application in a range of clinical presentations, mainly relating to the stimulation of wound healing, pain relief and facilitated oedema resolution.

HVPC Waveform and Stimulation Parameters
There are several variations on the specific waveform employed in machines from different manufacturers. Some machines allow very little control over the pulse parameters whilst others enable variation of several key parameters.
(A) direct current (B) monophasic pulsed DC (C) symmetric biphasic pulsed (D) twin peak monophasic

Some devices allow the operator to adjust both the pulse duration, the interval between the 'twin peaks' and the interval between the pulse pairs. A 'typical' HVPC set of parameters are pulse duration set at 200µs, the interpulse interval is set at 9800µs and therefore 1 cycle will take 10000µs to deliver (which is 10ms - milliseconds). If 1 cycle takes 10ms to deliver, the stimulation frequency will be 100Hz.

H-WAVE – Specific waveform stimulation

Electronic Waveform Lab, Inc., is the manufacturer of the H-Wave device and markets their product to rehabilitation and sports medicine providers across the globe. The H-Wave device was designed to simulate a natural muscle contraction and utilizes a low frequency (1-2 Hz) non-tetanizing, non-fatiguing contraction. H-wave appears to preferentially stimulate smaller muscle fibers and not the motor nerves of larger white muscle fibers. Neither A-delta nor C–nerve fibers are recruited thus

eliminating the discomfort associated with tetanizing contractions/fatigue. Unlike a TENS unit that acts to overload the spinal gateway to stop pain signals from reaching the thalamic portion of the brain, the H-Wave is thought to deactivate the sodium pump which leads to post-synaptic depression and ultimately offers a longer-lasting period of analgesia for the patient. Another physiological mechanism of H-Wave is postulated to be the production of nitric oxide-dependent angiogenesis which has again been demonstrated in rodent studies.

The research studies conducted to date on the H-Wave device show significant gains being made in three distinct areas:

functional improvement,
pain reduction, and
medication use reduction.

The H-Wave generates a mild signal that produces comfortable, non-fatiguing muscle contractions to improve circulation and lymphatic drainage, which is the basis for recovery. It has a second setting which generates a stronger signal that creates a profound analgesic effect, therefore providing hours of significant pain relief. Non-invasive electrotherapy is commonly used for treatment of chronic low back pain.

TMS - Transcranial magnetic stimulation

Transcranial magnetic stimulation (TMS) is a form of neurostimulation. TMS is a non-invasive procedure in which a changing magnetic field is used to cause electric current to flow in a small targeted region of the brain via electromagnetic induction. During a TMS procedure, a magnetic field generator, or "coil", is placed on the scalp. The coil is connected to a pulse generator, or stimulator, that delivers a changing electric current to the coil.

TMS is used diagnostically to measure the connection between the central nervous system and skeletal muscle to evaluate damage in a wide variety of disease states, including stroke, multiple sclerosis, amyotrophic lateral sclerosis, movement disorders, and motor neuron diseases. Evidence suggests it is useful for neuropathic pain and treatment-resistant major depressive disorder.

For neuropathic pain, for which there is little effective treatment, high-frequency (HF) repetitive TMS (rTMS) appears effective. For treatment-resistant major depressive disorder, HF-rTMS of the left dorsolateral prefrontal cortex (DLPFC) appears effective and low-frequency (LF) rTMS of the right DLPFC has probable efficacy.

Although TMS is generally regarded as safe, risks increase for therapeutic rTMS compared to single or paired TMS for diagnostic purposes. In the field of therapeutic TMS, risks increase with higher frequencies. The greatest immediate risk is the rare occurrence of syncope (fainting) and even less commonly, induced seizures.Other adverse short-term effects of TMS include discomfort or pain, transient induction of hypomania, transient cognitive changes, transient hearing loss, transient impairment of working memory, and induced currents in electrical circuits in implanted devices.

Most devices provide a shallow magnetic field that affects neurons mostly on the surface of the brain, delivered with coil shaped like the number eight. Some devices can provide magnetic fields that can penetrate deeper, are used for deep transcranial magnetic stimulation (deep TMS), and have different types of coils including the H-coil the C-core coil, and the circular crown coil; as of 2013 the H coil used in devices made by Brainsway were the most developed.

Others

In the European Economic Area, various versions of Deep TMS H-coils has CE marking for Alzheimer's disease, autism, bipolar disorder, epilepsy, chronic pain, major depressive disorder, Parkinson's disease, posttraumatic stress disorder (PTSD), schizophrenia (negative symptoms) and to aid smoking cessation. One review found tentative benefit for cognitive enhancement in healthy people.

Does TMS work?
Approximately 50% to 60% of people with depression who have tried and failed to receive benefit from medications experience a clinically meaningful response with TMS. About one-third of these individuals experience a full remission, meaning that their symptoms go away completely. It is important to acknowledge that these results, while encouraging, are not permanent. Like most other treatments for mood disorders, there is a high recurrence rate. However, most TMS patients feel better for many months after treatment stops, with the average length of response being a little more than a year. Some opt to come back for subsequent rounds of treatment. For individuals who do not respond to TMS, ECT may be effective and is often worth considering.

What is TMS therapy like?
TMS therapy is an intensive treatment option requiring sessions that occur five days a week for several weeks. Each session may last anywhere from 20 to 50 minutes, depending on the device and clinical protocol being used. When patients arrive, they briefly check in with a technician or doctor and then begin the stimulation process. The technician determines the ideal stimulation intensity and anatomical target by taking advantage of a “landmark” in the brain called the motor cortex. By first targeting this part of the brain, the team can determine where best to locate the stimulation coil as it relates to that individual’s brain and how intensely it must “fire” in order to achieve adequate stimulation. Calculations are then applied to translate this data toward finding the dorsolateral prefrontal cortex, the brain target with the greatest evidence of clinical effectiveness and an area known to be involved in depression. Though one session may be enough to change the brain’s level of excitability, relief isn’t usually noticeable until the third, fourth, fifth, or even sixth week of treatment.

Can TMS help with other conditions?
TMS is being studied extensively across disorders and even disciplines with the hope that it evolves into new treatments for neurological disorders, pain management, and physical rehabilitation in addition to psychiatry. There are currently large clinical trials looking at the effectiveness of TMS in conditions such as pediatric depression, bipolar disorder, obsessive-compulsive disorder, smoking cessation, and post-traumatic stress disorder.

MCT - Microcurrent therapy

Microcurrent therapy uses extremely low-level electrical currents (microcurrents) to improve athletic performance and treat nerve and muscle pain, inflammation, a variety of mental health challenges and aids cells in getting rid of toxins. Each tissue type in your body has its own unique electrical frequency, which may be disrupted by injury, disease, or cellular toxins. Simply put, MCT helps your body by restoring cells to their normal frequencies, resulting in remarkable improvements in pain, inflammation, and function.

MCT has been used to successfully improve:

- Concussion
- Athletic Performance
- Acute/Chronic Pain
- Arthritis

- Sports Injuries
- Bursitis
- Muscular Strains/Sprains
- Sciatica
- Headaches/Migraines
- Swelling/Edema
- Neuropathy/Neuralgia
- Back pain
- Tendonitis
- Carpal tunnel
- Joint/Ligament Injuries
- Fibromyalgia

Microcurrent therapy does not simply treat signs and symptoms, it addresses the body directly at the cellular level. MCT stimulates a dramatic increase in ATP, the energy that fuels the body's biochemical functions. It increases protein synthesis, which is how muscles grow and tissues repair. MCT also:

- Provides pain relief in nerves, joints, muscles, and tendons
- Accelerates recovery time at the cellular level
- Increases circulation
- Decreases inflammation
- Detoxes the body
- Improves cellular metabolism of injured tissues

Micro Current Therapy VS TENS
For years, TENS has dominated the pain relief world. It has been used for all manner of pain related issues, such as arthritis and chronic back pain. It bombards the nerve endings with electricity, blocking the pain signals to the brain, however, although this procedure can stop your pain it has a number of drawbacks. Firstly, it only has a success rate of between 40 and 50%, about a third of all people find the intensity of the current unpleasant due to the tingling or throbing sensation the device causes.
MCT uses microamps which are are thousand time smaller than the milliamps TENS uses. This much smaller current is naturally found in the body too, and enters damaged cells. Damaged cells reject the body's current because they are swolen, but MCT reintroduces this current and restores the functions in said cells. Unlike TENS, the treatment cannot be felt and is stimulating healing in the body in stead of simply blocking the pain. It is for this reason that specialists are leaning more and more towards MCT.

Injured cells resist the body's natural micro-current. This causes the natural micro-current to take the path of least resistance around the area of injury rather that through it. This prevents the supply of blood, oxygen and vital nutrients to the injured cells, causing pain and retarding the healing process.

The micro-current device acts as an external battery. This sends the body's natural micro-current through the area of injury. Therefore, the effectiveness of micro-current therapy stems from its ability to closely mimic the human body's natural current. It acts at the cellular level to potentially accelerating the healing process.

All tissue in the body has its own signature electrical frequency, which provides power for the body, however when an injury or disease occurs, the injured cells resist this microcurrent so that it takes the path of least resistance around the area of injury rather than through it. This prevents the supply

of blood, oxygen and vital nutrients to the injured cells, causing pain and retarding the healing process.

Microcurrent therapy works on the affected pain area, reaching injured cells, potentially restoring and regenerating them to alleviate chronic pain.

MET - Microcurrent Electrical Therapy

By definition microcurrent devices stimulate the affected tissue with less than 1mA of electrical current, most commonly delivered with hand-held probes or self-adhesive electrodes that bracket the treated area.MET is a highly effective modality in the treatment of a variety of pain problems, including:
Any nerve, muscle or articular pain
Cancer pain
Decubital ulcers and fractures
Periodontal, orthodontic and post surgical pain
Sprains, strains, and spasms
Paresis
Post-operative pain and scars

Postulated Mechanisms of MET
Microcurrent stimulation appears to affect cellular physiology and produce its effects by reducing the electrical resistance of the injured tissue and restoring its cellular capacitance. A study by Cheng et al. (1982) further indicates that applications of microcurrent stimulation (< 500mA) can dramatically increase the production of ATP in the tissue by as much as 500% and increase amino acid transport and protein synthesis in the treated area by 30-40%.

The classic works by Björn E. W. Nordenström and Robert Becker have shown that endogenous bioelectricity, and changes in the polarity of the tissue triggered by illness or injury, may represent the primary catalyst of the healing process. Zhao et al. (2006) have shown that minute electrical fields, similar to those detected endogenously, serve as a prime directional cue to direct cell migration during wound healing and manipulation of these endogenous currents may affect wound healing in vivo. It is then plausible to speculate that stimulation with mild electrical currents may not be limited to analgesis effects but may also help restore or enhance the endogenous current flow and consequently facilitate the healing process. MET, especially at low-frequencies, may also produce some analgesic effects via release of endogenous opioid peptides.

MET vs. Transcutaneous Electrical Nerve Stimulation (TENS)
In comparison with TENS therapy, MET uses 1,000 times less current (10-600µA), delivered at an extremely low frequency of 0.5Hz and a 2,500 times longer pulse width (<2s). MET can produce rapid and significant treatment effects, often within 2-5 minutes of stimulation and can treat even intense pain problems.

MET can produce a relatively long-lasting reduction or elimination of pain lasting several hours or days, often after a single or several treatments. Repeated stimulation with MET can produce greater benefits over time (5-7 applications) as the effects of this modality are residual and cumulative in many patients. Residual effects of TENS therapy are minimal in most patients.

The control of chronic pain using Microcurrent Electrical Therapy and Cranial Electrotherapy Stimulation. Tae-Kyu Lee, Kwan-Sung Lee, Shin-Soo Jeun, Young-Kil Hong, Chun-Kun Park, Joon-Ki, Moon-Chan Kim. From the Department of Neurosurgery, Kangnam St. Mary’s Hospital, College Of

Medicine, and The Catholic University of Korea, Seoul, Korea. Presented at the Korea Society for Stereotactic & Functional Neurosurgery, April 14, 2004.

Microcurrent electrical therapy is a holistic procedure. It may be necessary to clear the body of any and all electrical "blocks" in order to achieve the best results. Even brief 10 to 20 second treatments of other problems and/or old injuries may reverse a refractory case.

Use 0.5 Hz frequency most of the time. 100 Hz sometimes produces faster results when treating inflammatory articular problems (e.g., arthritis, bursitis, tendonitis, etc.). However, 100 Hz does not contribute long term results so treatment should always be completed using a low frequency. The highest comfortable position is usually 500 to 600 μA for probes, although sometimes less for the silver electrodes used with MET. Do not use standard TENS electrodes except in the initial treatment of hypersensitive patients. Carbon TENS electrodes have a resistance of about 200 ohms, while silver electrodes have a resistance of about 20 ohms. Only silver electrodes will work effectively with MET devices.

When using probes, first affix new felt electrodes and saturate them with an appropriate electromedical conducting solution. Then apply firm pressure, but less than that which would cause more pain. Tap water does not work well in some places because of recent advances in desalination during water processing. Saline solution may be used if a conducting solution is not available.

For extremely hypersensitive people, it is better to start with a minimal amount of current. Even low level MET currents may be uncomfortable in some patients. For these patients it may be necessary to initially reduce the conductivity by using more resistive electrodes. Over the course of a few weeks, the therapeutic dosage of electricity can gradually be increased. Most people do not feel MET stimulation at a current of 600 μA.

There are only a few principles one must remember when treating patients with MET. The patient should be in a relaxed position to receive maximum beneficial effects. For example, do not let the patient help with the treatment of their hands by holding up their arms, which would cause the arm muscles to tense. In this case, it is better to place both hands on a table.

The most important variable is the position of the probes, or silver electrode pads. Place the probes, or pads, in such a way that if a line were drawn between them, that line would travel through the problem area. Keep in mind that the body is three-dimensional. Therefore, there are many possible lines that can be drawn through the problem area. Some lines work much better than others. The correct electrode location is the one that works! However, the one that works may be transient, working one day, but ineffective another day. As the problem begins to resolve, the electrode locations may require frequent adjustments.

A common mistake made by clinicians familiar with traditional TENS is placing the electrodes on each side of the spine for back pain. This is a two dimensional approach. With such a placement microcurrent travel just under the skin between the electrodes and never reach the spine. Nor can the electrodes be effectively placed "between the pain and the brain". These are common placements for TENS electrodes, but MET is not TENS. A better way is to place one electrode next to the spine at the level where the problem is, and the other on the contralateral side, anteriolaterally (front and opposite side). A line drawn between those goes right through the spinal nerves. Next, reverse the sides. Then follow-up by doing another set of contralateral placements one spinal level above, and one below the problem to accommodate overlap in the dorsolateral fasciculus.

Always treat bilaterally. Bilateral treatment includes the spinal cord thereby involving dermatomes, myotomes, and sclerotomes. Also if the problem is within the axial skeleton and the contralateral side is ignored, there is a good chance that the primary location of a pain problem has been missed. Pain often presents itself on the tense side which may be compensating for muscular weakness on the other side.

Silver Self-Adhesive Electrodes
For optimum results, silver electrodes may be moved around the problem area. Silver electrodes should be left at each location for at least 5 to 10 minutes. Some cases require an hour or even several hours of stimulation daily. Accordingly, silver electrodes are best used for home care. However, if brief stimulation works, do not continue treatment at that session. More is not better when using MET technology to manage pain!

If the patient can no longer identify any pain, but complains of stiffness, this indicates that it is time to stop treatment for the day. Microcurrent may not reduce residual stiffness. Post-pain stiffness usually wears off by itself. Yoga, Tai Ch'i, or simple stretching exercises are good means of controlling chronic stiffness.

Although most patients have an immediate response to treatment, in some the effects is delayed, continuing to improve over a day or two after the treatment. In these patients relief generally occur one to three hours post treatment or even as late as the next morning. Some patients experience a cumulative effect, continuing to improve over time. Patients who experience a delayed effect are more difficult to treat due to lack of immediate feedback.

Follow-up
Most patients should be given at least three to seven treatments before evaluating their response to microcurrent electrical therapy. It helps to explain to the patient that the effects of MET treatment are cumulative. Like antibiotics, one must take several doses over a period of time to get results. Although results usually be seen during or subsequent to the first treatment, the longevity of the results can only be evaluated after a series of treatments.

E-STIM - Electro-stimulation

An assortment of erotic use insertable Violet Wand attachments known as electrodes. The tempered and evacuated glass tubes are back-filled with noble gas, causing them to emit sparks and glow with various colors when the violet wand is powered.
The use of electricity for entertainment purposes dates back at least as early as the 1740s. In the 1830s, insertable electrode attachments for small magnetos could be purchased.

By the 1970s, medical TENS (transcutaneous electrical nerve stimulation) units were used for electrostimulation. In the 1980s the first devices manufactured specifically for erotic electrostimulation became available, in particular the Titillator and the Pleasure Box, later known as the PES Power Box.

In the 1970s, experimenters noticed that bare speaker wires could deliver a jolt and began using recorded and live sound for electrostimulation. At that time, there were no professionally made attachments for such play, so people built their own out of copper plumbing parts and other metal pieces with attention to resistors placed in series with the human parts to control the current for safety. Although early e-stim units used only a simple, pulsed, sinusoidal wave, newer units use more complex wave forms and also allow for the use of ambient sound or prerecorded wave forms like music.

Erotic electrostimulation is a sexual practice involving the application of electrical stimulation to the nerves of the body, with particular emphasis on the genitals, using a power source (such as a TENS, EMS, Violet wand etc.) for purposes of sexual stimulation. Electrostimulation has been associated with BDSM activities, and erotic electrostimulation is an evolution of that practice.

E-Stim,electrostim,electrosex, electroplay all mean one thing. Using small electrical signals to stimulate the body in interesting and pleasurable ways. The human body runs on electrical signals, from touch to thinking, so its no great leap of the imagination to use a box of tricks to add to the feeling, and that's what E-Stim does.

Safety

The most common problems arising from electrostimulation tend to be burns from lack of sufficiently wide surface contact, i.e. bad contact, between the electrode and the skin's surface. Even at relatively low current and voltage, there is risk of interference with normal heart function (potentially including cardiac arrest), and this risk is higher for those who use an artificial pacemaker or similar device or who have heart conditions. Because of this, it is not advisable to place the electrical contacts in such a way that current passes through the chest cavity.

Erotic electrostimulation devices should avoid DC currents entirely, in order to avoid electrolytic effects. This is usually achieved through "biphasic" waveforms, each positive current pulse is followed an equivalent negative current pulse. Devices with multiple channels (e.g. for several users or body regions) should have a small pulse isolation transformer for galvanic isolation in each channel, such that currents cannot flow across the body between channels. Pulse frequency, duration and amplitude should be selected to achieve the desired stimulation with the least amount of power delivered into the body, for example avoiding current during the refractory period after each action potential, where neurons do not respond to stimuli. Typical erotic electrostimulation devices use pulse frequencies in the range 300–3000 Hz, where skin nerves are most sensitive.

Types of power sources

There are repackaged TENS and EMS units marketed as erotic electrostimulation power sources. These can be dangerous to use for erotic pleasures. Erotic electrostimulation power sources are specifically designed and manufactured for erotic use on the human body. The first analog devices became popular during the mid-1980s, and during the late 1990s digital devices became available. Both types usually allow for adjustments of frequency and power output levels, some with complex preset "programs" and computer controls. The setups usually consist of a "box" and electrodes connected by wiring. Many of the boxes are portable and can be powered by batteries or come with built-in rechargeable batteries. Some units can be connected to remote operators via an Internet-connected computer or controlled via radio frequency key fobs. Units which can be powered by a 9 volt battery are preferable to those plugged into mains as they reduce the risk of accidental injury.[3]

Electrodes

An electrode is used to deliver the actual electrostimulation to the body. For erotic electrostimulation, these are typically items designed to be applied to the genitals such as vaginal plugs and shields, anal plugs, probes to directly stimulate the prostate, testicle rings, CBT boards, cock rings, urethral probes, and other items for penile application. The pads used with TENS units are used in the sexual application of electrostimulation. There are electrified nipple and breast electrodes available, but while there is disagreement within the e-stim community about their safety the most commonly held consensus is 'only below the waist'. Still, the right-lateral of the body, the breast, is far not as risky as the left one, due the proximity of the left breast to the heart and its nerves, and so possibly colliding with the natural electro-impulse control of the heartbeat.

The electrodes can be made of metals such as gold, silver, aluminum, and stainless steel. There are also electrodes made out of conductive silicone. Conductive rubber is a cheap, flexible and efficient option.

Lubrication
Electroconductive gels play an important role in the success of erotic electrostimulation since without it, there is a greater risk of high-current skin burning. Water-based lubricants are generally recommended. Typically it is recommended to avoid any lubricant that contains silicone since it is an insulator and hence reduces conductivity. Practitioners of electrostimulation select lubricants for compatibility with the material of the electrodes, as well as for desirable conductive properties, which can maximize the strength and quality of the signal.

Electroejaculation is a procedure used to obtain semen samples from sexually mature male mammals. The procedure is used for breeding programs and research purposes in various species, as well as in the treatment of an ejaculatory dysfunction in human males.

With a wide range of electrodes available from insertables to toys designed to be used on the surface of the skin, from hard core monsters to items that tease and tantalise, there will be something for Her, Him and everyone else. And don't forget you also have the option of 'controlling' your partners fun, which adds a completely new dynamic to play.

Alpha-Stim / MENS – Microcurrent stimulation , CES (cranial electrotherapy stimulation)

Alpha-Stim gives physical therapy and occupational therapy professionals two unique treatment methods: Manual Microcurrent Electrical Therapy (MET) and Cranial Electrotherapy Stimulation (CES). MET delivers a current in alpha waveform directly to areas experiencing tightness and pain. This process happens through two separate points of body contact.

CES, on the other hand, offers a stream of an alpha waveform directly to the brain via a set of ear clips. The current thus regulates hormone and neurotransmitter imbalances. Both of these chemicals are associated with mood disturbances.

MET alters the way the cells of the targeted muscle group interpret pain. This treatment is proven to reduce and manage acute and chronic discomfort. A safe, non-invasive, and convenient session typically takes only two to five minutes.

The increase of alpha brainwaves from CES help to increase levels of serotonin and decrease beta brainwaves. This activity makes the brain feel happy and relaxed while also preventing neurological imbalances. Each treatment session lasts between 20 to 60 minutes. Like its counterpart, CES is safe and provides quick results.

Alpha-Stim® is a CES device for fast, safe, and effective treatment of depression, anxiety, insomnia, and all types of pain. Dr. Daniel L. Kirsch invented Alpha-Stim in 1981. Alpha-Stim generates a configuration of microcurrent unavailable in other CES device. For anxiety, depression, and insomnia, this waveform is transmitted to the brain via patented Earlip Electrodes.

Alpha-Stim microcurrent waveform activates particular groups of nerve cells that are located at the brainstem. These groups of nerve cells produce the chemicals serotonin and acetylcholine which can affect the chemical activity of nerve cells that are both nearby and at more distant sites in the nervous system. In fact, these cells are situated to control the activity of nerve pathways that run up into the brain and that course down into the spinal cord.

By changing the electrical and chemical activity of certain nerve cells in the brainstem, Alpha-Stim technology appears to amplify activity in some neurological systems and diminish activity in others. This neurological fine tuning is called modulation, and occurs either as a result of, or together with the production of a certain type of electrical activity pattern in the brain known as an alpha state

Such alpha rhythms are accompanied by feelings of calmness, relaxation and increased mental focus. The neurological mechanisms that are occurring during the alpha state appear to decrease stress-effects, reduce agitation and stabilise mood and regulate both sensations and perceptions of particular types of pain.

These effects can be produced after a single treatment and repeated treatments have been shown to increase the relative strength and duration of these effects.

CES (cranial electrotherapy stimulation) treats a variety of ailments, but because of legal restrictions, the manufacturers are only allowed to say that it effectively treats anxiety, depression, stress, and insomnia. To receive a "brain treatment," electrode clips are placed on the earlobes for an average of twenty minutes three times per week. The user may feel a slight tingling sensation but often feels nothing at all.

Some users report feeling light (or heavy then light), as their anxiety fades away. Unlike drugs used to treat mood disorders, the mind is left alert while the body is relaxed. Dr. Kirsch uses the analogy of having a Type-A mind with a Type-B body. (Type-A personalities are usually creative, hard working go-getters, but often suffer from stress-related ills. Type-B's are more relaxed and laid back but tend to live with their parents until their 30's.)

Anxiety reduction is usually felt during the first treatment although the effects are cumulative over time. Depression and insomnia are usually controlled, if not cured, in two to three weeks. Users also report feeling more energetic, focused, and, well, good. Although not its primary mechanism of action, microcurrent treatment increases natural endorphin output.

Studies are still ongoing in many of these areas, but people are noticing marked improvements in the treatment of ADD, phobias, and drug and alcohol addiction (including prescription drug addiction) using CES. Users also report an increased ability to learn, concentrate and focus. This technology has even been used to treat criminals since some types of crime are considered to be manifestations of anxiety.

SES – Sexual Electric Stimulation

Vaginal electrical stimulation (VES) is a technique sometimes used in women's pelvic floor physical therapy. The pelvic floor muscles work together to keep the urinary and bowel systems working smoothly. They are important for a woman’s sexual health, as they are involved in arousal, lubrication, and orgasm. Sometimes, the pelvic floor muscles need strengthening and toning. There are a number of different techniques that can be used, including VES.

VES can be done in the therapist office or with a personal device at home. First, lubricant is applied to a small sensor, which is then placed inside the vagina. Next, a low-voltage current is delivered through the sensor. This current stimulates nerves in the muscles and makes the muscles contract – exercising them, in a sense. The strength of the current can be adjusted for a woman's comfort. She or her therapist can control the amount of time the current lasts. Usually, the procedure involves short periods of current alternating with periods of rest.

Past studies have shown that VES can help women who have both pelvic floor problems and sexual issues. In a December 2014 report published in The Journal of Sexual Medicine, scientists from Turkey discussed whether the technique could help women who had sexual dysfunction only, without any problems with their pelvic floor. They analyzed data from two groups of women who reported sexual problems. One group received VES treatment; the other received a placebo treatment. The overall results from the two groups were not much different. The researchers noted that VES might be effective for sexual dysfunction only, but more research is needed.

Erotic Electrostimulation Health Benefits
E-stim can be felt within the electrodes and can stimulate one to experience a hands-free orgasm with little effort. These machines are designed to increase erotic pleasure and can also be used to relax muscles and reduce stress. Furthermore, they may be helpful for medical inhibitors which prevent normal sexual functioning and may be useful in cases of infertility, erectile dysfunction (ED), female sexual dysfunction and even for those who have disabilities that prevent them from having sex such as paralysis. It is always best to consult with your physician before using such a device when you have health concerns and important to understand that erotic electrostimulation will not "cure" any of these or other health conditions; rather they may be able to address symptoms with improvements to performance.

Electroejaculation has been used for many years in humans and does address some of the issues related to ED. Electroejaculation is when a electrostimulation probe is inserted into a male's rectum in order to produce ejaculation and is often used in cases of ejaculatory dysfunction for both animals and humans.

While there have been very few studies using erotic electrostimulation for sexual health benefits, there have been several through acupuncture studies which is referred to as electro-acupuncture. This is where an electrical current is used through acupuncture needles and inserted into the skin. Below are a few studies to give you an idea of how well this form of treatment worked in some of the studies-

In 2011, a study showed that women who had an electro-acupuncture for infertility treatments had a better chance of giving birth. The study was conducted with a total of 309 women who underwent vitro fertilization (IVF). It was determined that those who had electro-acupuncture at the time that their embryos were implanted were more likely to give birth.

Use of electro acupuncture has also been show to treat erectile dysfunction when the perineum and penis were needled. A study done by NIH was done in regard to using such a treatment for erectile dysfunction and it was found that there was a marked improvement of 39% of men who tried it. Specifically, it also improved the quality of erections by over 15% of patients and even more promising was the 31% of men who reported an increase in their sexual activity.

Tips
When using a probe vaginally, the best way to test it is to turn it on and place it in the crux of your elbow. If you grab it with your hand it hurt as the micro-currents of electricity is stronger as it is

bouncing off the tiny bones in the hand. A vagina does not have bones, but rather soft tissue so the feeling will be much different. Vaginal electrostimulation dildos are sex toys that can be used as a Kegel exerciser with long term pleasure benefits. Once Kegel muscles are toned and tightened, a woman may have stronger and longer orgasms as reported by many women who have tried them. It is also advised not to get to the highest level until you work up to it. Women will see a lot of benefit from just being on lower levels.

Keeping Things Clean & Shaved

When using erotic electrostimulation sex toys it may be beneficial to have freshly washed skin that is hair free. By having smooth and clean skin you ensure that you are getting full contact with the electrodes and avoiding hot spots and electrical arcing. If you opt to use an anal electrode, you may wish to consider using an enema beforehand to wash away fecal matter before any electrostimulation.

If you have a an estim probe and wish to clean it, use a good sex toy cleaner to keep from transferring harmful bacteria anywhere else on the body. Even if it is silicone, do not boil it or put it in the dishwasher to sterilize as it has electronic components.

Using The Right Lubricant

While you can use olive oil or any waterbased lubricant for erotic electrostimulation, you find much better results when you use an estim gel as they are designed to promote electrical conductivity and contain ingredients such as salt to assist in maximizing results. You want to avoid any silicone or silicone hybrid lubricants as they act as an insulator and reduces conductivity.

Full Contact
To be successful in estim, it is important to have full contact which means that there are no gaps or space between the electrode and the skin. If there is space, the electricity may arc and create an electrical 'zapping' sensation that can be uncomfortable. This is typically used for BDSM play as it somewhat painful. For users who do not wish to experience such pain, it is important to make sure there is no space between the electrode and the skin.

Hot Spots
These can occur when there is not enough lubricant used, contact with metal jewelry, unshaved pubic hair and other things that would keep an electrode from having full contact with the skin.

PET-ES, animal stimulation

Neuromuscular Electrical Stimulation (NMES) for Pet Pain Relief. Neuromuscular electrical stimulation (NMES) is a valuable tool for treating orthopedic and neurological injuries and diseases. It helps to relieve muscle spasms, prevents muscle atrophy, improves joint mobility and circulation, increases muscle mass and strength, and decreases pain. Electrical stimulation, also called e-stim, is recommended for pets recovering from orthopedic surgery, fracture repairs, spinal cord injuries, or several other neurological or orthopedic conditions in which the use of a limb is inhibited.
The microcurrents are delivered through wired "sticky" pads placed at strategic places on the pets injured body part or limb. As the stimulation is applied, the muscles quiver and contract. These contractions work to retrain or exercise the targeted muscle or muscle group.
When performed by a rehabilitation certified practitioner, electrical stimulation is a safe and effective procedure that integrates well with other rehabilitation modalities. The sensation

may feel like a slight internal tingling to your pet, but it is not painful. Electrical stimulation therapy is recommended based on a patient's specific condition. The frequency and duration of the treatments will vary according to your pet's individual needs.

BMAC – Burst Mode Alternating Current

This type of electrical stimulation is referred to as a medium frequency alternating current (in the low kHz range - thousands of cycles a second), delivered in a pulsed (or burst or interrupted) output. The pulsing or bursting is at a 'low' frequency, and as a result, nerves respond. It is employed to generating a motor response.

Russian Stimulation was the earliest name for this stimulation type. Burst Mode Alternating Current (BMAC) is a generic and recently employed term. The timing (stimulation/rest/repetitions) protocols are considered as the core of treatment frequency. The 10/50/10 protocol is identified as being effective (this is stimulating for 10 seconds, leaving a 50 second rest period and repeating sequence for 10 minutes (i.e. 10 stim/rest cycles) is effective.

The stimulation generates fatigue if delivered more than 10 seconds (at maximal tolerable intensity). Various interpulse rest phases ranging from 10 through to 50 seconds. Both the 40 and the 50 seconds rest were identified as effective, though some subjects appeared to start to demonstrate fatigue with the 40 seconds rest, hence the 50 second period was subsequently adopted.

The stimulation applied at a range of 'medium' frequencies (100-500-1000-2500-3000-5000Hz) and it is found that when the stimulating frequency increased, there was greater comfort for the recipient, and it was therefore (predictably) identified that a greater current could be delivered to the muscle with increased (higher) frequencies.

The researchers concluded that 2500Hz (2.5kHz) was the most effective frequency at which to stimulate muscle tissue (1000Hz or 1kHz was more effective for nerve trunk stimulation), stimulating for a 10 second duration. Using a 2500Hz stimulation at 10milliseconds means that the effective muscle stimulation is at 50Hz.

The continuous vs burst protocols were evaluated (i.e. continuous 2500Hz or 2500Hz burst at 10ms intervals). There was no significant difference in the maximal force generated, but the burst mode generated the same result with less current is applied (50% less). The recommendation is that the stimulation should be applied with a 2500Hz carrier medium frequency sinusoidal alternating current, burst at 50 Hz (10ms ON : 10ms OFF) at a maximum tolerable level.
Russian Stimulation (at 2500Hz or 2.5 kHz) has been shown to be effective in increasing muscle strength and torque generation.

IFT – Interferential therapy

Interferential therapy (IFT) is one of various types of physical therapy. It uses a mid-frequency electrical signal to treat muscular spasms and strains. The current produces a massaging effect over the affected area at periodic intervals, and this stimulates the secretion of endorphins, the body's natural pain relievers, thus relaxing strained muscles and promoting soft-tissue healing. Its use is contraindicated if the affected area has wounds, cuts or infections.

Interferential Current stimulation is the treatment of circulatory and muscular disorders, stiffness of joints, edema, and inflammation. Interferential current therapy is a deeper form of the common treatment TENS. The frequency is higher at 4000Hz from interferential current therapy compared to

the same signal released by a TENS unit at low frequencies of 5-160 Hz per second. The IFC's high frequency waveform reaches the skin deeply with a higher level of stimulation and less discomfort to the patient.

Interferential current therapy is stimulation made by the interception of two electrical mediums of varying frequencies that work together to successfully stimulate large impulse fibers. These frequencies interfere with the pain transmission messages at the spinal cord level. Due to the frequency aspect, the interferential current meets fewer obstacles when crossing the skin to treat the underlying tissue.

The basic principle of Interferential Therapy (IFT) is to utilize the significant physiological effects of low frequency (<250pps) electrical stimulation of nerves without the associated painful and somewhat unpleasant side effects sometimes associated with low frequency stimulation.
The skin impedance at 50Hz is approximately 3200 whilst at 4000Hz it is reduced to approximately 40. The result of applying a higher frequency is that it will pass more easily through the skin, requiring less electrical energy input to reach the deeper tissues & giving rise to less discomfort. The effects of tissue stimulation with these 'medium frequency' currents (medium frequency in electromedical terms is usually considered to be 1KHz-100KHz) has yet to be established.
Modern machines usually offer frequencies of 1-150Hz, though some offer a choice of up to 250Hz or more.

The use of 2 pole IFT stimulation is made possible by electronic manipulation of the currents - the interference occurs within the machine instead of in the tissues. There is no known physiological difference between the effects of IFT produced with 2 or 4 electrode systems. The key difference is that with a 4 pole application the interference is generated in the tissues and with a 2 pole treatment, the current is 'pre modulated' i.e. the interference is generated within the machine unit (Ozcan et al, 2004).The are 4 main clinical applications for which IFT appears to be used:
Pain relief
Muscle stimulation
Increased local blood flow
Reduction of oedema

Electrical stimulation for pain relief has widespread clinical use, thought the direct research evidence for the use of IFT in this role is limited. Logically one could use the higher frequencies (90-130Hz) to stimulate the pain gate mechanisms & thereby mask the pain symptoms. Alternatively, stimulation with lower frequencies (2-5Hz) can be used to activate the opioid mechanisms, again providing a degree of relief.

Iontophoresis

Iontophoresis is based on the activity of "ions", biological charged particles – water-soluble substances that have a positive or negative charge – and based on the principle that like charges repel and unlike charges attract. By using a direct (**galvanic**) current, an ion can be 'pushed' into the skin if the electrode (the active or working electrode) on which it is applied has the same charge as the ion. A positive ion (cation) is pushed into the skin by a positive electrode (anode) and a negative ion (anion) by a negative electrode (cathode).

Electrodes come in a variety of forms including balls, rollers, disks and full face masks. When using a direct current, another electrode (the passive, indifferent or return electrode) is

required to complete the electrical circuit and get a current flow. One or two electrodes are filled with a solution containing an active ingredient and a solvent.

The **positively charged electrode**, called the **anode**, will **repel a positively charged chemical** into the skin.
The **negatively charged electrode**, called the **cathode**, will **repel a negatively charged chemical** into the skin.

Eelectromotive drug administration (EMDA) is the name used for applications to delivers a medicine or other chemical through the skin. It is a non-invasive way to administer medications through the skin. It is different from dermal patches, which do not rely on an electric field. It drives a charged substance, usually a medication or bioactive agent, transdermally by repeating electromotive force, through the skin. IONTOPHORESIS is NOT the same as PHONOPHORESIS which involves driving ions across the skin with therapeutic ultrasound.

Reverse iontophoresis is a technique by which molecules are removed from within the body. The negative charge of the skin at buffered pH causes it to be permselective to cations such as sodium and potassium ions, allowing iontophoresis which causes electroosmosis, solvent flow towards the anode. Electroosmosis then causes electrophoresis, by which neutral molecules, including glucose, are transported across the skin. This is currently being used in such devices as the GlucoWatch, which allows 'drive' ions into the skin tissues, a **DIRECT (Galvanic) CURRENT** is employed. The duration of a treatment is individual dependent but the current need to be monophasic in nature, a pulsed application can be used. Continuous (classic) DC is most commonly used in practice.

The substance to be driven into the tissues NEEDS to be IONIC in nature, and should be placed under the electrode with the equal charge i.e. positively charged ions placed under the positive electrode (anode) and the reverse for a negatively charged ion.

The ions are driven into the skin via the pores - hair follicles, sweat gland ducts - rather than through the stratum corneum per se (the stratum has a high resistance, limiting any current to pass through it - the ducts have a lower resistance, which allow higher passage of current, and makes this a route of preference). It depends on the goal of treatment/use which ionic substance is chosen. Enclosed table shows a series of most used substances. The application of substances may vary per therapist and treatment.

Ionic Penetration
It is considered that penetration of the ions into the skin tissues is less than 1mm. Deeper penetration is likely to due to local capillary circulation effects. There is no evidence that the current itself is responsible for penetrations beyond this level. It is possible that different ions travel varying distances into the tissues, there is not a 'set' penetration equal for all substances.

Redox reaction. It is important to use redox salts for the solution to maximize the effect of the treatment. The redox salts assist to improve ion transportation in the solution and into the dermis faster and deeper.

Acid / Alkaline Reactions

While employing the use of several chemicals it is possible to get **ACID** accumulation under the **POSITIVE** (anode) electrode (weak HYDROCHLORIC ACID) because the negatively charged chloride ions (Cl- from NaCl) will transit towards the anode.

On the other side there is an **ALKALINE** accumulation under the **NEGATIVE** (cathode) electrode (SODIUM HYDROXIDE) because the positively charged sodium ions (Na+ from NaCl) move towards the cathode. The Na+ ions react with water to form sodium hydroxide (NaOH). The chemical reaction at the negative (cathode) electrode could improve a softening of the skin.

A reactive hyperemia is observable under BOTH electrodes due to (chemically mediated) local vasodilation.

The magnitude of the local reaction (independent of the ions utilized) depends on :

- Current Intensity (more current, greater reaction)
- Time (longer time, stronger reaction)
- Tissue Resistance (greater resistance, stronger reaction)

The evidence is collected by Belanger (2010) who concludes that based on the available evidence (e.g. Banga et al, 1998 and Anderson et al, 2003) the penetration of ions is highest in the region of the pores, and the substance is most likely deposited below the stratum corneum, acting as a depot.
Onward migration of the substance to the deeper tissues is achieved by diffusion rather than being 'driven' deeper by the applied current.

Iontophoretic ingredients used in salon treatments today include such products as vitamins, minerals, collagen, elastin, amino acids, hyaluronic acid and a range of animal and plant extracts pre-prepared in a variety of forms, e.g. gels, serums, ampoules, etc. Therapists are provided with little or no information on how these products may be active. They are told that the skin condition on which they are applied and the polarity of the electrode to be used will improve. With many ingredients in skin creams, it is doubtful whether some of these substances could penetrate the skin, whether an electric current is used or not, neither they would be effective.

Figure ; Anodal and Cathodal Reactions in response to Iontophoresis

Cathode	Anode
NEGATIVE electrode	POSITIVE electrode
Attraction of +ve ions	Attraction of -ve ions
Alkaline reaction by the formation of NaOH	Acid reaction by the formation of HCl
Increased density of proteins	Decreased density of proteins
Increased nerve excitability via a depolarisation effect	Decreased nerve excitability via a hyperpolarisation effect (sometimes called anode blockade)

Optimal Current Variables used in Iontophoresis (after Rothstein et al, 1998)

Current Type	DC
Current Amplitude	1.0 - 4.0 mA
Treatment Duration	20 - 40 minutes
Total Current delivered	40-80mA/min

There are some authors who identify very specific substance concentrations, volumes, electrode sizes, current intensity and treatment duration (the critical parameters for an iontophoresis treatment). Others provide general guidance, saying that it is not possible to be specific for a particular patients with a particular clinical presentation. The reality is that everything is based on the individual reactions and physical properties. There are guidelines as given in this book but all need to be tested and adjusted on individual basis.

Polarity, Current Intensity and Drug Concentrations

In general terms, low current intensities appear to achieve good results. The treatment is usually applied with currents up to 5mA and low ionic concentrations – up to 5%, it is also possible to increase current intensity up to higher levels and employ 'stronger' substance concentrations. Treatment times are typically in the 20 - 40 minute range.

There is evidence to suggest that using a higher concentration of the substance does not increase the effectiveness of the therapy, and does not increase the amount of the drug delivered to the tissues - low concentrations of drug (or substance) (typically 2-5%) and a low current intensity (up to 5mA) appears to be the most effective delivery method.

It has commonly accepted that the NEGATIVE electrode is made larger (relative to the positive electrode) to avoid skin irritation (whether the ionic driving electrode or not). It is suggested that the negative (cathode) electrode should be 2 x larger than the positive (anode) electrode.

Current Density

The current density (how strong and concentrated the current is), is measured in mA/cm2, which is an important factor in these treatments. If the current density reaches too high a level, tissue damage, and especially skin burn, may occur. It is advised (Belanger, 2010), that a current density of not higher than 0.5mA/cm2 is applicable at the negative(cathode) electrode and 1.0mA/cm2 at the positive(anodal) electrode.

If a current of 2mA is delivered using an electrode of 6cm2, the current density is 2(mA)/6(cm2) = 0.33mA/cm2, which is safe at both the positive (anode) or negative (cathode) electrode.

It is possible, using a transposition of the equation, to establish the maximal current that can be applied with a particular electrode whilst ensuring a safe treatment.

Maximum Current (mA) = Maximum Safe Current Density (mA/cm2) x Electrode area (cm2)

E.g.

If the (active) electrode is used is 6cm2

If the active electrode is made NEGATIVE (cathode)

The maximum safe current density is 0.5mA/cm2
The maximum current that can be safely applied is therefore :
= 0.5mA/cm2) x 6 (cm2) = 3mA

Application and care
The skin should be abrasion / cut free and the area carefully washed (mild soap & streaming water).
Heat application is not advised as it may work counteractive.
All electrode pads should be thoroughly soaked in tap water or other appropriate solution prior to application. Dry electrodes are inappropriate and should not be used.
Adequate fixation of the electrode and pad to the skin needs to be carefully maintained.
Uneven current distribution can lead to skin burns and/or irritation

Table of Commonly Used Medications and Solutions with Iontophoresis (after Rothstein et al (1998)and Belanger (2010)). Also called **transdermal drug delivery (TDD)**

Drug / Solution	Main Indication(s)	Rationale	Parameters
Acetic Acid	Calcific tendinitis (myositis ossificans)	Acetate increases solubility of calcium deposits in tendons (and other soft tissues)	2 - 5% aqueous solution NEGATIVE pole
Calcium chloride	Muscle spasm (and hypersensitive peripheral nerves)	Calcium stabilizes excitable membranes, appears to decrease excitability threshold in peripheral nerves and skeletal muscle	2 - 5% aqueous solution NEGATIVE pole
Dexamethasone	Inflammation	(synthetic) anti inflammatory	4mg/mL aqueous solution NEGATIVE pole
Hydrocortisone	Inflammation	Steroid based anti inflammatory	0.5% ointment POSITIVE pole (Rothstein et al)
Hydrocortisone, prednisone	Inflammation	Steroid based anti inflammatory	NEGATIVE pole (Belanger)
Iodine	Adhesive capsulitis Other soft tissue adhesive presentations Infection (microbial)	Iodine acts as a broad spectrum antibiotic. Its actions in relation to adhesive presentations appear not to be fully understood	5 - 10% solution (some use ointment) NEGATIVE pole
Lidocaine	Soft tissue pain Inflammation	Local anaesthetic effects (blocks peripheral nerve activity). May stimulate healing	4 - 5% solution (ointment) POSITIVE pole

Magnesium sulphate (sulfate)	Muscle spasm Myositis	Thought that 'relaxing' effect is achieved by decreased excitability of muscle membrane and reduced activity at neuromuscular junction	2% aqueous solution (ointment) POSITIVE pole
Hyaluronidase	Oedema (local) Subacute and Chronic stages	Increases permeability in connective tissues thus allowing dispersion of accumulated fluid. Hydrolysation of hyaluronic acid	Delivered after reconstitution with 0.9% sodium chloride (Normasol) to give a 150µg/mL solution POSITIVE pole
Salicylates	Muscle and Joint pain Acute and Chronic	Mode of action akin to Asprin - analgesia and anti inflammatory. Inhibits synthesis of prostaglandins	2-3% sodium sallicylate solution OR 10% trolamine sallicylate ointment NEGATIVE pole
Tolazoline hydrochloride	Ulcers (open wounds)	Stimulates local blood flow Stimulates tissue healing (thought to be via inhibition of local vascular smooth muscle contraction)	2% aqueous solution POSITIVE pole
Zinc Oxide	Open wounds - ulcers Some dermatological conditions	Antiseptic effects related to the zinc. May stimulate healing	20% ointment POSITIVE pole
Tap Water	Hyperhydrosis (illustrations below)	Suppresses sweating in palms, soles of feet, axilla through ?keratin plug formation in ducts	Equal time with POSITIVE and NEGATIVE polarity - use 2 x hand baths. Reverse polarity 1/2 way through treatment (typically 30 minutes : 15+15)

Currently Iontophoresis is most used to treat hyperhidrosis disorder, a condition that results in persistent and excessive sweating. This sweating may occur in certain situations, such as during warm weather or physical activity, or without any trigger at all. It can also be caused by other medical conditions, such as hyperthyroidism or menopause.

Doctors aren't entirely sure *why* iontophoresis helps reduce excessive sweating. There are a few theories that make sense:
The electrical current and minerals in the water act together to thicken the outer layer of the skin and block sweat from flowing.
The current may disrupt nerve transmission, preventing sweat ducts from functioning properly.

Iontophoresis decreases the pH value in the sweat glands, making them more acidic and reducing the amount of sweat produced.

Iontophoresis doesn't require any special or advanced preparation. For personal safety it should be reported if a person is;
Is pregnant
have epilepsy
have a heart condition
have a pacemaker or other metal implants, such as artificial joint replacements

Iontophoresis for a Sports Injury
When being used as a treatment for a sports injury, iontophoresis is always performed at a ES specialists office. The care provider adds an anti-inflammatory medication to a redox-basin of water, and you'll place the injured area in the water. The a mild electrical current is applied to the medicated water like in all mentioned treatments before. The difference is the place of application and the use of more specific redox salts and supplements. Most iontophoresis sessions for sports injuries last 10 to 15 minutes. Several sessions per week are needed until the injury begins to heal.

In rehabilitation medicine, including physical therapy, iontophoresis is used to reduce inflammation that might be seen in musculoskeletal conditions such as lateral epicondylitis, medial epicondylitis, plantar fasciitis, tendo-nitis/bursitis, rheumatoid arthritis, and enthesopathic conditions of various origins. The most popular and well researched iontophoresis application is the use of dexamethasone, a corticosteroid in a sodium phosphate solution. In this form, the drug is composed of negatively charged ions of dexamethasone phosphate and, when loaded into a negatively charged reservoir or electrode pad, the electrical force of the like charges pushes the medication molecules into the desired area.

What Are the Side Effects of Iontophoresis?
Iontophoresis is a safe and painless procedure. The most common side effect is dryness of the skin. Blistering, peeling, and irritation might also occur on the skin. However, these side effects can usually be treated by applying moisturizer to the skin after each session. An over-the-counter hydrocortisone cream can also make you more comfortable.

Desincrustation

The developers of the treatment described these 'incrustations' as 'microscopic crystallisations' formed by chemical reactions between certain chemicals and minerals in creams, make-up, atmospheric pollution and perspiration. As the impurities built up in the skin they were said to adversely affect it – causing in wrinkles, pimples, acne and blackheads – and therefore needed to be removed, that is, the skin had to be 'de-incrustated'.

The chief characteristics of the method consist in breaking up, reducing and eliminating all the impurities (waste matter, dust, toxins, crystallisations, etc.) which block up the

glandular tubes. … The immediate result is—increased blood circulation and, gradually, recolouring of the epidermis.
The treatment became another established practice within Beauty Culture. Later known as disincrustation or desincrustation it uses another well-known effect of direct (galvanic) currents.

Basic principles
Desincrustation relies on the fact that when a direct current is used, an alkali (sodium hydroxide) is produced at the negative electrode and an acid (hydrochloric acid) is generated at the positive electrode.

Unlike electrolysis, where the sodium hydroxide (lye) is concentrated in a small area in the living dermis of the skin through the insertion of a needle, in desincrustation the sodium hydroxide is spread over the stratum corneum of the epidermis. So, rather than destroying tissue, as in electrolysis, the effect of the sodium hydroxide in desincrustation is merely to soften the keratin in the epidermis. This assists in desquamating surface keratinocytes and in loosening any hard plugs of sebum that occur in blackheads. The treatment is therefore commonly employed on 'congested skin' as precursor to extractions.

As with iontophoresis, the negative electrode used in desincrustation can be a disk, roller or ball electrode, a full facial mask, or something as simple as a tweezer electrode encased in a pad of cotton wool soaked in conducting solution. Unlike iontophoresis, where specialised ampoules are needed, a simple salt solution is all that is required. One can be made up using the following formula:

Baking soda (sodium bicarbonate)5 ml (1 teaspoon)Distilled water250 ml (1 cup)Sodium bicarbonate beaks down into sodium (positive) and bicarbonate (negative) ions when dissolved in water. This makes the solution slightly alkaline making it more effective than using common table salt (sodium chloride).

Combining treatments
In order to carry out either desincrustation or iontophoresis, a salon need to purchase a galvanic machine. Having done so it makes sense for them to maximise the return on their outlay by combining iontophoresis and desincrustation into a single treatment. This is commonly done by first carrying out desincrustation, using the negative electrode, and then following this with iontophoresis, using only the positive electrode.

The reasoning behind this is as follows. Using desincrustation first, reduces the barrier properties of the skin by assisting with exfoliation, in theory making it easier for ions to move across the skin during iontophoresis. Then, as acid is produced under the positive electrode with iontophoresis (using only the positive electrode) this helps to restore the acid balance of the skin upset by the alkali generated during desincrustation.

The future

Brainwave communication: In clinical trials, people are controlling computer cursors and opening email with just their thoughts. BrainGate is an investigational brain implant system from a biotech company called Cyberkinetics that places a computer chip into the brain, which monitors brain activity and converts the intention of the user into computer commands.

In the Electrical Stimulation Machines market is EarthPulse, a pioneer in PEMF devices technologies and brought PEMF to the masses, even before NASA research. EarthPulse has launched an Electrial Stimulation machine, the EarthPulse E-Stim that provides both AC and DC settings. This configuration is a result of more than 20 years of research.

In the nearby future we expect Electro Stimulation to be connected with brain control mechanisms. This connection may improve mobility and disease control.

Electrodes & application (samples)

Electrode types:

- Commercial pads and rubber-backed electrodes, with a variety of connecting mechanisms.
- Moistened paper towels, with aluminum foil plates, which necessitate alligator clips for connecting them to leads.
- Sponge/foam types, with inserted electrodes and rubber carriers.
- Carbonized, rubber electrodes (TENS), which require transmission gel. the carbon rubber has a much higher resistance than metal, which prevents high current concentrations in small areas
- Copper-tipped, utilized for internal administration (intra-vaginal).
- Platinum Foam Neurostimulation Electrodes combine stainless steel knit fabric and hydrogel construction with a soft foam top.
- Silver electrodes, designed and intended to be used with transcutaneous electrical nerve stimulators, pure silver conductor provides uniform current dispersion.
- Gel pad set can be reused up to 50 times, hydrogel electrodes are not stable at temperatures over 40°C and over long time periods. The skin interface layer includes an electrically conductive gel with relatively low peel strength for removably contacting the subject's skin. It has a wet feeling and can be removed relatively easily from the skin. The conductive gel is made from co-polymers derived from polymerization, e.g. of acrylic acid and N-vinylpyrrolidone . A second hydrogel layer connects the substrate (a low resistive material like carbon rubber or a wire mesh) with the skin hydrogel layer. This second conductive gel layer has a relatively high peel strength that provides very good adhesion to the substrate.
- Textile electrodes
  Textile electrodes are up to now mainly developed for the recording and monitoring of biosignals.

Specialized electrodes:

- Iontophoretic Drug Delivery System is an intelligent, accurate iontophoresis delivery with SmartPower LED to provide visual feedback to clinicians and patients. It is a disposable, single use, non-invasive drug delivery system that utilizes an intelligent microprocessor to deliver 40 or 80mA min dosage of a negatively-charged ionic solution. The self contained and fully integrated SmartPower system functions without a charging station or dose controller.
- Bilt-Rite Conductive Fabric Glove takes the place of traditional adhesive electrodes when used in conjunction with an electrical stimulation device such as TENS or HVPS. It provides even stimulation to the entire hand. Conductive Fabric Glove is used to treat sports injuries, repetitive strain disorder and/or post-operative swelling in the hand.
- Biofeedback sEMG Triode Electrodes comes with standard 2cm circle spacing of silver chloride electrodes, backed with nickel plated brass snaps to prevent corrosion when connected to pre-amplifiers for extended periods.
- Covidien The Kendall Medi-Trace 700 Series Tape Electrodes are for general purpose adult monitoring of stress test, holter test and other diagnostic applications. The clear tape substrate allows for visual evaluation of patient skin. The hydrogel adhesive provides additional adhesion, leaves no messy residue to clean up and is designed to stay fresh up to 45 days out of the package.
- The large wings are designed to provide a bigger coverage area of pain relief for back, shoulder, and other large treatment areas. The iTENS will give you up to 24 hours of use per charge for continuous pain relief. The gel pads are good for 10-12 applications.
- Pencil Electrode Set is used for manual stimulation procedures where pin-point control is required. It has an on and off switch so that stimulation can be turned on and off. It requires a banana type connector to be plugged into the electrode cable set.
-

Electrode dimensions:

Great variation is found among electrode sizes, depending on the treatment technique and the current configuration:
- Equal sizes: For equal distribution of current.
- Differential sizes: For current shaping.
- Special instruments: For internal administration.

Large muscle groups like the knee extensors (quadriceps) are either stimulated with 10cm×5cm single electrodes or with several 5cm×5cm electrodes that are located over the four different muscle heads. For the stimulation of denervated muscles even larger electrodes are recommended to prevent too high current densities and risk of skin burns. On the other hand smaller electrodes are used when reflexes are elicited at afferent nerves, e.g. for the flexion reflex.

Array electrodes are also composed of multiple small electrode elements which can be individually activated to form a virtual electrode of arbitrary size and location [40]. However, there are no guidelines on how small the individual elements should be in order to achieve comfortable stimulation of deep nerves. Elements that are too small might not be effective on persons with thick fat layers because the large current spread within the fat layer prevents the current to reach the motor nerves laying deeper [41]. With FE modeling and simulations we could find an optimal electrode pad size of 0.8cm×0.8cm for the proximal arm when the fat thickness is less than 1cm.

Electrode tips:

- Alligator tip: For aluminum plate connections.
- Banana tip: For standard receptacles.
- Telephone tip: For pin-receptors.
- Snap tip: For button-type connections.

Securing devices:

These devices are needed to prevent movement of the electrodes during treatment. They have to be of an insulating material coverage to prevent current conduction on their surfaces.

- Soft-rubber sandbags.
- Lightweight sandbags.
- Adhesive tapes.
- Velcro bands.
- Adhesive gels.

Electrode gel

Our results indicated that that using electrode gel resistivities that are above the values of the skin resistivity (ρgel > 700Ωm) should be favored. Lower gel resistivities always resulted in a less homogeneous current distribution.

How long do electrode pads last?

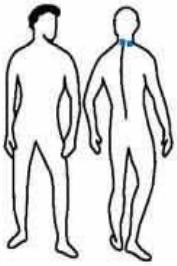
Usage of Electrodes or electrotherapy pads vary depending on skin condition, skin preparation, storage and climate. The effectiveness electrodes declines substantially with each successive use. Excessive use of electrodes (beyond 2-4 times) can decrease the effectiveness of the therapy.
What can be the limitations of electrodes? Overuse of electrodes can lead to skin irritations.
How should one take care of their electrotherapy pads? Clean the skin of any dirt or moisturizer before applying the electrotherapy pads to extend the life of the pads.

Why the electrode pads are not sticking?
Check that the protective plastic covering the pads has been removed. Electrode pads are water activated, dip your fingers into water and rub onto each pad. Stick the pads immediately to your skin while they are still wet.
Do electrotherapy pads sting?
The Electrotherapy pads must be moist and sticky to work. If not so, they will produce a weak and stinging sensation. Worn out pads may also produce a stinging sensation

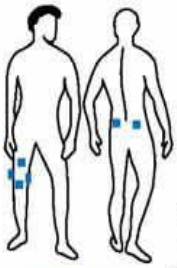
For the characterization of the electrode-skin interface we first should have a look at the skin and its layered structure. The skin consists of the epidermis and the dermis. It has a variable thickness from less than a millimeter at the eyelid up to more than a centimeter at the palm or foot. Some skin is hairy, some regions are especially sensitive, e.g. face and finger tips, and some are not (back, foot soles).

Where to place electrodes

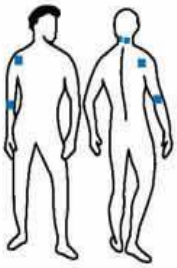
ELECTRODE PLACEMENT CHART



HEAD AND NECK PAIN

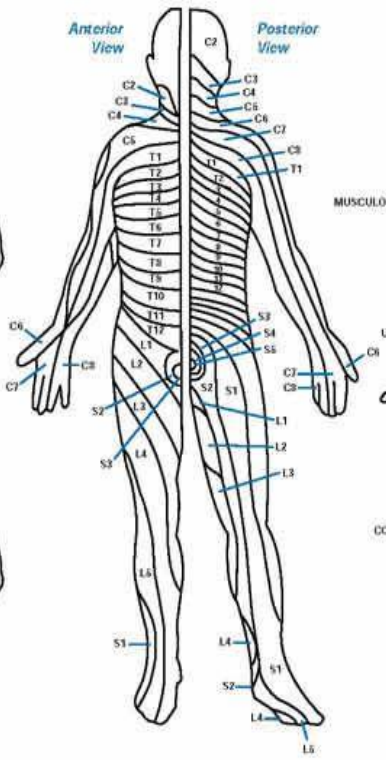


KNEE PAIN

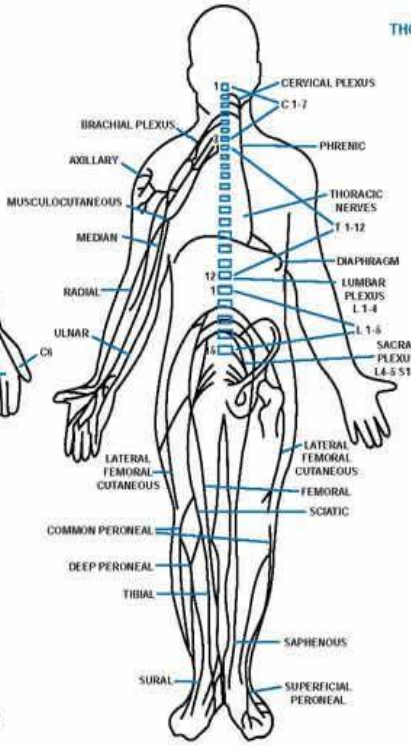


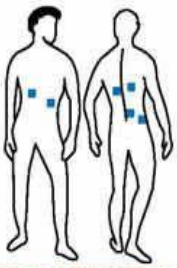
SHOULDER AND/OR ARM PAIN

DERMATOMES

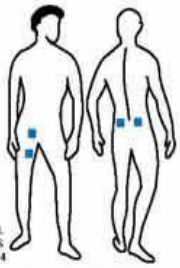


PERIPHERAL NERVOUS SYSTEM

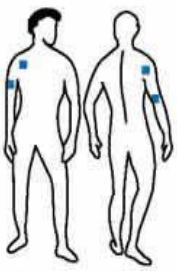




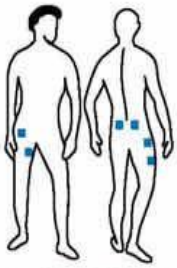
THORACIC OR INTERCOSTAL PAIN ALTERNATE USE BOTH CHANNELS



FEMORAL PAIN



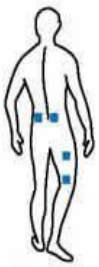
PHANTOM PAIN– UPPER EXTREMITIES



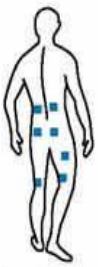
BACK WITH GROIN OR HIP PAIN

LOW BACK SACRAL OR COCCYGEAL PAIN

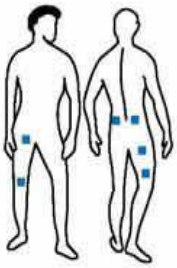
LOW BACK AND SCIATIC PAIN



UNILATERAL LOW BACK PAIN INTO SCIATIC NERVE DOWN LEG ALTERNATE



BILATERAL LOW BACK PAIN DOWN BOTH LOWER EXTREMITIES ALTERNATE



PHANTOM PAIN– LOWER EXTREMITIES

Commercial and Salon application

Professionalism

There are several basic and extremely important considerations in determining if electrical stimulation is indicated.

- Each patient is like an individual fingerprint in terms of his or her needs. A knowledgeable clinician or clinical team is required to determine candidacy for ES.
- There must be a very specific goal or expected outcome that will improve daily life in a way that can be objectively measured before ES is prescribed for a patient.
- While the benefits of ES for a particular application may be realized within a few days, often it is necessary to use ES for an extended period or even for the rest of the patient's life. For example, when ES is added to an exercise protocol to augment the return of muscle control, once the desired control has been achieved ES is no longer required. If, however, volitional control does not return to a useful level, continued ES may be necessary to support function. There are many instances when the withdrawal of ES would be detrimental to function and so it is continued on a daily basis. The expected time for use of ES as well as the responsibility to be borne by the patient and family must be understood by all parties.
- Effective ES is not a treatment that is provided only for a few minutes during clinical visits. If it is to be effective, ES must be available to the patient around the clock at home, school or work. For example, if the goal of ES is to gain wrist mobility after wrist fracture and removal of the cast, ES can be used at home several times a day with excellent results when compared to three clinical visits per week for four or more weeks. If ES is employed to help the patient relearn to exercise muscles after injury, ES can be used at home during every exercise session. When recovery of muscle function is insufficient, ES will be needed every day to substitute for the lack of voluntary muscle control. This may be true for the stroke patient with a subluxing shoulder or the brain injured patient who requires ES to keep the toes from dragging when taking a step.
- The majority of ES users will have sensation or the ability to feel the effects of the electrical current flow. ES must be comfortable if treatment is to be successful. Stimulation characteristics such as current type, waveform, pulse

duration, pulse repetition rate, intensity and modulation are critical issues in ES with skin as well as implanted electrodes.

- When involuntary muscle contraction results from stretching the muscle [called spasticity] and interferes with positioning or movement in disorders of the brain and spinal cord, ES may reduce the unwanted muscle contractions and unmask existing voluntary muscle control. THIS IS AN EXTREMELY IMPORTANT CONCEPT. ES may reduce interfering spasticity WITHOUT causing weakness or paralysis of the muscles required for function. A trial of ES is warranted prior to instituting chemical, drug or surgical measures that may reduce spasticity but paralyze the muscles. When ES alone does not adequately reduce interfering spasticity, a combined strategy may be effective with lower doses of medication or less aggressive surgical intervention.
- ES is most often integrated into a rehabilitation plan, as one component of treatment. While it may speed up the rehabilitation process, reduce the number of clinical visits, reduce cost and increase the expected outcomes, it is seldom a "stand-alone" intervention.
- Although the cost of ES will vary from one application to another, cutaneous or skin electrode systems are relatively inexpensive. Rental or lease options bring the cost down to the equivalent of 1 or 2 clinical visits per month.
- Knowledgeable clinicians [physicians and physical therapists] in any treatment setting can guide the patient in obtaining and using appropriate ES devices.
- Sophisticated, surgically implanted ES technology, such as that designed to give the high quadriplegic patient hand function or to give the spinal cord injury patient control of the bladder and bowel, can be expected to cost substantially more. These systems are provided at specialized centers in a few countries around the world.

Practical, functional applications of electrical stimulation are described for each of the following disabilities. The information will give the patient, family, clinician and third party payer general information designed to facilitate discussion between patients and medical caregivers and to enhance understanding by insurance carriers and other agencies that are responsible for allocation of health care resources. It must be recognized that these are general guidelines and that each patient will need to consult with their medical caregivers about their specific treatment options. Selected references are provided for further reading.

Salon

Opening a business is the beginning of a long road to success. I have collected the opinion and advises of worldwide entrepreneurs who founded a small and developed a bigger business. They became successful by implanting strategic ways of commerce. These are suggestions that may work in your case. Read and take what suits you and share with others.

- Offer Online Booking system
    - Managing calls and emails from clients wanting to book appointments can be complicated and take up a lot of your time.
- Have a selfie station inside your hair salon.
    - Everybody is all about social media and exposure, create a small area in front of your company logo and have the clients snap photos and share all over social media. Free advertising/marketing for sure! Also put a sticker in the mirror with your own hashtag.
- Create a salon-friendly website.
    - Having a great website is what your customers expect.
- Announce a Birthday Discount with an Automated Email Campaign
    - When a customer signs up to receive your email communications, try to convince them to enter basic contact information, including their birthday. When their birthday arrives each year, send a customizable birthday incentive to invite them to the salon. Use a discount, free product, service or small gift.
- Reward customers for referrals.
    - Give customers a bonus for doing your advertising for free and sending new clients your way
- Create a Customer Loyalty Program
    - Offer exclusive benefits and loyalty rewards to special customers.
- Select Your Own “Influencers” & Offer Special Incentives for their Referrals
    - carefully select your “influencers,” who might have jobs that connect them with a lot of people in the community, or they want to represent your work.
- Have a mobile app for booking services.
    - It is possible to connect to a larger network provider and get your own booking space
- Market yourself on Instagram using professional photos.
    - Instagram is one of your best tools when it comes to marketing. Put all of your relevant hashtags in a comment below the picture. Use the best time to post, experiment with captions that work best, and watch clients begin engaging with you!
- Add value instead of discounting.
    - The aim is your client to love the results that they will pay for the same treatment on their next visit.
- Run specials during the holiday season.
    - Special events, holiday parties, and family reunions are reasons why consumers need salon and spa services.
- Partner with different establishments around your area.
    - Photo studios and gyms are your friends and most are open to cross-promotions.
- Extend your salon hours to cater to night owls.
    - The trendy spa keeps with the late-night feel by offering clients a glass of wine with their service.
- Be your own model customer

    - The way you look, show health and appear in front of the customer tells them how important they are and how valuable your work is.
- Have a local publication feature your business.
    - The feature article may detail how you began in the business, your expertise, past employment before striking out as an entrepreneur, what you offer than no one else does and/or do best, offer testimonials from your clients (if they have name recognition/“celebrity” status, that’s even better) and promote your namesake product line.
- Don’t forget traditional advertising
    - Even if social media and internet advertising seem to be the most important part in life these days, traditional advertising tools have relevance. A mix of advertising represents the best opportunity to generate awareness and preferences for what you have to offer.
- Find a factory and/or wholesaler to make your products
    - Cultivating a brand identity should include being realistic about your product and providing service.
- Keep an eye on competitor activity
    - Part of your customer research should be an awareness of what’s missing for local consumers.
- Customer research can be done through social media.
    - Twitter advised interacting with people who offer a similar service to you. This helps build contacts, and keeps you in tune with the voice your competitors are projecting on social media. Instagram shows what they put on display. Facebook give inside on what people share and LinkedIn is what they like to express on a business level.
- Running a small business is not a nine to five job.
    - You need to be continually reassessing your business model and direction. Put yourself in your customers’ shoes and ask if you are offering what your market wants
- It is important to be aware of the trends covered by the media,
    - Always stay true to your venture.
- Skin care isn't just about the face.
    - Skin care starts with the face ends at your nipples.
- The most boring product is the most important.
    - Part of becoming a successful grown-up is solidifying healthy daily habits, however minor and boring they may seem to be. Basic products are always needed.
- Bedtime is when all the beauty happens.
    - Good sleep after treatment but also on a daily scale keeps the body fit. Ask customers on their sleep habits and if able assist with finding a solution for possible problems.
- Choose A Niche
    - Choose your area of specialty in which you have some
- Develop A Marketing Plan
    - A marketing plan gives you a direction about how to move forward in a calculated way at the time of selling your products to the people. Your well thought of strategy regarding pricing, costs and an effective way to sell your cosmetics items will guide you during your efforts to enhance your reach in the niche market.
- Test Your Products

    - Before you start selling your products, test those unique items. Having a practical test of the products is always desirable to know beforehand about how rest of the people and your target audience will respond.
- Get Opinions And Improve
    - Get opinions from experts of your field and make necessary improvements.
- Create a profitable front desk.
    - Train your staff to re-book clients for their next session. Teach your front desk what services to cross-sell and up-sell.
- Develop a relationship.
    - Developing a long term relationship with a client will undeniably help make a connection and win you a 'lifetime' guest who will also recommend your product.
- Be price savvy.
    - Price your services and products too low, and you'll lose money. Price them too high, and you'll lose clients. Be concise about your pricing.
- Display testimonials.
    - Have a few testimonials from satisfied clients displayed in your salon. Print it, frame it, and display it visibly to clients.
- Google Adwords.
    - This concept is simple. People search for salons on Google, in your local market, and you pay for them to click on your ad. They head over to your website, and fill out a contact form or call you. That's a lead.
- Start a blog.
    - If you don't have one, set one up. If you do, continue writing quality content for your readers. It will pay off in the long run. Content marketing is one of the best ways to convert new clients.
- Contribute to top salon blogs.
    - Write guest posts on popular salon publications. Should they accept your content piece, you'll enjoy free traffic to your website and coverage for your brand.
- Publish a case study.
    - Conduct a survey or research that's relevant to the salon industry. Show that you are a leader by evoking discussion.
- Get links to your website.
    - One of the best ways to rise through the ranks on Google is to get other related businesses or blogs to link back to your site.
- Create something viral.
    - It may not be easy, but if your image, video, or story is share-worthy, you could have the next cooL thing skyrocket your salon's exposure.
- Create a video.
    - Educating through video marketing is one of the best ways to get views on websites like YouTube. You get free traffic and a chance to convert new business if the viewer loves your video content!
- Host a webinar.
    - Similar to a workshop, a webinar is simply hosted online and will help educate your clients about what's right for them. For example, you could host a webinar about the right type of product for every hair style.
- Keep educating yourself.

    - Partner up with local colleges or other establishments to show the public how your business can be of benefit. Offer special discounts to college students (often an untapped market).
- Learn from the best.
    - Follow successful industry leaders and try to procure their skills and accomplishments. They must be doing some things right that you can put to use at your salon.
- Devote a day to prospecting.
    - All the individuals who opened your marketing email, commented on your blog, or interacted with you on LinkedIn…send them a personal message. They will appreciate the special attention.
- Address their life goals.
    - Many clients may be worried about retirement. Why not set up a program where a guest gets a certain percentage off their service? The proceeds would be sent to their retirement brokerage! Just a fresh idea.
- Draft a brochure that's direct.
    - You want to be personal with the message on your brochure, but remain direct and persuasive. Market yourself to new clients with an eye-catching pamphlet.
- Send appointment confirmations.
    - Sending a confirmation to your client as a reminder can avoid several missed appointments.
- Last minute appointments.
    - Is your schedule not completely full for some AM spots? Fill in the gaps by sending out e-mails for discounted appointments.
- Timed reminders.
    - Is your client due back in to book their next color treatment after 5 weeks? Send them a reminder. What about clients who haven't been in to your salons in 3 months? Send them a 'we miss you' incentive.
- SMS messaging.
    - Have your salon software send clients a text message with your daily or weekly promotion. This is underrated and can be really effective. Just collect the client's phone number and send a special offer.
- Send out a survey.
    - Do you want an easy way to get some feedback? Send out all your guests for the day or the week a survey request to see how your salon is doing.
- Gift certificate promotions.
    - Send your clients a reminder about your latest gift card incentive…something as simple as; buy a $100 gift card for a friend or family member, get a $20 gift card for yourself!
- Geotargeted Ads
    - Whether you utilize Facebook or AdWords, geotargeted ads should be your best friend. You don't want to be fielding appointment requests from a client in California when your salon is in New York! Need help setting it up? We have great guides on AdWords and Facebook targeting options.
- Mobile Ads
    - Like geo targeting, mobile ads can be hugely beneficial—especially with AdWords new bidding features that allows users to bid differently on desktop and mobile.

- Show off your Skilled Staff
    - I love sitting in the waiting area at a salon and looking at magazines for ideas. I also love being able to point to any picture and know my stylist can get it done! Instead of placing magazines on the table, try creating a binder of styles and cuts that your own staff has completed—maybe a collection of shots from your Instagram!
- Post Coupons Locally
    - When I was in high school, we received daily planners at the beginning of the year with a schedule for the year and various coupons from local businesses strategically placed throughout the planner. Every year, all the boys rented tuxes for prom from the same place, and all the girls got the hair and nails done at the same local salon (there were two locations, but still a huge crowd). It's a great way to capitalize on a big money-making event—and get involved in your community!
- Carry Business Cards
    - Salon Marketing 101: be your own greatest advertisement. Ever have a stranger compliment your hair or nails on the subway or while shopping? Not only is it flattering, it is the perfect opportunity to say, "Thank you! I did it myself, here is my business card if you're interested in the same treatment!"
- Host Parties
    - This might be the most fun salon marketing tip! Hosting pamper parties; for charity, for a birthday or bachelorette; can be a great opportunity to bond with your clients and get the word out about your salon.

Treatment center & Exercise facility

Besides the above mentioned marketing tips & tools there is more to do for a treatment center. Here we separate "treatment center" in two major category:

- Treatment center which is focused on pain, injury, mobilization, customer/treatment interaction (tDTC), sexual problems,
- Assist center, here is the focus on sport and muscular activities, recuperation, physical improvement, mobility improvement,

Both have a different and in some aspects overlapping target group. But both also have a strong common feature which is: customer interaction.
Service is the key factor in both cases. Knowledge is important but having a practical experience and knowing how to apply this into customer treatment has high priority.

From my research, visiting many centers and take part in treatments and exercises, it is clear that most employee in the current industry have neither knowledge nor connected experience. This leads to serious mistakes and misjudgment in different situations. Working in this segment of semi-healthcare practice has a high responsibility factor for employee, manager and company. This responsibility can have far reaching consequences when something goes wrong and customers complain.

The additional (see Salon chapter) information for this specific segment of our work is:
Five tips on messaging your information to (potential) customers

1. **Look Within Yourself**. Carefully consider what makes your center special. What is your purpose? Why are you here? How does your treatment fit into the bigger picture? Does it at all resemble the story you are telling today? This is all related to your work consciousness. The awareness of what and how you do things every day. It is your personal view on life and work.

2. **Tell the Truth**. Liars are not only lying about their centers, they're lying about everything else. Many competitors are liars. And they do not need to be the small players. As you construct your brand story, you have to rise above this deception by committing to a truthful articulation of your treatment protocol, success rates, insurance disposition, even your location. The truth is the easiest way to compete with a lie. Lies always change, facts and reality hardly ever do.

3. **Write for Humans Not Algorithms**. You just know when a website has been written for search engines rather than people. The text sounds awkward. Write the way you would write a business letter. Google rewards credibility and authenticity.

4. **One Size Fits One.** Your prospects are potential patients, family members, professional referents and others. It's critical that you know not only who they are, but also what they need, want and expect. Try to envision what day-in-the-life of each looks like. Because this differs for each audience, you'll need to develop a segmentation strategy as you send your message into the market.

5. **Listen and Learn.** Once you think you have developed your unique brand position, share it. Get reaction and feedback from those in your organization that you trust, whether they be clinicians, medical staff, marketing and admissions employees, or techs. Listen to their feedback and take from it what you believe strengthen what you have. Gaining buy-in from those who could be customer-facing is invaluable.

Word of Mouth Marketing

Nothing beats good, old-fashioned word of mouth marketing (WOMM). Why? Because customers trust the opinion and experiences of others over a commercial, or a social media post. Have you ever heard the old business saying, "A happy customer will tell 3 people about their experience, and a mad customer will tell 10"? Word of mouth has always been one of the strongest marketing tactics.

Today, word of mouth marketing also includes:

- Online customer reviews on websites and industry related sites.
- Social media posts and testimonials from clients and their family members
- Press, both positive and negative

While it is difficult to dedicate and track funding to word of mouth marketing, you can budget funds for the marketing tactics that help facilitate it.

Client Success Stories: The Ultimate First Impression

Capturing client success stories is a great way to gain a positive first impression. Most of us have witnessed amazing examples of our residents overcoming obstacles and achieving the impossible. When we fail to capture and glorify this success and share it with the public, we are doing an injustice to our industry as a whole.

There is an enormous amount of healing, restoration and vitality within our walls. Let the world see and hear this success on your website, newspaper, billboard and other media outlets. Word of mouth is still the best and most cost effective way to advertise.

Therapy should be working together with your marketing department to capture testimonies and success stories. Certificates of achievement or graduation, pictures, graduation parties or case studies are just a few of the many ways therapy can get involved in highlighting success.

Strategic Partnerships

Your online marketing and content marketing efforts will position you as the go-to resource and authority. With this in mind, you'll have more opportunities to forge strategic partnerships with advantageous organizations and companies within the industry.

Creating Quality Content

No matter what form of marketing you choose to pursue for your center, you need to have quality content available. Investing in content creation, execution, and distribution is one of the smartest marketing decisions you can make for your treatment center.

You aren't limited to blogs and articles. Utilize different content types such as:

- eBooks, Whitepapers, and Research
- Videos
- Presentations
- Imagery and Infographics
- How-To Guides
- Print Marketing Materials
- Press Releases
- Email Newsletters

Sell Your Therapy Team!

Marketing representatives should not only be able to effectively talk about treatment, but be able to hone in on the specifics of your unique program. Train Marketing staff to include these talking points in their information. Know what the therapy equipment does and be able to list examples of conditions that would most likely benefit. Know and understand what skills your team members bring to your "clinical table" so that you can effectively market this to your community. Do they use **evidence-based practices** or have specialized? How many cases did your therapy team treat this last year? What were the results? Knowing this information does several things.

- Instills confidence in the care that the public receives when they walk in to your building
- Positions your community as a trusted community partner being the provider in the area.
- Builds rapport with Physician/Hospitals to generate referrals

Develop personal videos that foster comfort and trust

When it comes to clients searching for an treatment centers, comfort and trust are often more important to clients than rates and name recognition. With Video Marketing strategy, you can personally introduce yourself and your office online, and put potential clients at ease before they walk into your center.

Social Media Videos (Facebook, Twitter, LinkedIn)

Every professional center needs to take advantage of Social Media for promoting their center. People surf the web on their phones searching for centers that specialize in specific types of treatment — and video is a tremendous part of that! By combining assistance and content on sites like Twitter and Facebook, your center generate trust, and reach a high social stature.

Using Social Marketing videos is a great tool to boost your practice's social media presence. Did you know social media conversions, when implementing video, increase followers by 65%?

Soft Sell More as a Marketing Technique
By making your posts on social media personal and casual, you are able to effectively soft sell other products that your center might carry. This kind of social soft selling or publishing success stories of a control group that agreed to test the product for you, soft sell in a way that makes people want to buy what you're selling, increasing revenue.
Over Deliver on Your Fitness Promises
When you send emails, text messages or other messages, try to make sure that you're being as personal as you can be without sending everyone individual messages. Take time to reply when people respond to your marketing with questions. Talk to everyone possible, not only your clients. By always going the extra mile, and by ensuring that you're treating everyone like people and not just income, you'll make much more loyal customers. If they feel important and listened to, they're likely to recommend you going forward. Personalization is important, and can be done through the use of merge tags in your emails that automatically grab the customer's name or other information and pull it into the message.

Walk Your Talk and Show it in Your Online Fitness Marketing
As a expert you are a walking, talking billboard for your business. That implies that your lifestyle choices and reputation affect your company or the company that you work for. If you're not in shape or unable your clients take note. In other words, if you don't look the part, and you don't show them that you can put in the work, they aren't going to be motivated. Show them that you can deliver the results they paid for. You need to show them in your marketing that you live the life you promote as well, be it in video advertising or just in images on your site. If they see that your strategies work for you, they'll want to share in that success.

Provide Meal Plans
One of the most difficult aspects of having a healthy lifestyle is nutrition! You know food is a constant battle of customers so provide them a helping hand with meal plans!
A big problem with eating healthy is that most people don’t know what to eat or how to make “healthy” food taste good. Nutrition is one of the hardest thing for people to master. By providing a meal plan keeps your customers happy. They feel like you’re going the extra mile, working harder to make sure they are seeing the results they want.

Influencer marketing
Instagram, Twitter, YouTube and Facebook have produced a new category of celebrity - the influencer. These people may not be on primetime TV or on magazine covers, but they have millions of dedicated followers, eager to see their next update. One tweet or mention of your company on Instagram from the right influencer could be all it takes to super-charge your business.

Attend Local Meetups And Events
As great as social media is, never forget about real personal connections. Search for local events and go and attend. Or hold an event to speak on a topic in front of an audience and at the end offer to book people for transformation sessions.

Offer a Free Transformation Session
Think about the outcome that your prospects want: It’s transformation. Instead of offering a "free consultation" reposition the free initial session you offer as a free transformation session. In this session, you assess prospects, put them through a treatment and then have a powerful conversation to close the deal.

Be Yourself, Show Vulnerability

In a world that worships the "perfect body" and the "perfect life," people are looking for those who they can connect with. One of the best things you can do is open up to your audience on social media in a genuine way that connects you with them. This is connective, genuine marketing. What you find is that people start naturally messaging you, and then if the opportunity is right, you can sign them up as a client.

The key to growing a successful fitness business is consistency, action and the ability to use your creativity to follow through on those ideas that come up. If you simply apply a few of these strategies you'll notice some big changes — not just in your income, but in terms of your impact, too. Be willing to test new things constantly and be willing to try and fail. Have the confidence to get in front as many people as you can with your message, add value and then convert them into clients. Be as confident in your business.

Encourage staff and member interaction

Encouraging staff to interact with members on a consistent basis is not easy. It takes time and patience to realize this culture in your center but the rewards were definitely worth the effort. One piece of advice à Don't hire introverts if you want your staff to interact with members! Members love feeling like they are part of a center and staff interaction is a key to ensure they feel connected. Here are some tips that can be easily implemented straight away:

1. Train your reception staff to greet and farewell each member by name.
2. Center staff need to be trained to greet customers by name as they come in the door and engage in conversation. Customers need to feel supported with their programs and not alone. Center staff need to be involved with programs, assessments, encourage variety with training and keep customers motivated.
3. Introducing new customers to other staff and current customers is a great way to make a new customer feel more comfortable. Involve the new customer in conversation so they don't feel isolated and take interest in their progress, especially as they are starting out.

EXIT survey for cancelled/ready customers

The treatment industry has a high turnover of customers. The majority of centers lose 50 to 100 members per month and gain 50 to 100 new customers per month. A small percentage of centers survey their customers when they cancel. This is a simple process and can provide some valuable information about customer satisfaction, staff performance and facilities. The survey can be completed as the customer fills out the cancellation form. Some customers won't fill it out but many will.

The form can include the following questions:

1. How long have you been a customer?
2. Reason for cancelling? (moving house, changing gyms, can't afford it, not enough time, family, etc)
3. How would you rate the staff? (include categories for knowledge, friendliness, approachability, availability, etc and rate 1 to 5)
4. How would you rate the facilities? (cleanliness, range of equipment, space, car park, etc and rate 1 to 5)
5. Any other comments or feedback?

Each week go through the comments and take the feedback on board. Customers often see things from a different perspective and highlight areas that you can improve. Making simple changes and improvements can have a big impact on client retention.

Tap into customer pain points
There are definitely some cornerstones to keep in mind for effective campaigns and lead generation that are the difference between wasting a whole bunch of money and time, and actually getting the results you want .
The secret: Get in the shoes of the customer! Using this strategy makes the customer feel as though you understand them and their journey ! People don't buy from you unless they trust you, and if they see that you understand them, that immediately creates a sense of trust that is very valuable to you as a marketer.

How to benefit from investment

Investing in Electro Stimulation is a challenge and can work out profitable if you exactly know what you are doing. Many physiotherapist did buy different ES products but finally gave up using them, wasting a lot of money. Why did they gave up?

1. Lack of knowledge. While it is expected of physiotherapist to study the products they buy, facts proof the contrary. Most did buy the products for easy gain and use. Some did open the manual but most did not even do that.
2. Not combining methods. Electro stimulation is a part of a complete treatment and not an independent treatment only. Each ES product must be built in a program.
3. To high expectation. Many physiotherapist did, and most still do, expect miracles of machines. Expectations of results are again and again to high.
4. Not innovative. Like many healthcare workers they follow existing methods even when they experience no results. There is a frequent lack of developing innovative methods.

Writing these negative statements is not what I like to do. Fact is that due to these developments millions of investment went down the drain and good products hardly used. On the other hand some did take their time and did study the possibilities, had innovative ideas, did combine different methods and developed new treatments. These therapist were successful and got full gains of their products. They had the needed "returns on investment"(ROI). The relative cheap ES products made ROI's of thousands of percent's. The profitability of ES products is extremely high compared to the investment, but you have to spend time knowing the machines as well as the application.
Some business ideas that makes the profit are:

- Pain reducing. Many people suffer from pain. These pains have different sources. Using different methods of pain reducing on a physical, mental and electro way helps the sufferer to make life better. It is the combination of treatments that gives best results.
- Maximizing muscle efficiency. Using EMS to strengthen muscles, improve endurance and speed are implemented all over the world in top sport. It can be adjusted to suit every sports person to an individual level.
- Improving brain power. Concentration, better focus and a more clear mind are some of the benefits people get from the right brain stimulation. Used in combination with physical exercises it is even more effective.
- Improving Range of Motion (ROM). Many people have problems with joints and decrease the movement without considering the long term results. Consulting customers at least once a year on a physical test for ROM of different parts of the body is one idea. Helping to improve the current ROM in another.

- Using ES as part of physical testing. An increasing amount of people wish to have a yearly test of physical condition. ES can be a part of the process.

A very profitable way of working with ES products is the Station / Portable rent out. TENS is particularly of interest. Many people who suffer of pain problems wish to have maximum control over their pain control. Placing a fixed station at home and a portable for when people are on the move for a monthly rent fee is a good option. Customers rent the machines on contract for periods of months or even years. This delivers a regular income for the therapist. Renting out comes as a part of a package deal.

EMS devices are useful to rent out as part of a sports or exercise improvement program. At a gym or therapy center the devices are tested and a program set up. The program is made for weeks or months with a 2 or 3 weeks result test. The EMS can be portable 4 / 6 / 8 channels. Also this rent away is part of a package deal.

tDCT can be used for homework improvement. It is delivered as a program of concentration, focus and relaxation. Beside the brain stimulation, lights and sounds can be used for maximizing the result. The real work is done in a controlled situation while light stimulation can be used in a home combination package. Again this is a package deal.
Sexual stimulation devices are hardly used in therapy but are an amazing option. Be aware to have strong knowledge about the topic before starting. The customer must receive clear and detailed instructions. Electrodes are sold but the machines can be rented out. These products can be rented on a day to day basis or for a week. Products come with instructions and products as gels, electrodes and cleaners.

The combination of fixed standalone machines in the treatment center or fixed at homes and portable devices, package deals on treatment, ReDox supply and an open advice line can deliver high profits for the right treatment center.

Portable devices

All Electro Stimulation come in standalone fixed devices and portable products. Due to the very low need of energy it is possible to use batteries in all portable products. In the past only battery versions did enter the market. Some factories have invented their product for the use of more environment friendly rechargeable batteries.

Portable versions are very useful for TENS and EMS versions. The new Microcurrent models can be used as portable devices. Most ES products come in pocket or portable size. It all depends on the right instructions, programs, advise and control to make it work.
The advantages of portable products are the price and the opportunity to rent them away. Renting brings a connection, continuation of visits, customer loyalty and often additional sales. Consider extra electrodes, pads, gel, batteries and straps as products for sale. All these go with a profit.

Smart phone APP devices

Using an app on your mobile phone you can initiate and control your workouts. All you do is select the muscle groups you want to target and an impulse is sent to the pods that causes your muscles to activate. An application downloadable to a mobile device is provided for facilitating muscle therapy, the applicable programmed and configurable to generate

waveform signals, the waveform signals configured to be employed by a power circuit to generate energy, conforming to the signals, to a muscle pad. The application may be combined as a system with a muscle pad electrically interfacing with the downloadable application, as well as a discrete device in electrical communication with the mobile device and the muscle pad. A power circuit and a muscle metric feedback circuit are contemplated as part of embodiments of a system or kit.

Benefits:
• Compact, lightweight and portable
• Controlled by your Smart Phone
• Minimal wiring and multiple sets of electropads
• Reduces muscular tension
• Stimulates blood circulation
• Speeds up recovery
• Improves endurance and explosiveness
• Reduces common injury risks from training

Stand alone

A standalone is the home station of ES products. Compared to the portable it has a bigger size, often comes with more possibilities such as channels, is able to deliver higher powers and is more stable in current and frequency.

Standalone is used in a treatment center but also at home. We use a standalone as rent-out for continue treatment such as pain. TENS is a good sample when used for night pain treatment in bed. The wires of the TENS are strapped to the different ligaments for maximum flexibility. Standalone devices are also used in specific physiotherapy treatments or in a Salon where masks and longer term use is needed. Working with a standalone is easier as the screen display is easy to read, the buttons better to manipulate and the wires longer.

There are new developments on the way where portable and standalone devices become connected and distance control is possible. Different day to day treatment options become possible.

The use of Iontophoresis needs standalone for the application for main doses treatment. Portable options are not yet available but they would become optional if the treatment does supply maintenance doses with special prepared electrodes. Customer receives this electrodes from pharmacy of therapist.

Professional application

Healthcare professionals as surgeons are using Electro Stimulation in combination with different implantations. These samples are for review only and we do not promote the use by not certified medical workers.

Brain implants
Implants in the brain are used to (de) activate different functions. There are many ways an electrode (probe) is inserted in the brain. Some probes are to monitor functions and become

active when needed. These are programmed electrodes or receive instructions from elsewhere. The electro stimulation is precise, individual and temporary.

This is a risky operation as the brain is that the brain is also very resistant to intrusion. One function of the microglia when activated is to cluster around foreign bodies and degrade them enzymatically. It has been proposed that when the foreign body cannot be degraded, as in the case of implanted electrodes whose material composition is resistant to such enzymatic dissolution, this 'frustrated phagocytosis' contributes to the failure of recordings, releasing necrotic substances into the immediate vicinity and contributing to cell death around the electrode

Electric Stimulation of Healing Bone

In most cases of fracture healing, electrical simulation is performed through a process called capacitive coupling. In this process, two skin electrodes are placed on either side of the broken bone, and a low voltage battery passes a small current between the electrodes. The patient cannot feel the current, but it does have an effect on the bone cells.
The most notable effect is that this type of electrical stimulation seems to cause bone cells to proliferate. There are other cellular effects of electrical currents on the broken bone, but by stimulating bone cells to divide, healing of bone is accelerated. The skin electrodes are worn at all times, and the battery is changed regularly.

Faster Bone Growth?
Bone healing from capacitive coupling has been shown to be faster in patients who have nonunions (non-healing bones) or patients who have difficult to heal fractures, such as scaphoid fractures. Electrical stimulation has not been shown to be helpful in uncomplicated fracture healing.

Bottom Line
Electrical stimulation is a reasonable option for patients who have bone healing problems, or fractures that have poor healing potential. It is probably not helpful in healing of most fractures.

Medicine delivery (Nano)

Iontophoresis

Iontophoresis is based on the activity of "ions", biological charged particles – water-soluble substances that have a positive or negative charge – and based on the principle that like charges repel and unlike charges attract. By using a direct (**galvanic**) current, an ion can be 'pushed' into the skin if the electrode (the active or working electrode) on which it is applied has the same charge as the ion. A positive ion (cation) is pushed into the skin by a positive electrode (anode) and a negative ion (anion) by a negative electrode (cathode).

Electrodes come in a variety of forms including balls, rollers, disks and full face masks. When using a direct current, another electrode (the passive, indifferent or return electrode) is required to complete the electrical circuit and get a current flow. One or two electrodes are filled with a solution containing an active ingredient and a solvent.

The **positively charged electrode**, called the **anode**, will **repel a positively charged chemical** into the skin.
The **negatively charged electrode**, called the **cathode**, will **repel a negatively charged chemical** into the skin.

Eelectromotive drug administration (EMDA) is the name used for applications to delivers a medicine or other chemical through the skin. It is a non-invasive way to administer medications through the skin. It is different from dermal patches, which do not rely on an electric field. It drives a charged substance, usually a medication or bioactive agent, transdermally by repeating electromotive force, through the skin. IONTOPHORESIS is NOT the same as PHONOPHORESIS which involves driving ions across the skin with therapeutic ultrasound.

Reverse iontophoresis is a technique by which molecules are removed from within the body. The negative charge of the skin at buffered pH causes it to be permselective to cations such as sodium and potassium ions, allowing iontophoresis which causes electroosmosis, solvent flow towards the anode. Electroosmosis then causes electrophoresis, by which neutral molecules, including glucose, are transported across the skin. This is currently being used in such devices as the GlucoWatch, which allows for blood glucose detection across skin layers.

In order to 'drive' ions into the skin tissues, a **DIRECT (Galvanic) CURRENT** is employed. The duration of a treatment is individual dependent but the current need to be monophasic in nature, a pulsed application can be used. Continuous (classic) DC is most commonly used in practice.

The substance to be driven into the tissues NEEDS to be IONIC in nature, and should be placed under the electrode with the equal charge i.e. positively charged ions placed under the positive electrode (anode) and the reverse for a negatively charged ion.

The ions are driven into the skin via the pores - hair follicles, sweat gland ducts - rather than through the stratum corneum per se (the stratum has a high resistance, limiting any current to pass through it - the ducts have a lower resistance, which allow higher passage of current, and makes this a route of preference). It depends on the goal of treatment/use which ionic substance is chosen. Enclosed table shows a series of most used substances. The application of substances may vary per therapist and treatment.

Ionic Penetration
It is considered that penetration of the ions into the skin tissues is less than 1mm. Deeper penetration is likely to due to local capillary circulation effects. There is no evidence that the current itself is responsible for penetrations beyond this level. It is possible that different ions travel varying distances into the tissues, there is not a 'set' penetration equal for all substances.

Redox reaction. It is important to use redox salts for the solution to maximize the effect of the treatment. The redox salts assist to improve ion transportation in the solution and into the dermis faster and deeper.

Acid / Alkaline Reactions
While employing the use of several chemicals it is possible to get **ACID** accumulation under the **POSITIVE** (anode) electrode (weak HYDROCHLORIC ACID) because the negatively charged chloride ions (Cl- from NaCl) will transit towards the anode.

On the other side there is an **ALKALINE** accumulation under the **NEGATIVE** (cathode) electrode (SODIUM HYDROXIDE) because the positively charged sodium ions (Na+ from NaCl) move towards

the cathode. The Na+ ions react with water to form sodium hydroxide (NaOH). The chemical reaction at the negative (cathode) electrode could improve a softening of the skin.

A reactive hyperemia is observable under BOTH electrodes due to (chemically mediated) local vasodilation.

The magnitude of the local reaction (independent of the ions utilized) depends on :

- Current Intensity (more current, greater reaction)
- Time (longer time, stronger reaction)
- Tissue Resistance (greater resistance, stronger reaction)

The evidence is collected by Belanger (2010) who concludes that based on the available evidence (e.g. Banga et al, 1998 and Anderson et al, 2003) the penetration of ions is highest in the region of the pores, and the substance is most likely deposited below the stratum corneum, acting as a depot. Onward migration of the substance to the deeper tissues is achieved by diffusion rather than being 'driven' deeper by the applied current.

Iontophoretic ingredients used in salon treatments today include such products as vitamins, minerals, collagen, elastin, amino acids, hyaluronic acid and a range of animal and plant extracts pre-prepared in a variety of forms, e.g. gels, serums, ampoules, etc. Therapists are provided with little or no information on how these products may be active. They are told that the skin condition on which they are applied and the polarity of the electrode to be used will improve. With many ingredients in skin creams, it is doubtful whether some of these substances could penetrate the skin, whether an electric current is used or not, neither they would be effective.

Figure ; Anodal and Cathodal Reactions in response to Iontophoresis

Cathode	Anode
NEGATIVE electrode	POSITIVE electrode
Attraction of +ve ions	Attraction of -ve ions
Alkaline reaction by the formation of NaOH	Acid reaction by the formation of HCl
Increased density of proteins	Decreased density of proteins
Increased nerve excitability via a depolarisation effect	Decreased nerve excitability via a hyperpolarisation effect (sometimes called anode blockade)

Optimal Current Variables used in Iontophoresis (after Rothstein et al, 1998)

Current Type	DC
Current Amplitude	1.0 - 4.0 mA
Treatment Duration	20 - 40 minutes
Total Current delivered	40-80mA/min

There are some authors who identify very specific substance concentrations, volumes, electrode sizes, current intensity and treatment duration (the critical parameters for an iontophoresis treatment). Others provide general guidance, saying that it is not possible to be specific for a particular patients with a particular clinical presentation. The reality is that everything is based on the individual reactions and physical properties. There are guidelines as given in this book but all need to be tested and adjusted on individual basis.

Polarity, Current Intensity and Drug Concentrations
In general terms, low current intensities appear to achieve good results. The treatment is usually applied with currents up to 5mA and low ionic concentrations – up to 5%, it is also possible to increase current intensity up to higher levels and employ 'stronger' substance concentrations. Treatment times are typically in the 20 - 40 minute range.

There is evidence to suggest that using a higher concentration of the substance does not increase the effectiveness of the therapy, and does not increase the amount of the drug delivered to the tissues - low concentrations of drug (or substance) (typically 2-5%) and a low current intensity (up to 5mA) appears to be the most effective delivery method.

It has commonly accepted that the NEGATIVE electrode is made larger (relative to the positive electrode) to avoid skin irritation (whether the ionic driving electrode or not). It is suggested that the negative (cathode) electrode should be 2 x larger than the positive (anode) electrode.

Current Density
The current density (how strong and concentrated the current is), is measured in mA/cm2, which is an important factor in these treatments. If the current density reaches too high a level, tissue damage, and especially skin burn, may occur. It is advised (Belanger, 2010), that a current density of not higher than 0.5mA/cm2 is applicable at the negative(cathode) electrode and 1.0mA/cm2 at the positive(anodal) electrode.

If a current of 2mA is delivered using an electrode of 6cm2, the current density is 2(mA)/6(cm2) = 0.33mA/cm2, which is safe at both the positive (anode) or negative (cathode) electrode.
It is possible, using a transposition of the equation, to establish the maximal current that can be applied with a particular electrode whilst ensuring a safe treatment.
Maximum Current (mA) = Maximum Safe Current Density (mA/cm2) x Electrode area (cm2)
E.g.
If the (active) electrode is used is 6cm2
If the active electrode is made NEGATIVE (cathode)
The maximum safe current density is 0.5mA/cm2
The maximum current that can be safely applied is therefore :
= 0.5mA/cm2) x 6 (cm2) = 3mA

Application and care
The skin should be abrasion / cut free and the area carefully washed (mild soap & streaming water).
Heat application is not advised as it may work counteractive.
All electrode pads should be thoroughly soaked in tap water or other appropriate solution prior to application. Dry electrodes are inappropriate and should not be used.
Adequate fixation of the electrode and pad to the skin needs to be carefully maintained. Uneven current distribution can lead to skin burns and/or irritation

Table of Commonly Used Medications and Solutions with Iontophoresis (after Rothstein et al (1998)and Belanger (2010)). Also called **transdermal drug delivery (TDD)**

Drug / Solution	Main Indication(s)	Rationale	Parameters
Acetic Acid	Calcific tendinitis (myositis ossificans)	Acetate increases solubility of calcium deposits in tendons (and other soft tissues)	2 - 5% aqueous solution NEGATIVE pole
Calcium chloride	Muscle spasm (and	Calcium stabilizes excitable membranes, appears to decrease	2 - 5% aqueous solution NEGATIVE pole

	hypersensitive peripheral nerves)	excitability threshold in peripheral nerves and skeletal muscle	
Dexamethasone	Inflammation	(synthetic) anti inflammatory	4mg/mL aqueous solution NEGATIVE pole
Hydrocortisone	Inflammation	Steroid based anti inflammatory	0.5% ointment POSITIVE pole (Rothstein et al)
Hydrocortisone, prednisone	Inflammation	Steroid based anti inflammatory	NEGATIVE pole (Belanger)
Iodine	Adhesive capsulitis Other soft tissue adhesive presentations Infection (microbial)	Iodine acts as a broad spectrum antibiotic. Its actions in relation to adhesive presentations appear not to be fully understood	5 - 10% solution (some use ointment) NEGATIVE pole
Lidocaine	Soft tissue pain Inflammation	Local anaesthetic effects (blocks peripheral nerve activity). May stimulate healing	4 - 5% solution (ointment) POSITIVE pole
Magnesium sulphate (sulfate)	Muscle spasm Myositis	Thought that 'relaxing' effect is achieved by decreased excitability of muscle membrane and reduced activity at neuromuscular junction	2% aqueous solution (ointment) POSITIVE pole
Hyaluronidase	Oedema (local) Subacute and Chronic stages	Increases permeability in connective tissues thus allowing dispersion of accumulated fluid. Hydrolysation of hyaluronic acid	Delivered after reconstitution with 0.9% sodium chloride (Normasol) to give a 150µg/mL solution POSITIVE pole
Salicylates	Muscle and Joint pain Acute and Chronic	Mode of action akin to Asprin - analgesia and anti inflammatory. Inhibits synthesis of prostaglandins	2-3% sodium sallicylate solution OR 10% trolamine sallicylate ointment NEGATIVE pole
Tolazoline hydrochloride	Ulcers (open wounds)	Stimulates local blood flow Stimulates tissue healing (thought to be via inhibition of local vascular smooth muscle contraction)	2% aqueous solution POSITIVE pole
Zinc Oxide	Open wounds - ulcers Some dermatological conditions	Antiseptic effects related to the zinc. May stimulate healing	20% ointment POSITIVE pole
Tap Water	Hyperhydrosis (illustrations below)	Suppresses sweating in palms, soles of feet, axilla through ?keratin plug formation in ducts	Equal time with POSITIVE and NEGATIVE polarity - use 2 x hand baths. Reverse polarity 1/2 way through treatment (typically 30 minutes : 15+15)

Currently Iontophoresis is most used to treat hyperhidrosis disorder, a condition that results in persistent and excessive sweating. This sweating may occur in certain situations, such as during warm weather or physical activity, or without any trigger at all. It can also be caused by other medical conditions, such as hyperthyroidism or menopause.

Doctors aren't entirely sure *why* iontophoresis helps reduce excessive sweating. There are a few theories that make sense:
The electrical current and minerals in the water act together to thicken the outer layer of the skin and block sweat from flowing.
The current may disrupt nerve transmission, preventing sweat ducts from functioning properly.
Iontophoresis decreases the pH value in the sweat glands, making them more acidic and reducing the amount of sweat produced.

Iontophoresis doesn't require any special or advanced preparation. For personal safety it should be reported if a person is;
Is pregnant
have epilepsy
have a heart condition
have a pacemaker or other metal implants, such as artificial joint replacements

Iontophoresis for a Sports Injury
When being used as a treatment for a sports injury, iontophoresis is always performed at a ES specialists office. The care provider adds an anti-inflammatory medication to a redox-basin of water, and you'll place the injured area in the water. The a mild electrical current is applied to the medicated water like in all mentioned treatments before. The difference is the place of application and the use of more specific redox salts and supplements. Most iontophoresis sessions for sports injuries last 10 to 15 minutes. Several sessions per week are needed until the injury begins to heal.

In rehabilitation medicine, including physical therapy, iontophoresis is used to reduce inflammation that might be seen in musculoskeletal conditions such as lateral epicondylitis, medial epicondylitis, plantar fasciitis, tendo-nitis/bursitis, rheumatoid arthritis, and enthesopathic conditions of various origins. The most popular and well researched iontophoresis application is the use of dexamethasone, a corticosteroid in a sodium phosphate solution. In this form, the drug is composed of negatively charged ions of dexamethasone phosphate and, when loaded into a negatively charged reservoir or electrode pad, the electrical force of the like charges pushes the medication molecules into the desired area.

What Are the Side Effects of Iontophoresis?
Iontophoresis is a safe and painless procedure. The most common side effect is dryness of the skin. Blistering, peeling, and irritation might also occur on the skin. However, these side effects can usually be treated by applying moisturizer to the skin after each session. An over-the-counter hydrocortisone cream can also make you more comfortable.

Desincrustation

The developers of the treatment described these 'incrustations' as 'microscopic crystallisations' formed by chemical reactions between certain chemicals and minerals in creams, make-up, atmospheric pollution and perspiration. As the impurities built up in the skin they were said to adversely affect it – causing in wrinkles, pimples, acne and blackheads – and therefore needed to be removed, that is, the skin had to be 'de-incrustated'.

The chief characteristics of the method consist in breaking up, reducing and eliminating all the impurities (waste matter, dust, toxins, crystallisations, etc.) which block up the glandular tubes. … The immediate result is—increased blood circulation and, gradually, recolouring of the epidermis. The treatment became another established practice within Beauty Culture. Later known as disincrustation or desincrustation it uses another well-known effect of direct (galvanic) currents.

Basic principles
Desincrustation relies on the fact that when a direct current is used, an alkali (sodium hydroxide) is produced at the negative electrode and an acid (hydrochloric acid) is generated at the positive electrode.

Unlike electrolysis, where the sodium hydroxide (lye) is concentrated in a small area in the living dermis of the skin through the insertion of a needle, in desincrustation the sodium hydroxide is spread over the stratum corneum of the epidermis. So, rather than destroying tissue, as in electrolysis, the effect of the sodium hydroxide in desincrustation is merely to soften the keratin in the epidermis. This assists in desquamating surface keratinocytes and in loosening any hard plugs of sebum that occur in blackheads. The treatment is therefore commonly employed on 'congested skin' as precursor to extractions.

As with iontophoresis, the negative electrode used in desincrustation can be a disk, roller or ball electrode, a full facial mask, or something as simple as a tweezer electrode encased in a pad of cotton wool soaked in conducting solution. Unlike iontophoresis, where specialised ampoules are needed, a simple salt solution is all that is required. One can be made up using the following formula:

Baking soda (sodium bicarbonate)5 ml (1 teaspoon)Distilled water250 ml (1 cup)Sodium bicarbonate beaks down into sodium (positive) and bicarbonate (negative) ions when dissolved in water. This makes the solution slightly alkaline making it more effective than using common table salt (sodium chloride).

Combining treatments
In order to carry out either desincrustation or iontophoresis, a salon need to purchase a galvanic machine. Having done so it makes sense for them to maximise the return on their outlay by combining iontophoresis and desincrustation into a single treatment. This is commonly done by first carrying out desincrustation, using the negative electrode, and then following this with iontophoresis, using only the positive electrode.

The reasoning behind this is as follows. Using desincrustation first, reduces the barrier properties of the skin by assisting with exfoliation, in theory making it easier for ions to move across the skin during iontophoresis. Then, as acid is produced under the positive electrode with iontophoresis (using only the positive electrode) this helps to restore the acid balance of the skin upset by the alkali generated during desincrustation.

Distance care

The pressure on health care is tremendous all over the world. With less employee, more has to arranged. Professional employee are scares and time must be used as efficiently as possible.

These facts bring the need for distance care closer every day. This could account for Electro Stimulation for curative application. The current situation is a static one. People use a specific selected program and apply it. But this should change.

Electrodes must become receiver and sender of information and the collective information of the portable device is shared with the main database of the treatment center. In the near future an employee of the center will receive, study and judge. If there is a need a new program is send or a call is made to the owner of the device. When necessary a new program is send to the device and installed for the next treatment.

In the future this all will change. At the beginning a program schedule is prepared by the handling professional and time-planned in the main device. This device calculates the time frame of implementation and communicates this with the devices with nobody in between. A day by day care is guaranteed. If the treatment is not effective enough, the device report back to the main station which than alarms the handling professional.

With the use of voice or face call the customer is consulted. Customer care is more active on the care- and less active on the customer side. There is strong interactivity without a customer who need to worry. Treatment becomes silent and effective without bothering. Care and prevention become one.

AI devices (Artificial Intelligence)

AI is currently a small area in electro Stimulation but it is entering some decisive phases. The topic is a bit out of the scope of this book but I would like you to understand the possibilities in the future of our business. Events to keep in mind for your personal development opportunities and education.

During my Age Control research I found that the current use of ES in heart and bone control and healing are rapidly developing. It is possible to attach nano-medicine delivery systems to the ES implants which can release these medicines on certain moments under control of the biological environment and brain messages. New systems are developing AI control which will adapt to a changing environment (age) and need of medicines. A learning and developing implant that becomes part of the body.

In the military world there is profound research taking place on electro stimulation of the brain for more focus and long term concentration. The wireless empowered electrodes have AI properties on a changing chemical environment. During intensive work the brain composition is changing. Emotional status is and influencer of dangerous proportions. When soldiers get emotional involvement they may make fatal judgements. Medicine injection or release will activate certain brain parts to keep the person alert.

Aging brings degeneration of the bones. Arthroses is common in the elderly. It is possible to keep bones health and strong by electro stimulation of the biological system. A foundation of

redox salts, calcium, magnesium, potassium and other chemicals are needed. Through the use of external channels these chemicals are injected in the bloodstream and structures. As every individual is different, a learning system (AI) is needed to adjust amount and concentration to suit demand.

These are only samples of possibilities. I do not give moral judgement on any as that is not my goal here. Knowing the possibilities is important for every person. ES is still at the beginning of development and application and you should never give up trying to find your ways using and applying it.

Food supplements

The definition of a supplement is simple; that what is supplied as something extra to what is "standard". Basically the general food is enough for most people.
Since '70's I did start to work with supplements. The first time I came across people using supplements was during my work with Hercules, a magazine targeting Body Building and fitness. It was a very rudimentary magazine and there was hardly any knowledge.

The owner was selling proteins and vitamins without any knowledge. Articles from US magazines were taken over without any critical note. Selling was considered the main goal of the magazine post order company. Health was not important at all. This did bother me and was one reason why I decided to study Biochemistry.

Since that time the use of food supplement did develop and increased. In the beginning of the '90's the USA market was around 9 billion dollars. At the end of the same '90's it was shrunken to a low 2 billion. Wat happened?

People discovered that most supplements are only marketed very well but hardly has effect on the body or mind. They felt cheated and left a promising market. The lack of knowledge, incredible promises and little effect wasted customer confidence and trust. Nearly the same as what happened to the Electro Stimulation market.

But supplements are still around. The main reason is that science saw the need and possibilities of supplementation. Researchers tapped into the channel and step by step evidence matured. Things that were considered to be true without proof became subject to study and some ended up as proven others as myths.

Why to add a chapter on food supplements to a book of Electro Stimulation? First of all to show that we can use the right supplements to benefit customers. They can use some supplements to support their goals with ES. On the other hand, you can use supplementation to make ES more effective.

How useful are they?

Some supplements can be very useful. One of the most important supplements are "redox salts" with are used to transfer Electric current into Ion power. In most simple terms explained: the salts are inorganic chemicals with a certain potential. These chemicals are able to exchange potentials

very easy and are able to move from electricity (electron) to ion (chemical potential) status without any problem. This is the “missing link” in Electro Stimulation.

But redox salts alone are not enough. They have to be supported by other properties as neurotransmitters, stabilizers, stabilizing liquid and some vitamins and amino acids. The exact composition of this liquid is to complicated for this book but it definitely works.

Redox reactions are taking place all over our body. Every second of the day. The core of the redox reaction is the transfer of energy without the carrier being used in the process. This implies that the same carrier could, theoretically, indefinitely go on with the process and never be wasted. The “secret” behind redox reactions is the need for transfer of energy and translation of the different energy “levels”.

The body is a chemical pool of constant action and reaction. Most people can do with their daily food. Only some may use supplements and even so only for a period. In contrary with the Anti-Aging, which is mainly based on the use of hormones and medicines, the theory of Age Control is focused on the powers of your own body. Every body has good and bad times. Chemical composition is changing with the day. This effects our feeling of wellbeing.

Besides physical assistance for injuries, recuperation of muscles, conditioning, mental support, mood control and healthy issues, ES also has one benefit that leaves most competition behind. The feeling of being energetic, electrically loaded, recharged from top till toe. The “unique” feeling of powered. ES can deliver more than expected when you take good care of the customers general health. That is where the knowledge of supplements is useful.

In your intake form it is useful to pay interest in the use of supplements. There are some reasons to be equipped with the knowledge;

- Inside information on what is used (can it interfere with your work?)
- Trust in supplements (can you describe or sell supplements or not?)
- Practical application and form (are the used supplements pills, powders or drinks)
- Sensitivities of the customer (maybe even allergies)
- Interest of customer (chemical or herbal)

As mentioned before, our goal is to give effective and maximal result scoring treatments. To reach this goal it is important to have the complete confidence of the customer and use everything possible to reach the highest possible result.

Practical application

General supplementation and nutrition is a complicated matter. It takes a complete study of years to understand even the basic principles of it. Beside that it will take an equal, or maybe even more, years to reach a practical experience.

Questionnaires give some inside information in knowledge and use of the customer but it does not give a clue to the effects and results. Being not an expert on the topic it is important to stay away from risks. Avoid advises that are neither proven or guaranteed.

During my over 40+ years of practice in different segments of healthcare I did hear many advises of “what to do” with my health. (People interested in my background I would like to refer to my

personal sites.) As a professional I listen and judge a person for its advise and personal application of it. There is a saying: what you see is what you get. Imagine an overweight person advising on losing weight. It might be great advise but will not convince the customer. In their mind the thought of “if your advise is good, why don’t you do it yourself” pops up. It is like the bold male guy at a fair advising me to get a hair transplant as I grew some bold spots on my head. On my direct question why he did not use it himself he replied: “I do not need it, women are crazy with me this way”. He was not a particular attractive male with a bad breath.

Electro Stimulation was used to lose weight in the past. The effects were never scientifically proven. The USA – FDA even sanctioned the use of weight control with ES products. Be aware of your products qualities, application and your personal knowledge are highly important while working with customers. Stay always on the safe side. Follow these simple advises on supplements and you are safe:

- Elderly people which do not eat well, advise the use of some protein or amino acid supplements. Ask for lactose intolerance and advise accordingly.
- Do not advise on vitamins. Most products have added vitamins now and advising to take more care easily reach an overdose. Fact is that a to less or too much vitamins show the same result. This is confusing.
- Minerals are using in our ReDox formula’s and there is no need to add more.
- Young people with underweight can be advised to use carbohydrates but beware of diabetes!
- The use of additional boosters such as creatine, caffeine, GH promoters, testosterone boosters and so on are far out of your league and do not advise on them
- Joint products are good to take but only if effective and there is no single pill or powder on the market that is proven to be effective enough for all. Some liquid formula’s are working well, ask the specialist before advising a local or international brand.
- Some products suggest influence of the metabolism such as for losing weight, melatonin (sleep). Pre-workout (energy), creatine (enhancer), HMB (protection but they work only under certain conditions which is out of the scope of ES application.

Specialism , personalized

The sales of food supplements is a specialism but most people buy mainstream products. Large size trademarks with strong marketing and promotion create the idea that they deliver a quality product. But the contrary is true. Most trademarks are marketing and promotion companies with hardly any product expertise or ingredient knowledge. They focus on sale targets and profit margins. The health of their customers comes at least at second place if they bother at all.

Pharmaceutical companies buy well selling trademarks and use these to try out new formulations. When a formulation shows a promising results it is withdrawn from the market for further study. Finally when they discover it is not possible to bring the product under a “patent” right, it comes back onto the market. Samples of these practice are melatonin, GABA, ephedrine and many more. Effective ingredients when used in the right combination and at the right program.

Taste is something very personal. The individual taste of a person always differ from even the closed of kin. This fact is leading toward the next assumption. Every person has individual food needs. Biochemistry demands are never the same. Each body has a slightly different build, completion and digestive system (see www.agecontrol.nl).

Your customer comes with specific questions, demands, problems and needs. Every treatment is different even when the machine that serves you and the customer is programmed in a standard way. You and your knowledge, service and qualities do make the difference. The fact that you read this book already implies a curious and serving mind. Food supplements can be bought in standard production but also personalized and completely adjust to the needs and wishes of the customer.

To personalize the supplements it is important to have inside in the customer. There is a downloadable questionnaire which can be used to investigate the customer in different ways. After filling the form you can send it by email to the Age Control website for consult or, if you think to have the knowledge, prepare the supplementation for your customer.

Licensing

Education is the foundation of knowledge.

References

Product listing / Suppliers

Treatment Centers