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Healing with magnetic fields

PEMF Therapy Workshop 2016

William Pawluk, MD, MSc

advantages of magnetic field therapy

- non-toxic
- non-invasive
- stimulates body’s own capacity
- for healing
- re-usable
- natural – effects electromotive actions in the body
- home or professional use
- complementary to other therapies
- biologic evidence

"The number of people who have received substantial clinical benefit from exogenous EMF is certainly in the millions worldwide and increasing rapidly as new clinical indications emerge. EMF therapies also present as alternatives to many pharmacologic treatments with virtually no toxicity or side effects."

Mechanisms and therapeutic applications of time-varying and static magnetic fields. Pilla AA. In: Handbook of Biological Effects of Electromagnetic Fields, 3rd Edition. Barnes F, Greenebaum B, eds, CRC Press, 2006.

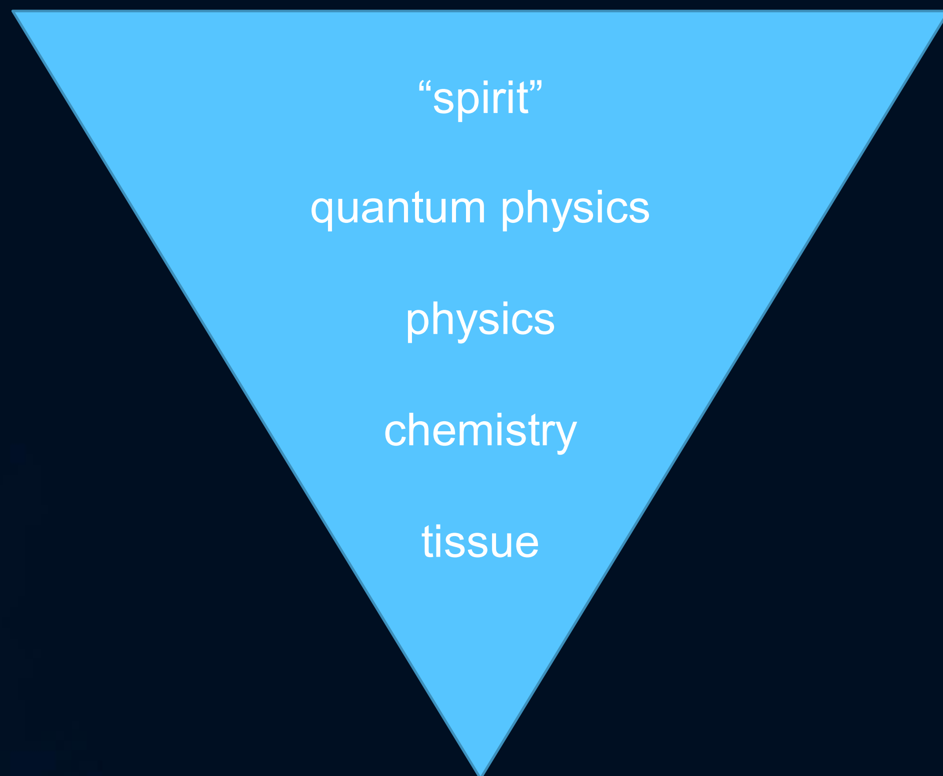
objectives

1. magnetic science
2. bioeffects
3. clinical proof
4. comparisons to other tech
5. available PEMF tech
6. practical considerations

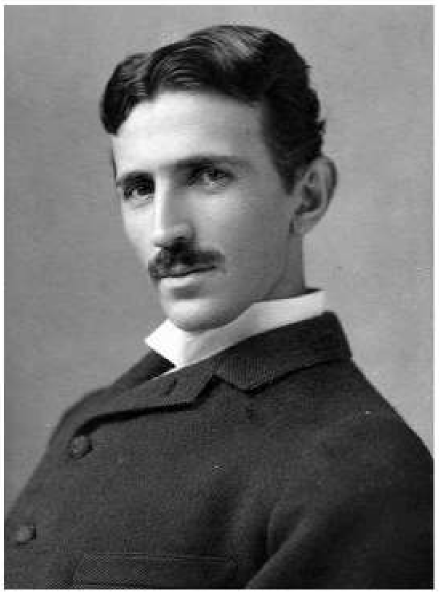
my clinical journey

- Family/Community Medicine
- acupuncture
- homeopathy/bodywork/hypnosis
- magnetic therapies
- nutritional medicine
- holistic/functional medicine

Levels of Healing



all life is
electromagnetic



"If you want to find the secrets of the universe, think in terms of energy, frequency and vibration." - Nikola Tesla

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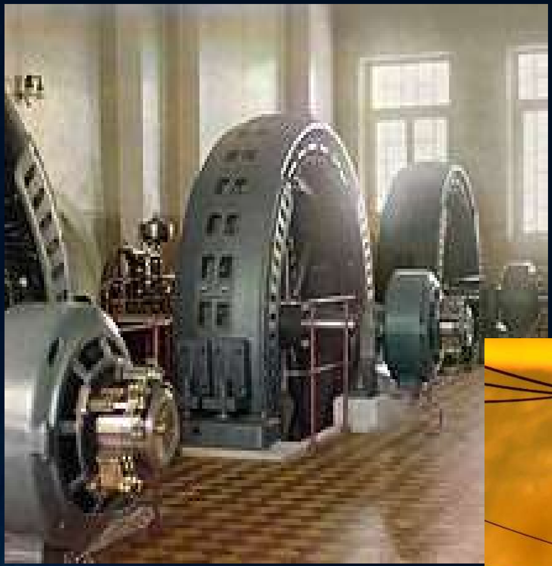
Tesla



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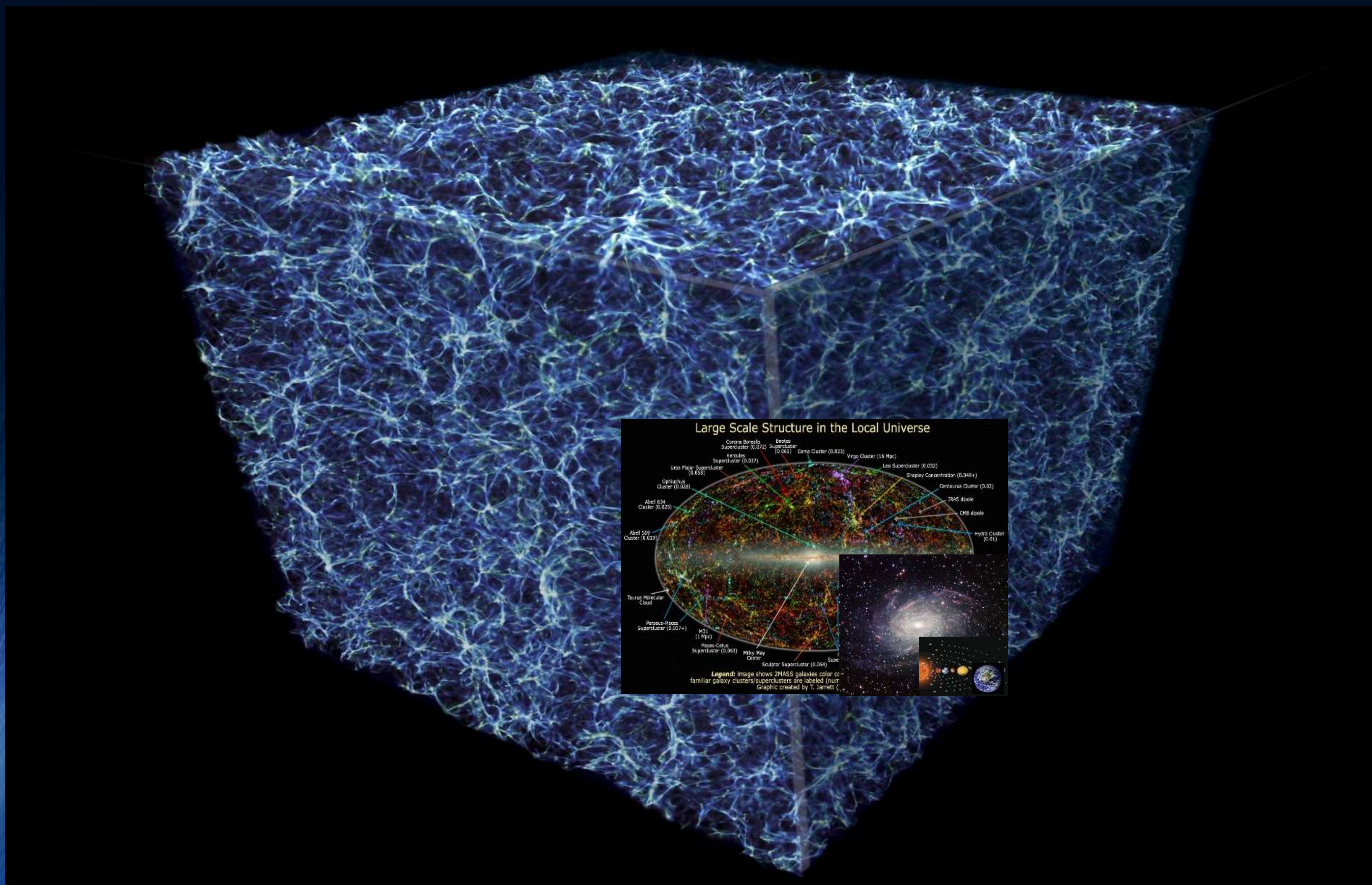
geomagnetic fields
the universe/earth we live in/on



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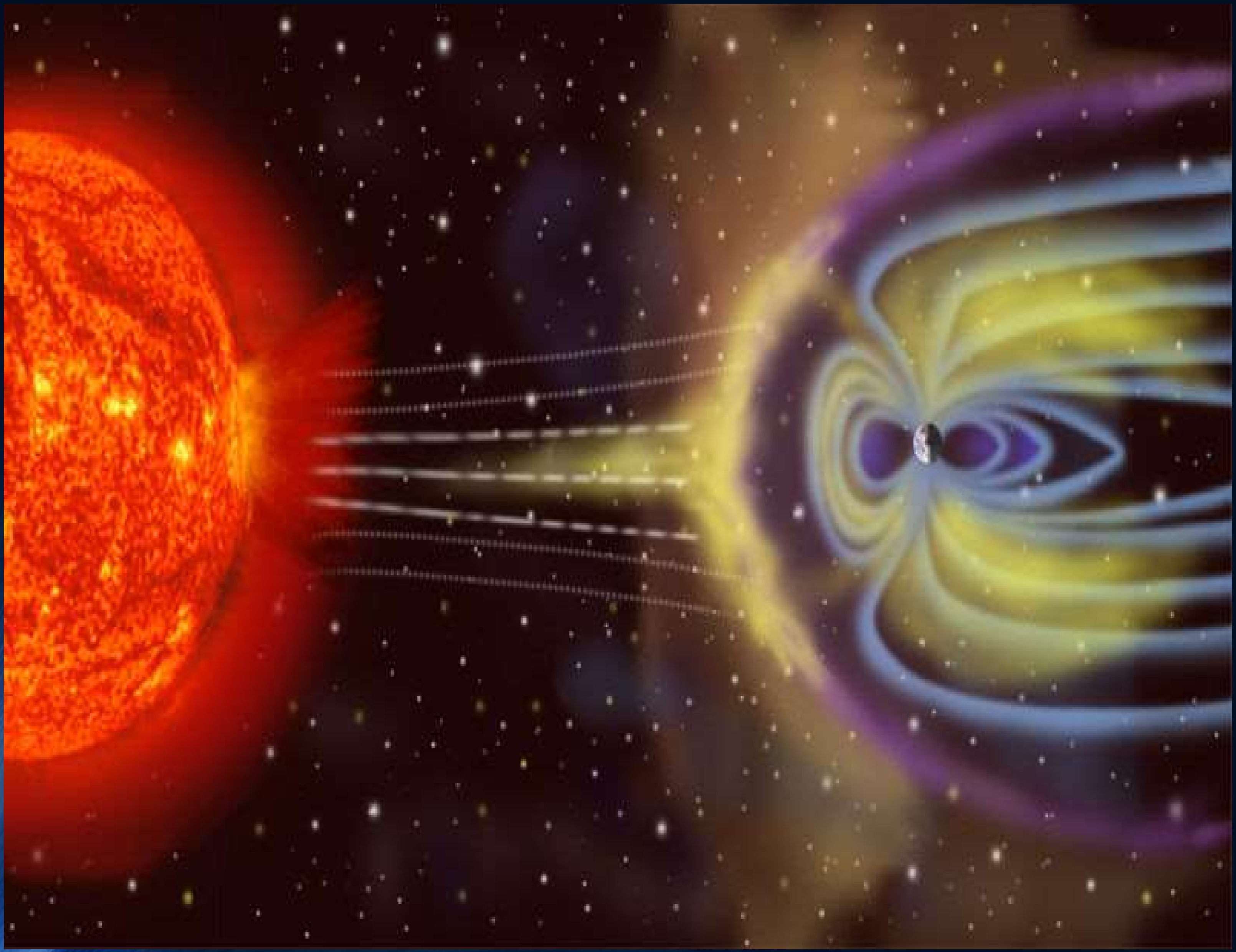

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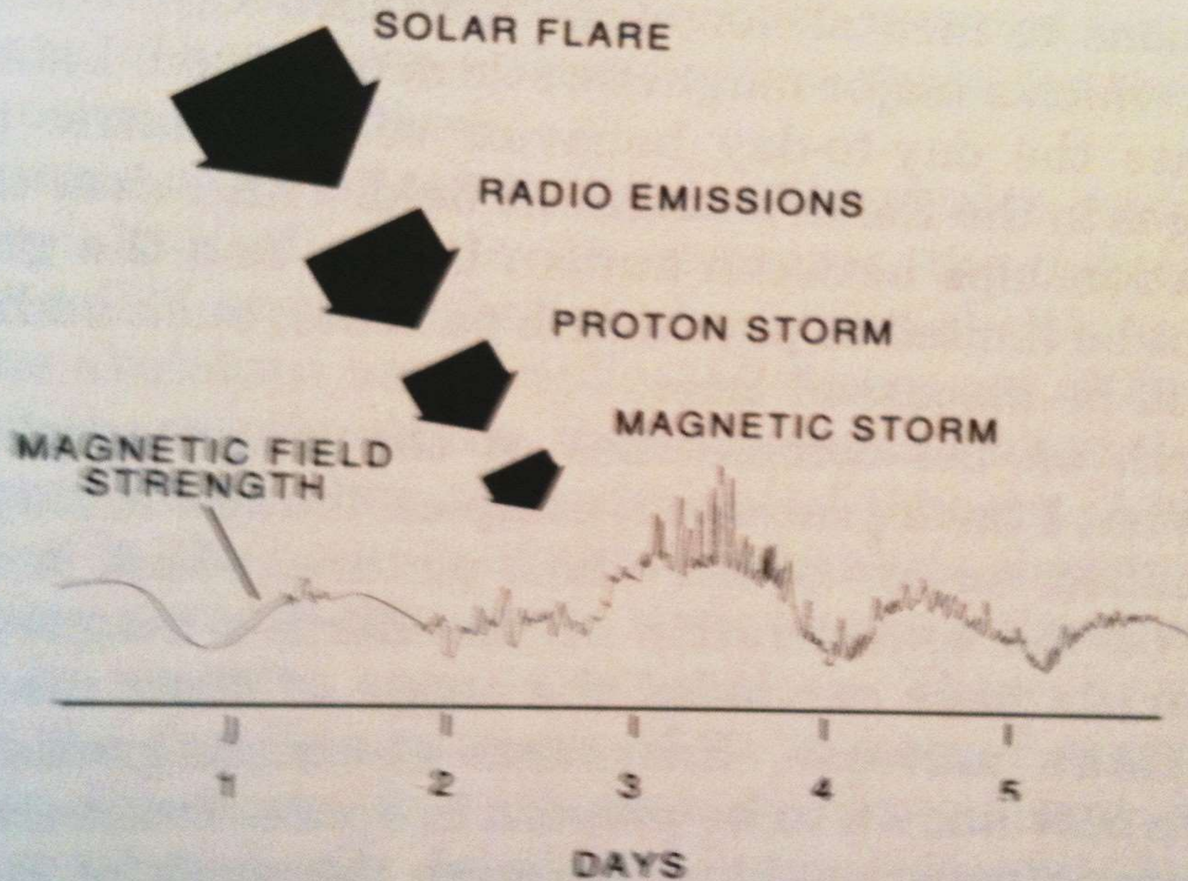

FIGURE 7-4. *The anatomy of a typical magnetic storm. There are many variations, depending on the type of solar disturbance and its duration.*

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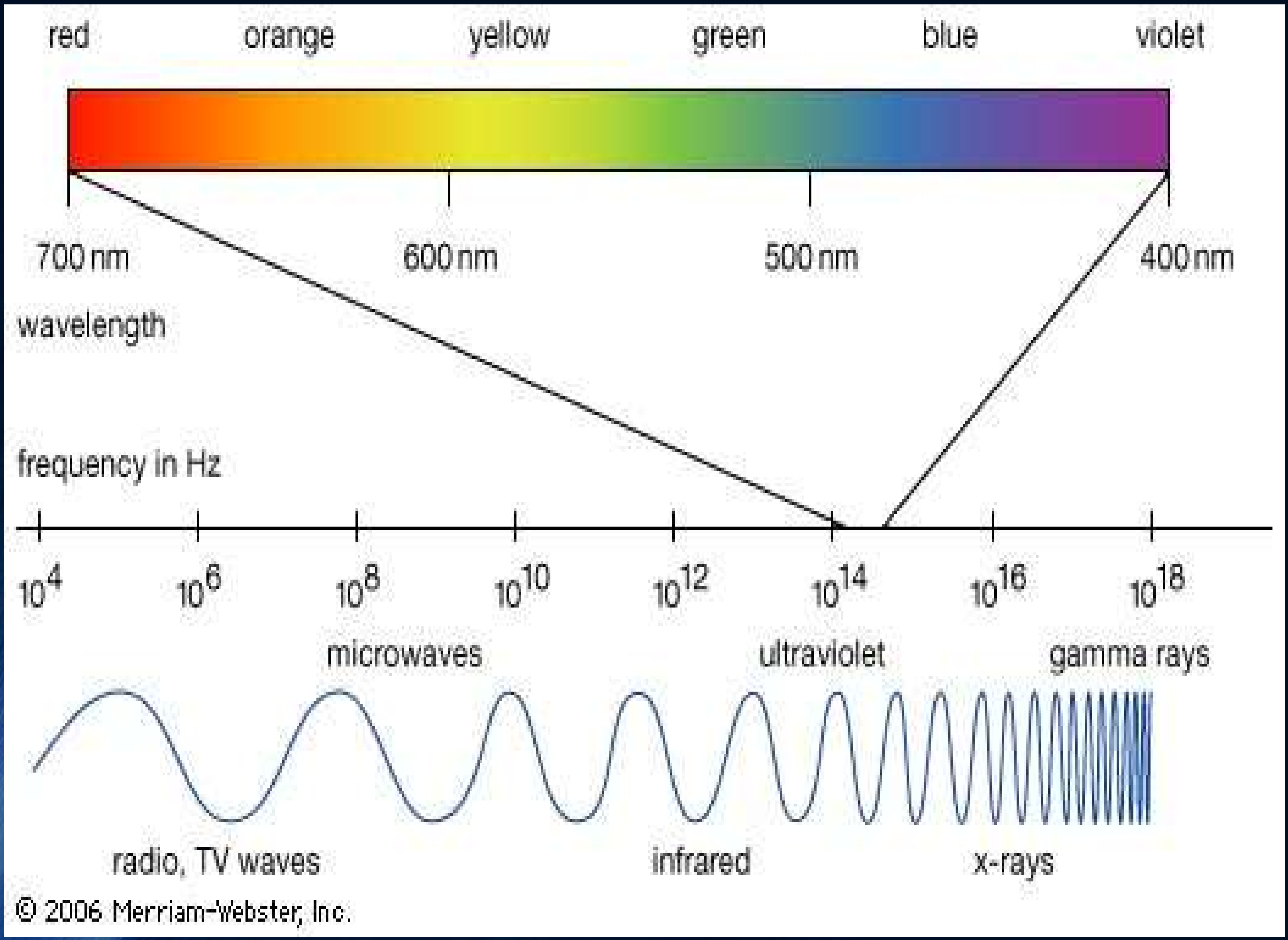

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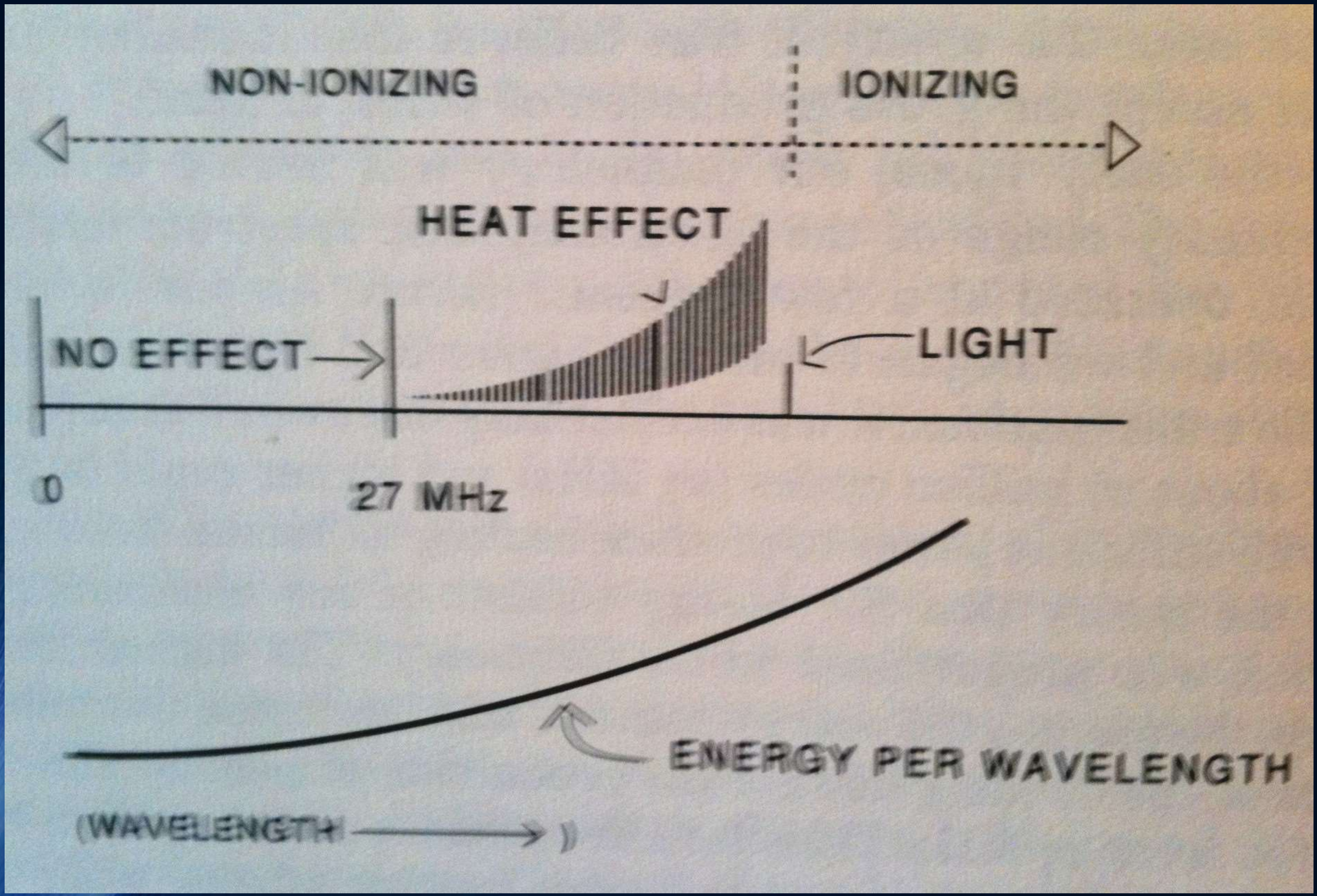

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man’s exposure to natural magnetic fields

- earth’s DC magnetic field
- magnetic rock formations
- Schumann resonances
- geomagnetic storms
- telluric ground currents
- body’s internal EMFs

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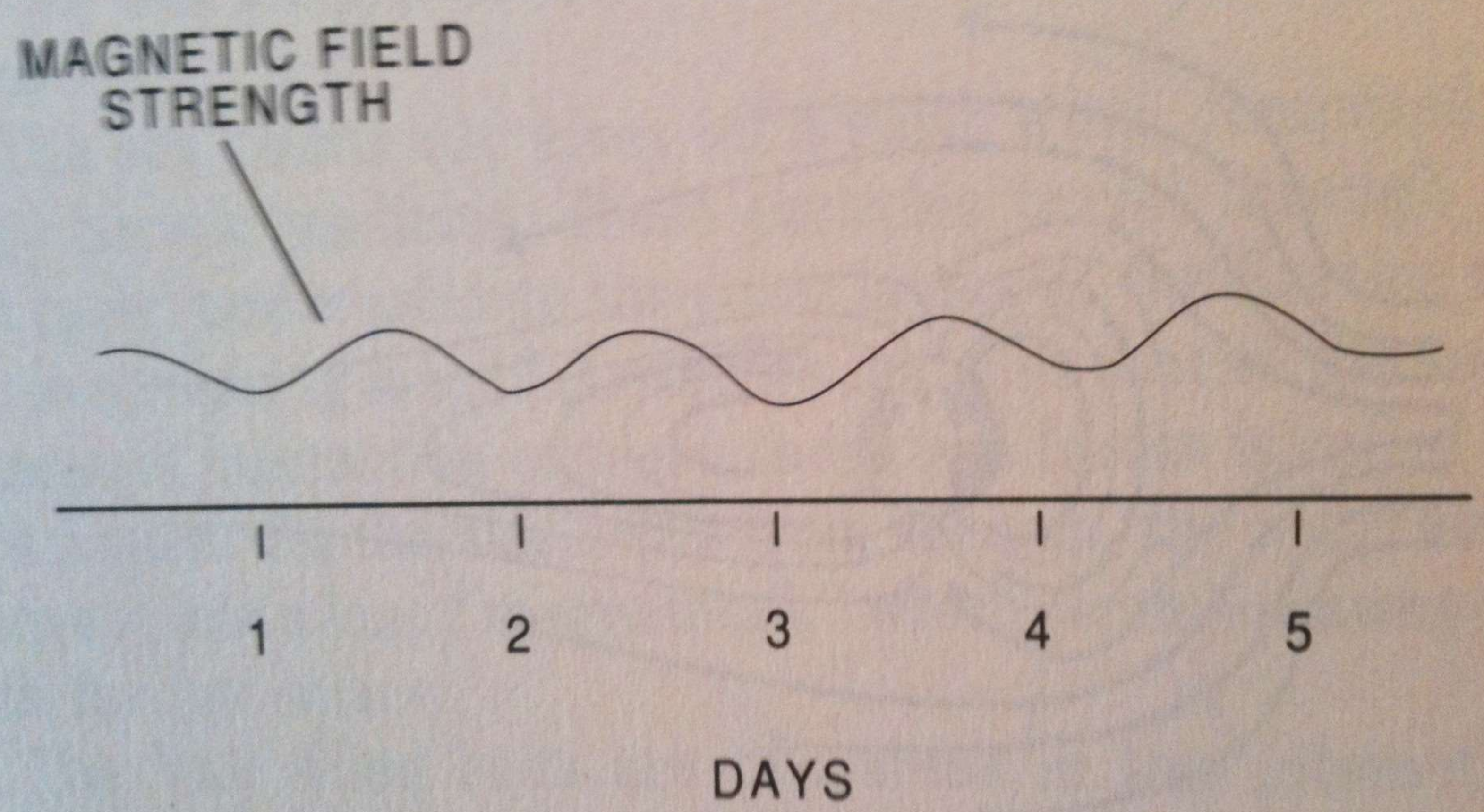

FIGURE 7-3. *Daily rise and fall in the strength of the magnetic field at one spot on the Earth during a quiet period of solar activity.*

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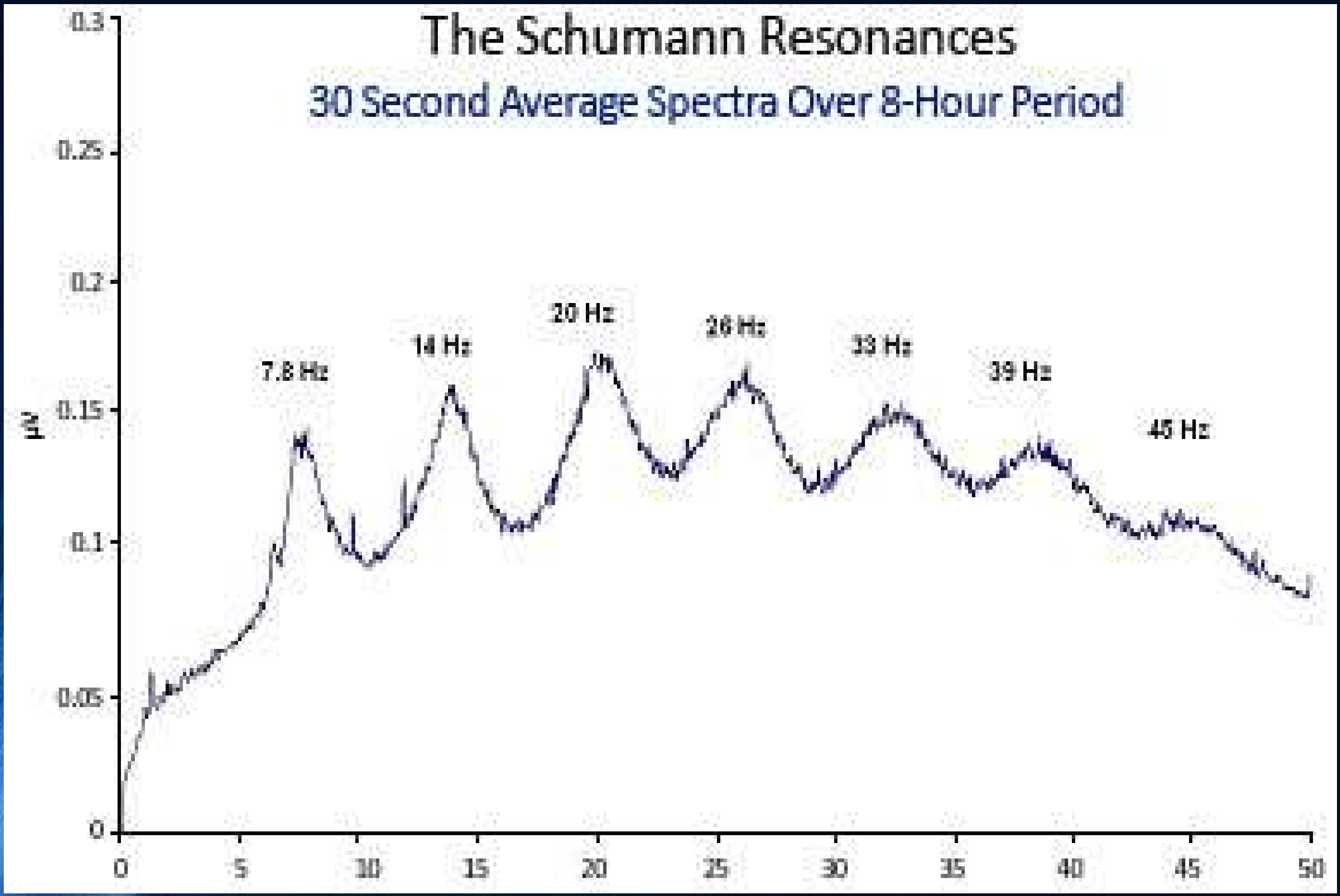

biologic and therapeutic issues to consider

- flux density
- gradient
- frequency
- shape
- dB/dT
- pulse
- polarity
- duration
- exposure duration
- volume of tissue
- localization
- vector

terminology

• intensity	Gauss/Tesla
• frequency	Hertz (Hz)
• waveform	various
• power	volts (v)
• current	ampere (A)

bioelectromagnetics

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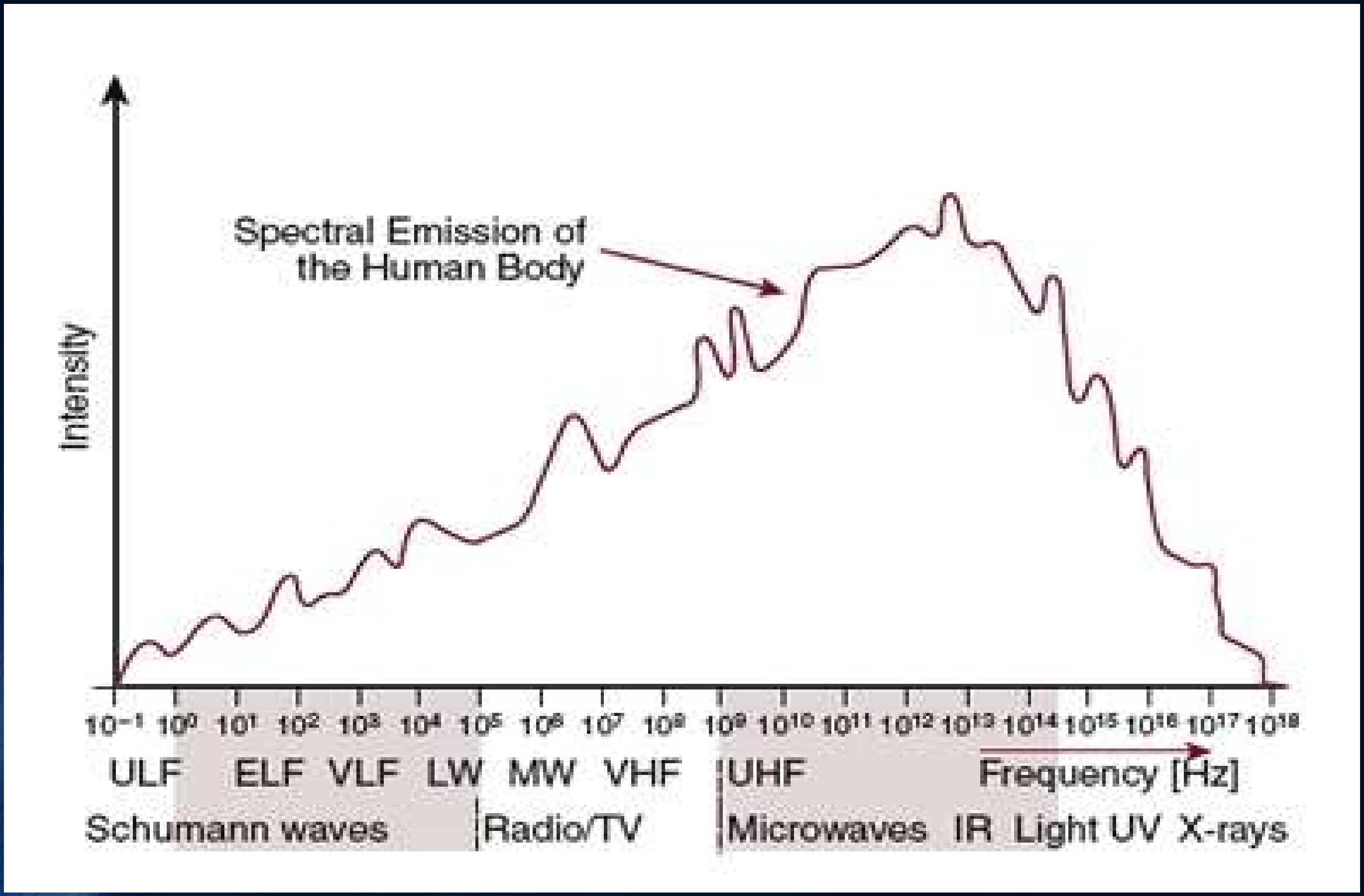
power spectrum of human body emission



From http://www.faim.org/measurement-of-the-human-biofield-and-other-energetic-instruments

human energy field

http://www.annechantalmisson.com/bhs-brennan-healing-science/history-of-energy-healing/?lang=en

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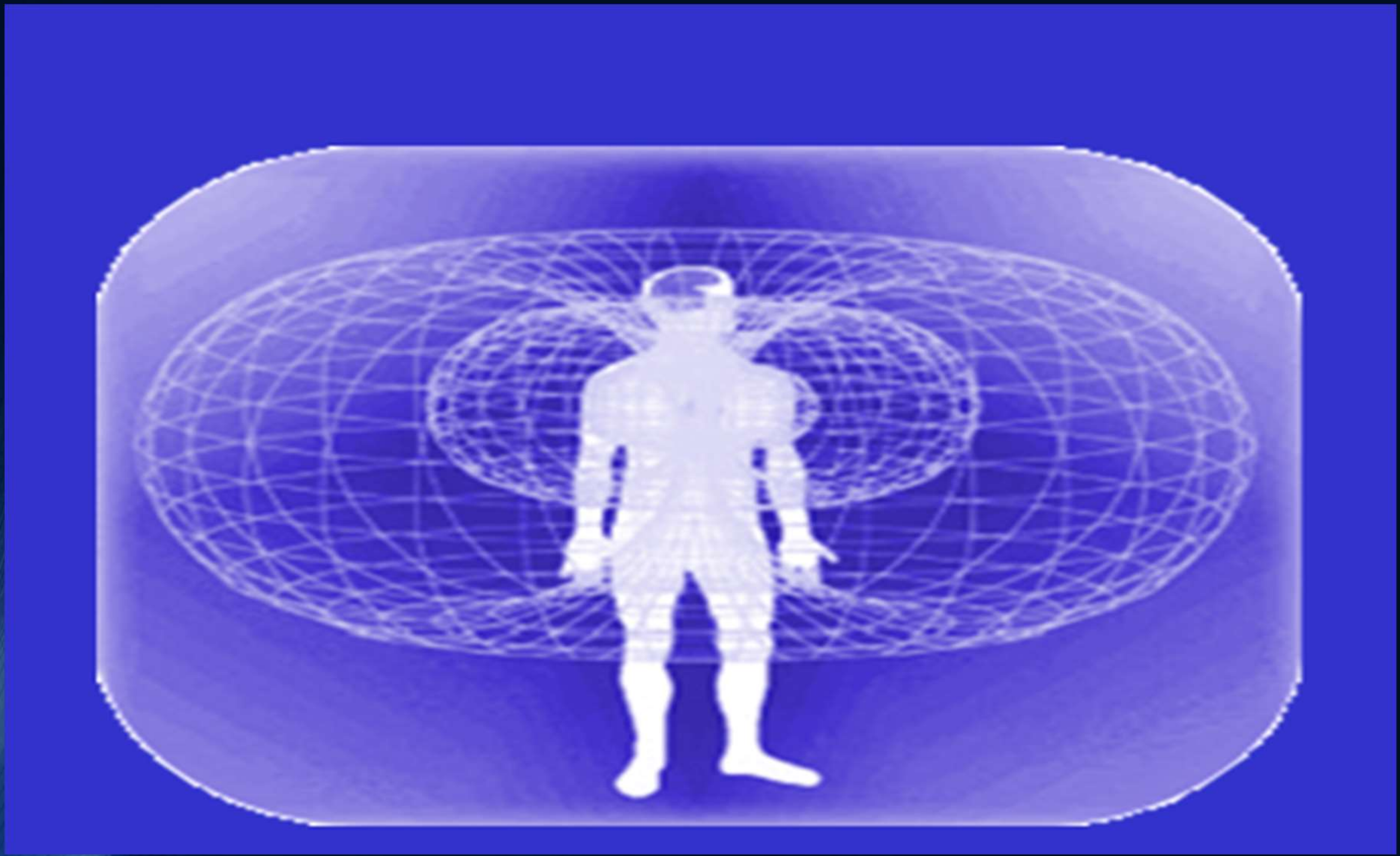
human electromagnetic field



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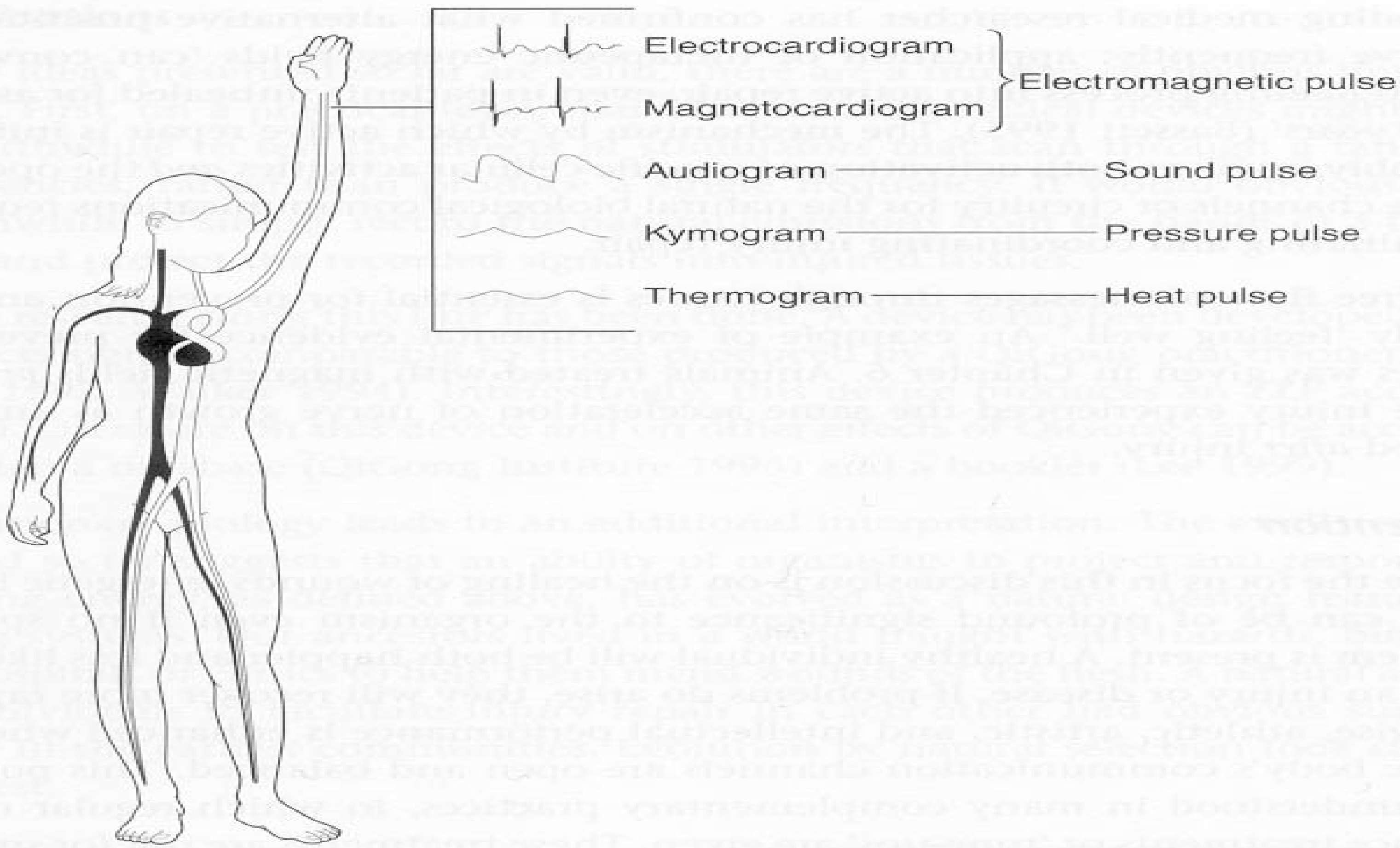

Fig. 7.2 Heart pulses in the order of their velocities. The fastest signal is an electromagnetic pulse (recorded with the electrocardiogram and the magnetocardiogram), followed by a sound pulse, a pressure pulse, and then a temperature pulse. (See Russek & Schwartz 1996.)

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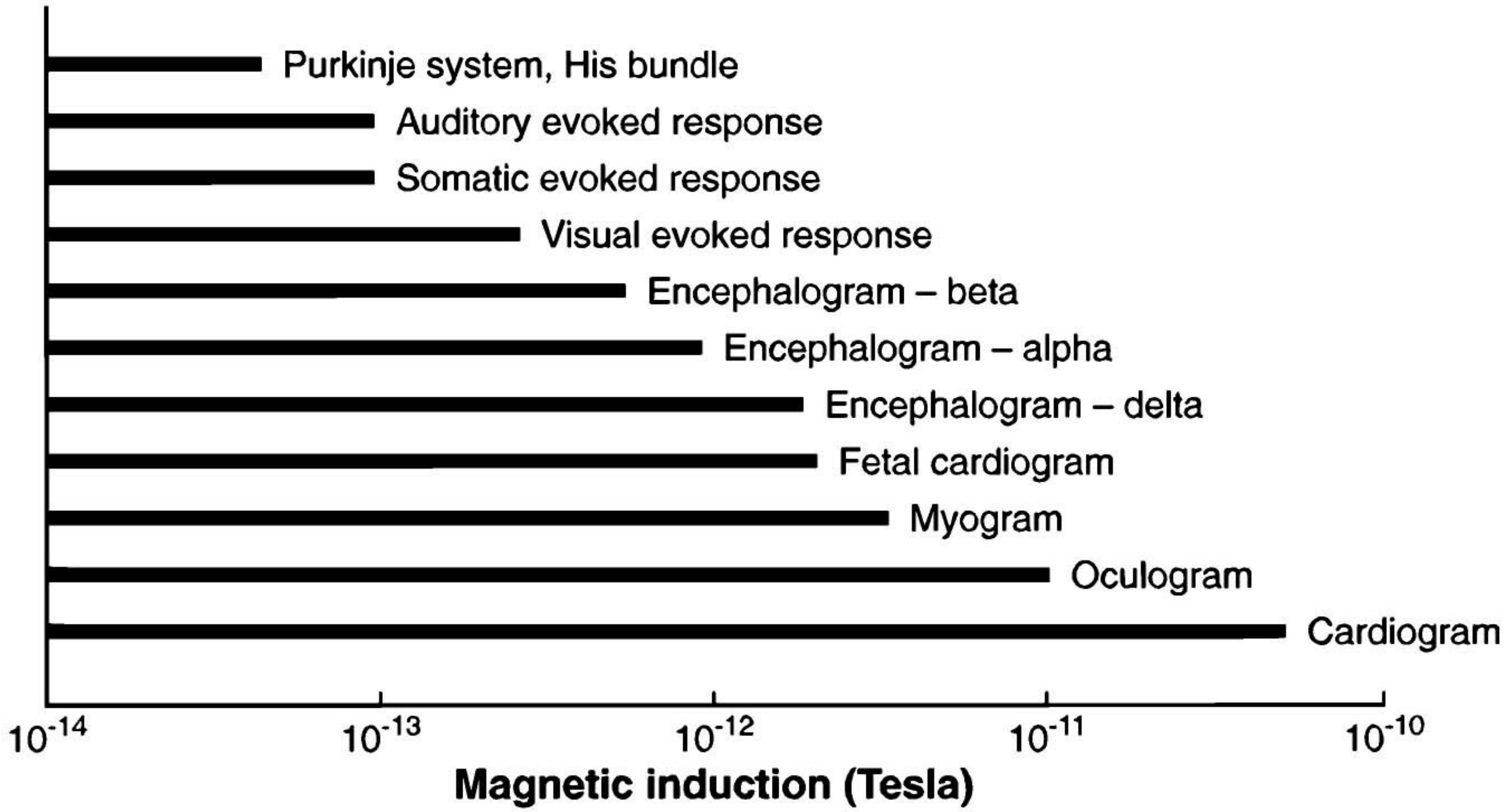

Fig. 2.6 The relative strength of the various biomagnetic fields measured in the spaces around the human body. (Based on data presented in Fig. 1 of Williamson & Kaufman 1981.)

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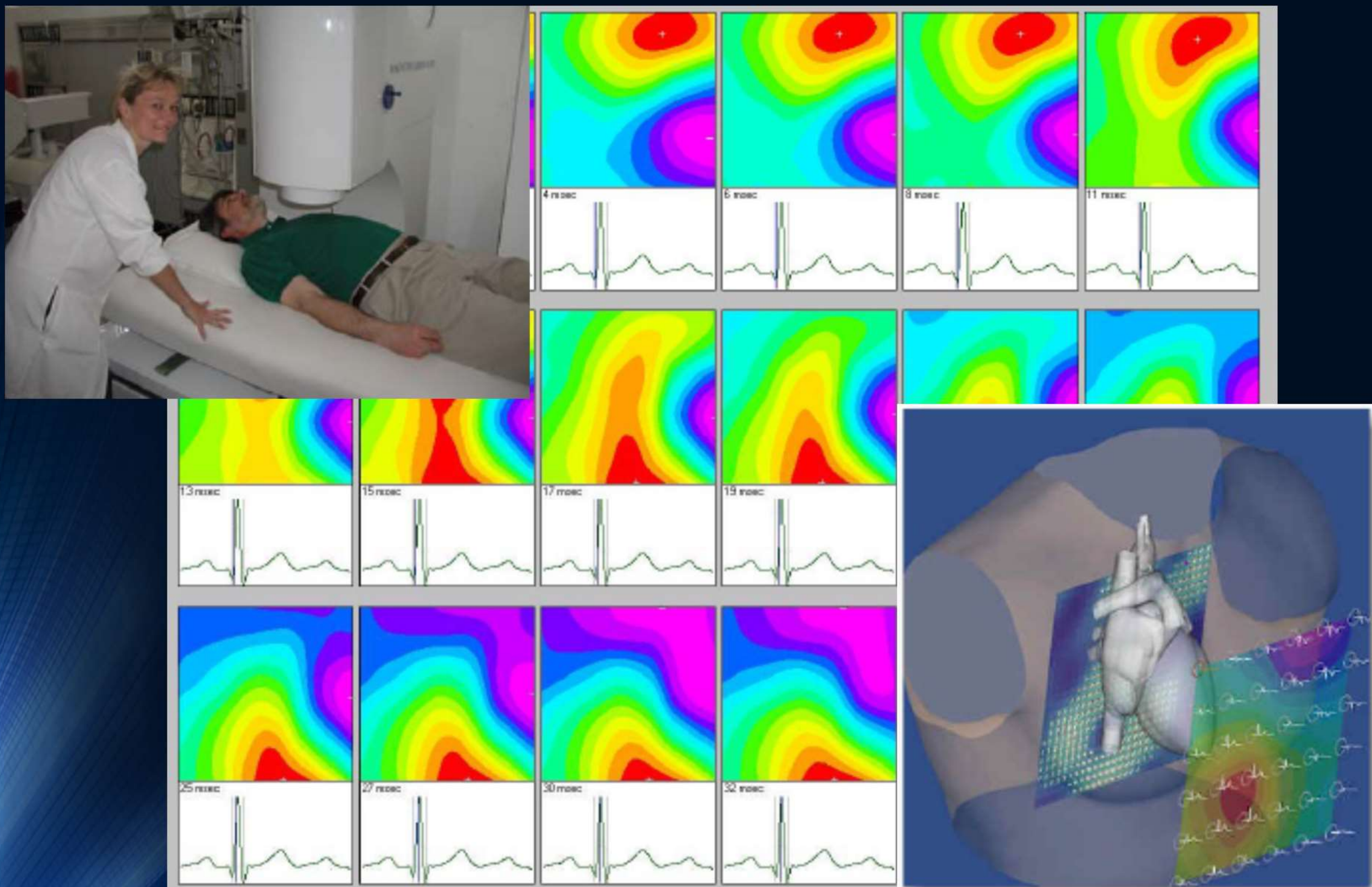
magnetic fields from the heart



www.cardiomag.com

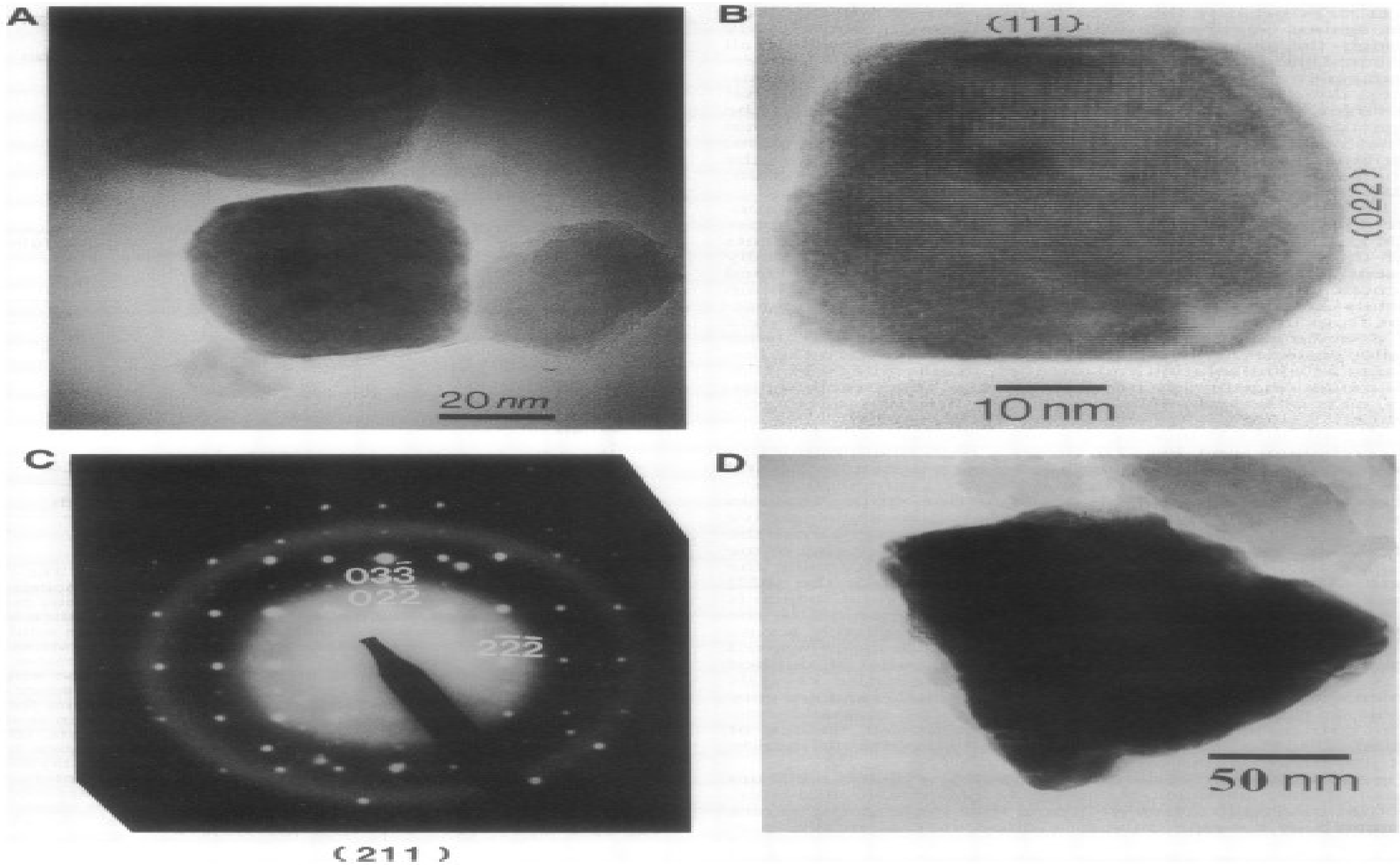


FIG. 2. TEM images and diffraction patterns of representative magnetite and maghemite crystals from the human cerebellum. (*A*) A clump of small particles. The high-resolution TEM image of the maghemite crystal in *B* shows the pattern of intersecting {111} and {02$\bar{2}$} fringes, with particle elongation in the [111] lattice direction. (*C*) The indexed selected-area electron diffraction pattern of this crystal, taken in the ⟨211⟩ zone. (A few miscellaneous spots are also present from the adjacent crystals seen in *A*, and the faint row of spots midway between the bright rows are [01$\bar{1}$] and equivalent reflections that indicate the oxidation to maghemite.) The diffraction rings from an aggregate of small crystals confirms the magnetite–maghemite identification. These measured values/γ-Fe_2O_3 standards/and [indexed] d-spacings for the rings are, respectively, 4.0 Å/4.18 Å [200], 4.8 Å/4.82 Å [111], 3.2 Å/3.41 Å [211], 2.8 Å/2.95 Å [220], 2.6 Å/2.78 Å [221], 2.2 Å/2.23 Å [321], 1.8 Å/1.87 Å [420], 1.7 Å/1.70 Å [422], 1.5 Å/1.61 Å [511], and 1.3 Å/1.32 Å [620]. The tetragonal reflections [211], [221], and [321] are present in maghemite, and not in magnetite, and the pattern from the aggregate is a mixture of the two. One of the large magnetite particles is shown in *D* (diffraction pattern not shown).

Magnetite biomineralization in the human brain. Kirschvink JL, Kobayashi-Kirschvink A, Woodford BJ. Proc Natl Acad Sci U S A. 1992 Aug 15;89(16):7683-7.

Proof of magnetic antennas in the brain

Study by Dr. Joseph Kirschvink, California Institute of Technology

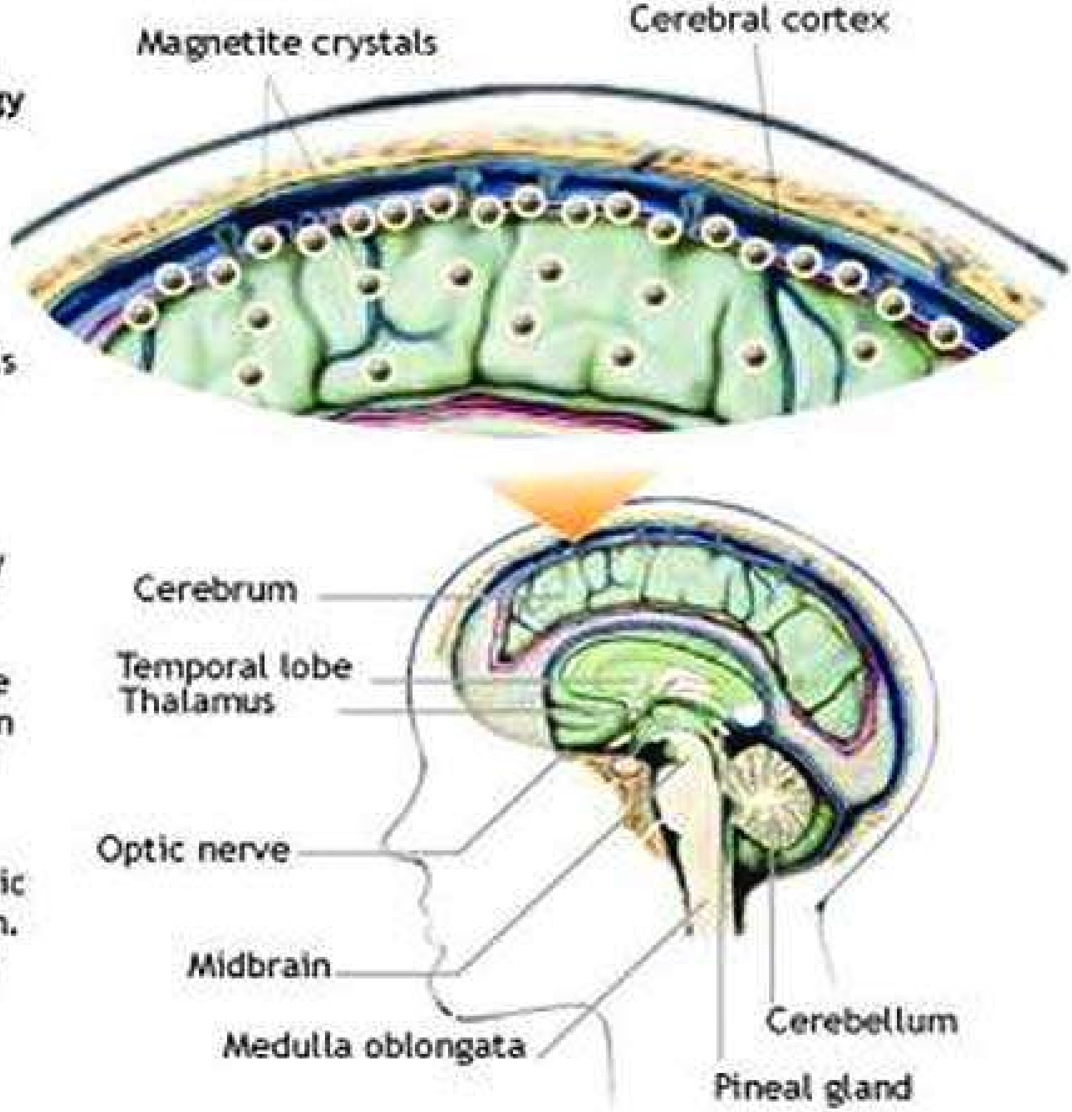
found evidence of:

- 5 million magnetite crystals per gram of brain cell
- 100 million magnetite crystals per gram of cerebral cortex

Magnetite crystals can sense very weak signals and react to them.

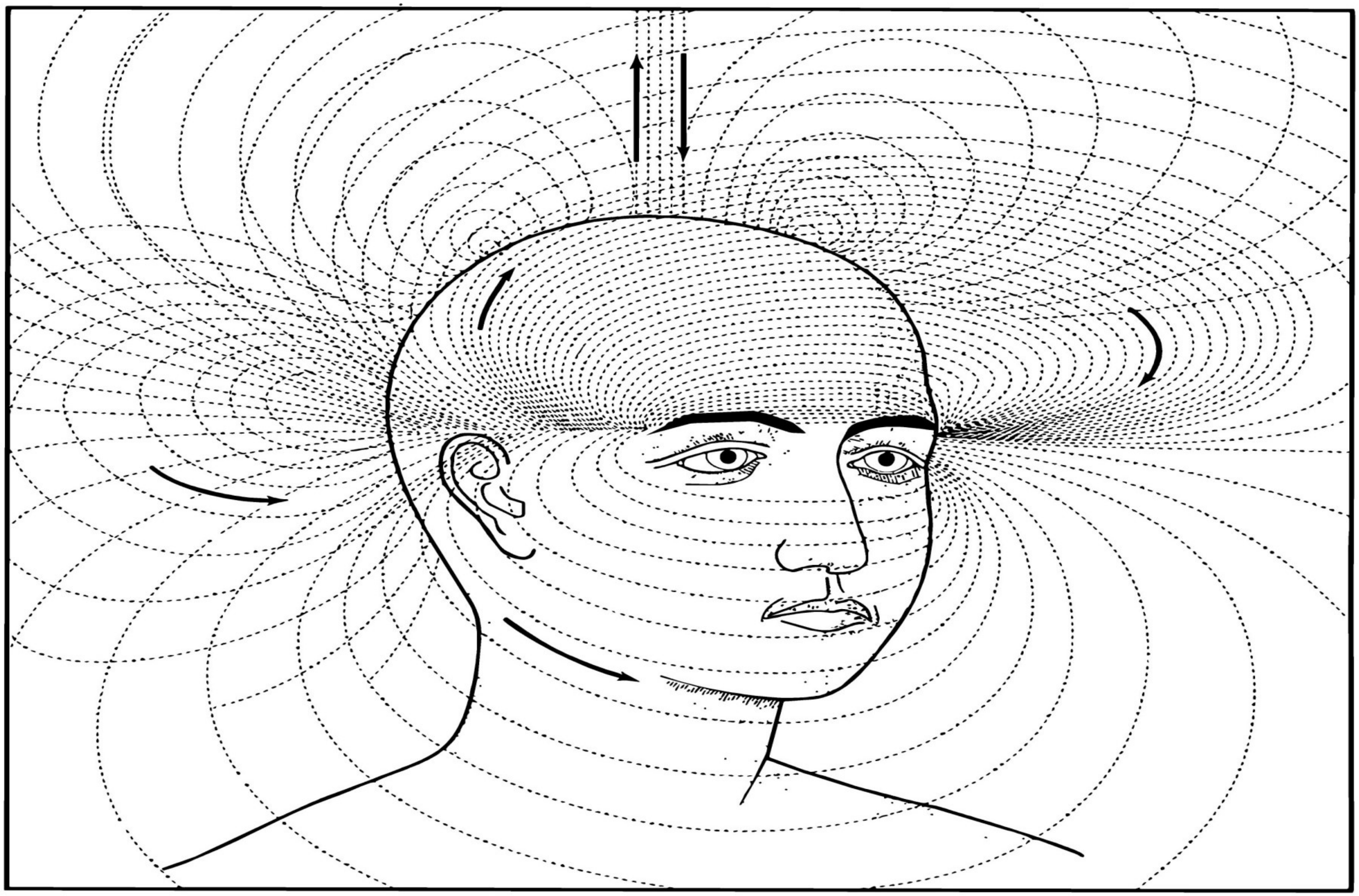
Megnetite (Fe_3O_4) reacts over one million times more sensitive to an external magnetic field than any other biological matter.

This means that external magnetic fields directly influence the brain. This can affect and disturb many functions of our metabolism.

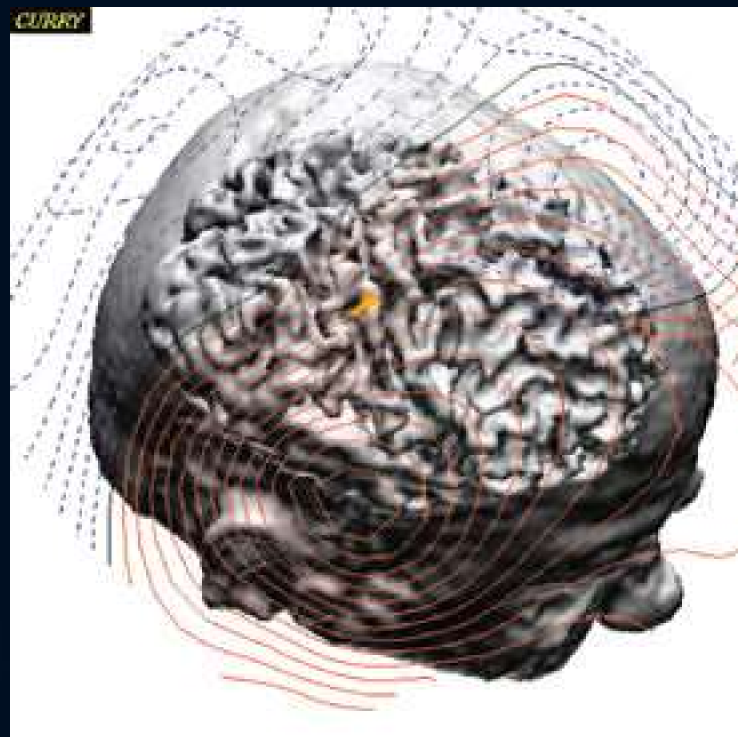


"The magnetic torque from external alternating fields will induce mechanical oscillations in the particles, and … such motions … have effects like opening transmembrane ion channels. … fields of 50 or 60 Hz with peak intensities slightly stronger than that of the earth (50 μT) would be required to make these effects stand above kT (thermal noise), but the large numbers of crystals might allow averaging to yield effects at lower levels."

Magnetite biomineralization in the human brain. Kirschvink JL, Kobayashi-Kirschvink A, Woodford BJ. Proc Natl Acad Sci U S A. 1992 Aug 15;89(16):7683-7.



magnetic fields from the brain



Coregistered MRI and magnetoencephalogram of the brain's magnetic field (red exiting the head, blue entering the head, yellow ball showing the equivalent dipole) was taken 30 µsec after an electrical shock to the left median nerve of the wrist.

http://www.diagnosticimaging.com/dimag/legacy/specialedition/neuro04.html

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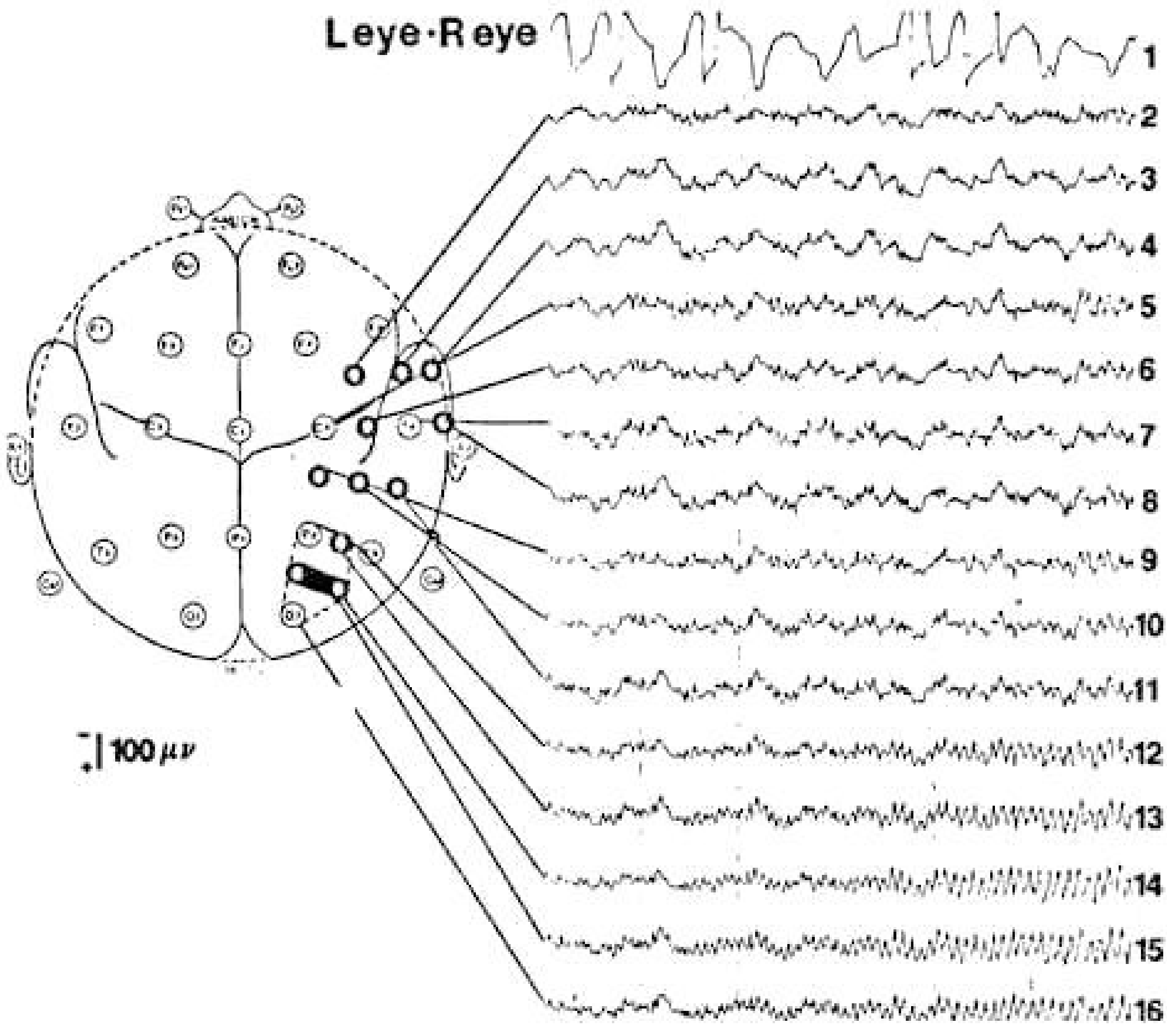

EEG of child with a vestibular seizure. On the bottom right the electrical activity of the brain changes markedly

EEG of seizure 4 using electrodes concentrated over right posterior scalp region. Horizontal eye movements were recorded on channel 1, and EEG using a referential montage to the opposite temporal region (T3) was recorded on channels 2 to 16. The 1st quick phase of the nystagmus (A) was associated with the development of sharp activity in leads 12 to 16 located in the region enclosed by the dashed line. Within this region, the maximum voltage occurred in channels 14 and 15, which is indicated by a dark bar. Each major division in the trace is 1 sec.

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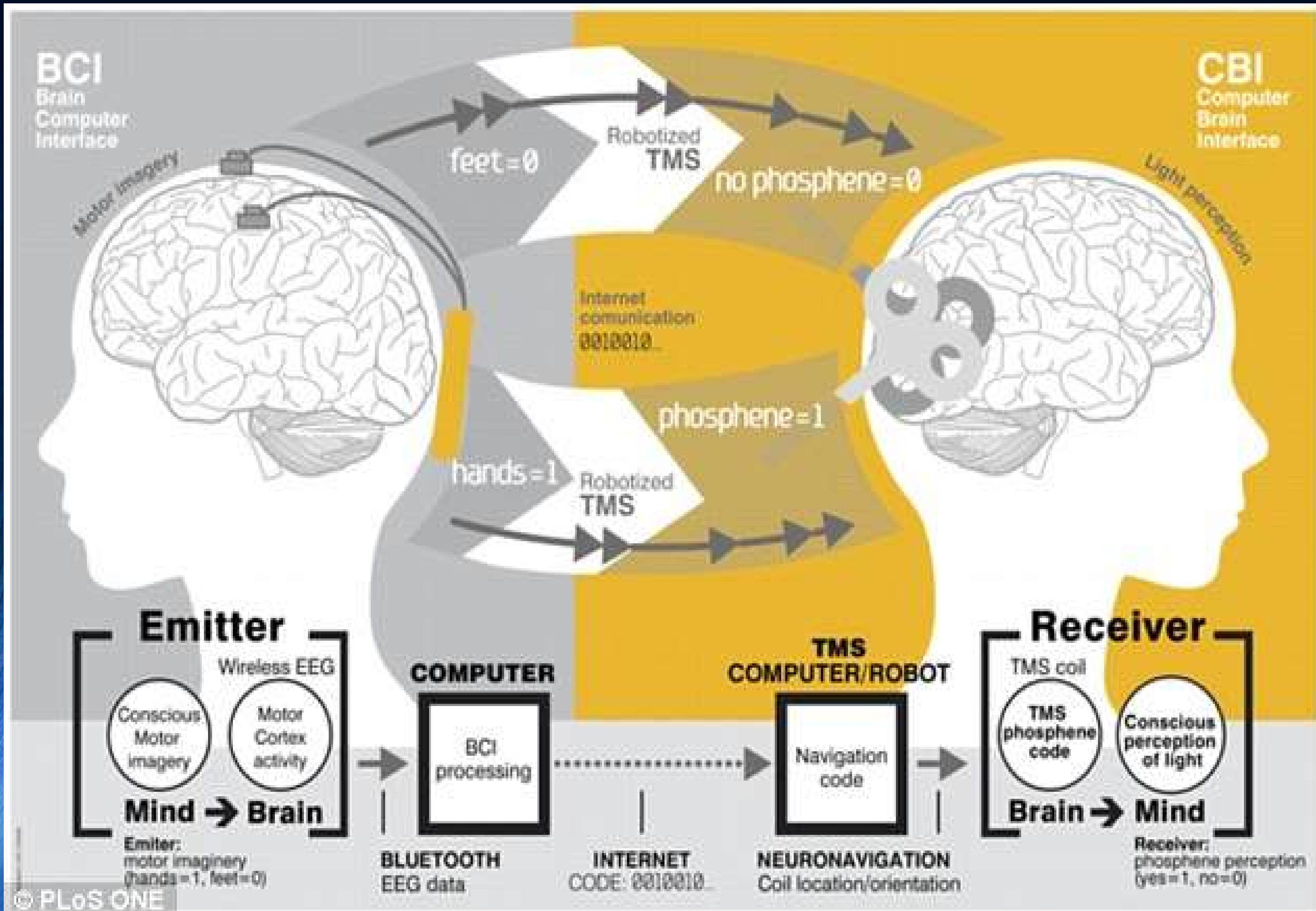

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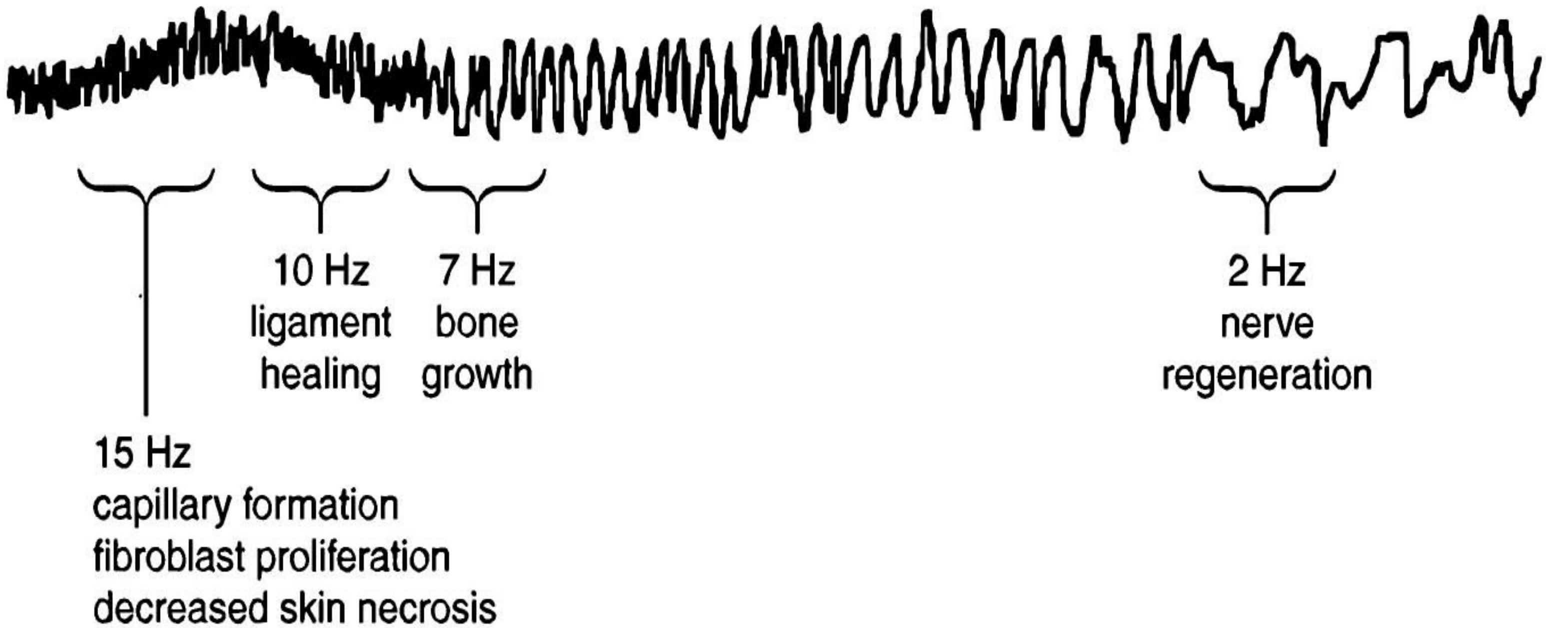

Fig. 7.1 Signal recorded by Dr John Zimmerman from the hand of a practitioner of therapeutic touch. The frequency was not steady, but varied from 0.3 to 30 Hz, with most of the activity in the range of 7–8 Hz. The second wide brackets show portions of the 'sweep' that approximately correspond to some of the clinical results presented in Table 7.1. (Reproduced with kind permission from Dr Zimmerman.)

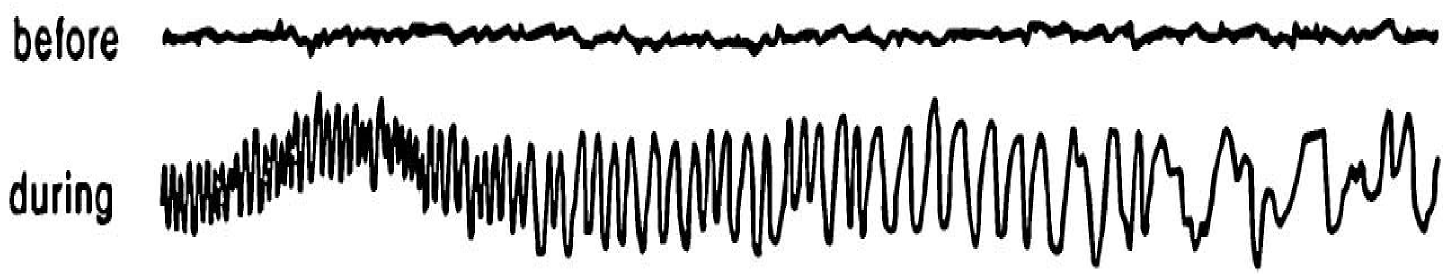

Fig. 6.4 Biomagnetic recordings made before and during a therapeutic touch session. During the 'healing state' the signal pulsed at a variable frequency, ranging from 0.3 to 30 Hz, with most of the activity in the range 7–8 Hz. (The recordings were made by Dr John Zimmerman at the University of Colorado School of Medicine in Denver and reproduced by Dr Zimmerman's generous permission.)

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Frequency	Effects
2 Hz	Nerve regeneration, neurite outgrowth from cultured ganglia
7 Hz	Bone growth
10 Hz	Ligament healing
15, 20, and 72 Hz	Decreased skin necrosis, stimulation of capillary formation and fibroblast proliferation
25 and 50 Hz	Synergistic effects with nerve growth factor

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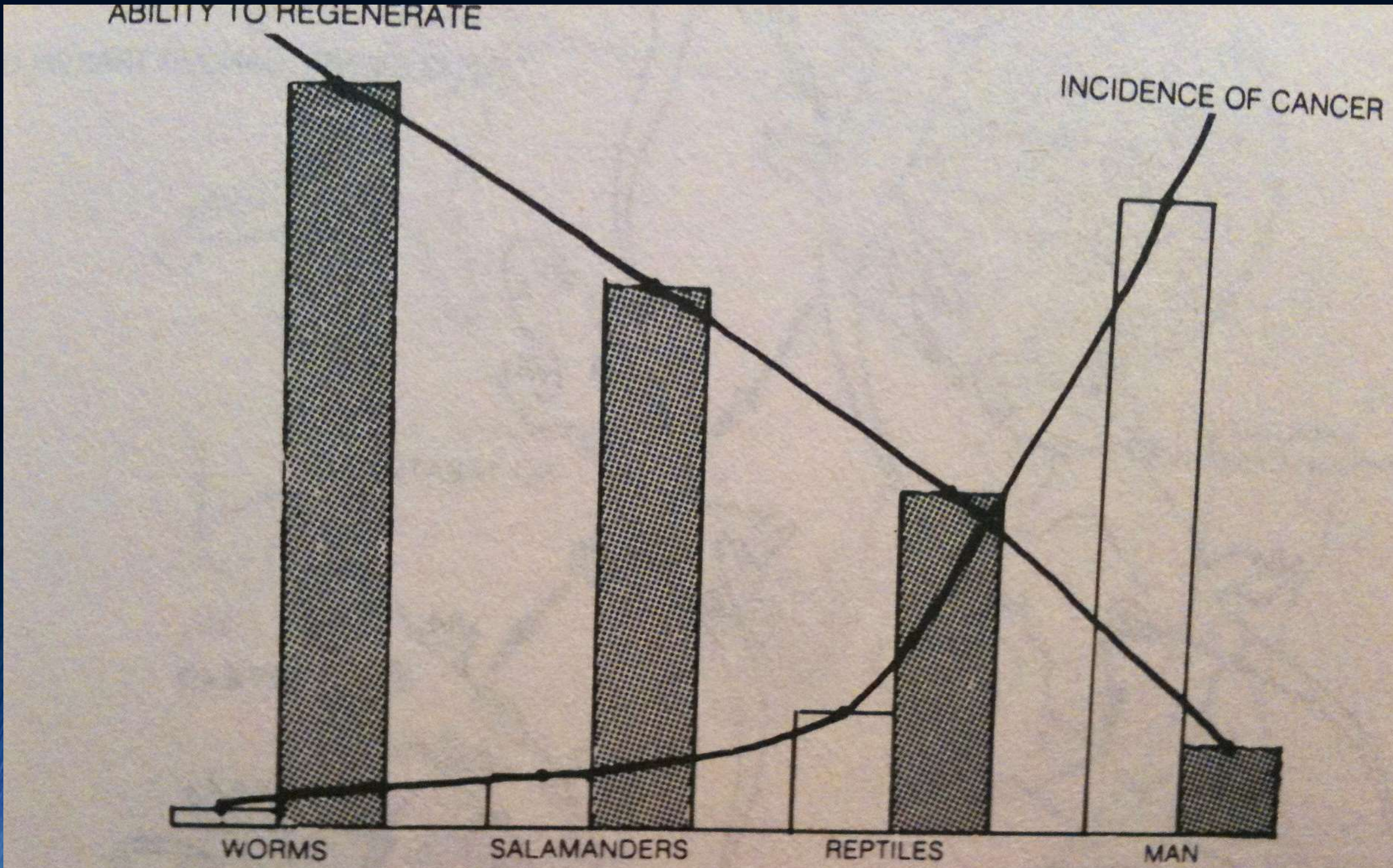


AS REGENERATION DECREASES, CANCER INCREASES

biologic and therapeutic issues to consider

- flux density
- gradient
- frequency
- shape
- dB/dT
- pulse
- polarity
- duration
- exposure duration
- volume of tissue
- localization
- vector

intensity

magnetic field strength

T	Tesla	10000 gauss (g)	1gauss=
mT	milliTesla	$1x10^{-3}$=10g	0.1mT
μT	microTesla	$1x10^{-6}$=0.01g	100uT
nT	nanoTesla	$1x10^{-9}$=0.00001g	100000nT
pT	picoTesla	$1x10^{-12}$=0.00000001g	100000000pT

Earth ~0.5 gauss (50 uT or 0.05 mT)
body ~10 nT to 100 pT
static magnets ~ 1-200 mT

clinical magnetic field strengths

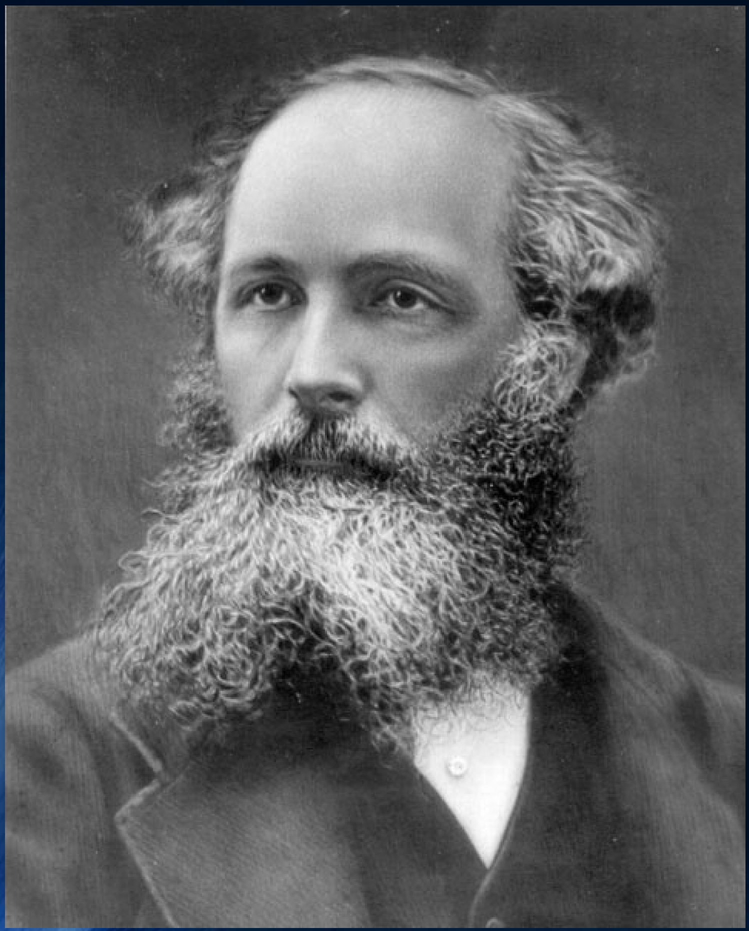
- Tesla – MRI, rTMS
- pT – Jacobson
- μT – most whole body systems
- mT – local & whole body

Carl Friedrich Gauss
German mathematician/physicist
1777 - 1855

gauss, G,
cgs unit of magnetic field B
also "magnetic flux density", or
"magnetic induction
1 gauss=1 maxwell/cm^2=0.0001
Tesla.

Gauss's law: magnetic field lines never begin nor end but form loops or extend to infinity

Maxwell
1831-1879



Faraday
1791-1867

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Faradays' Law

electromagnetic force is proportional to the rate of change of the magnetic flux

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

frequency

(ie wavelength)

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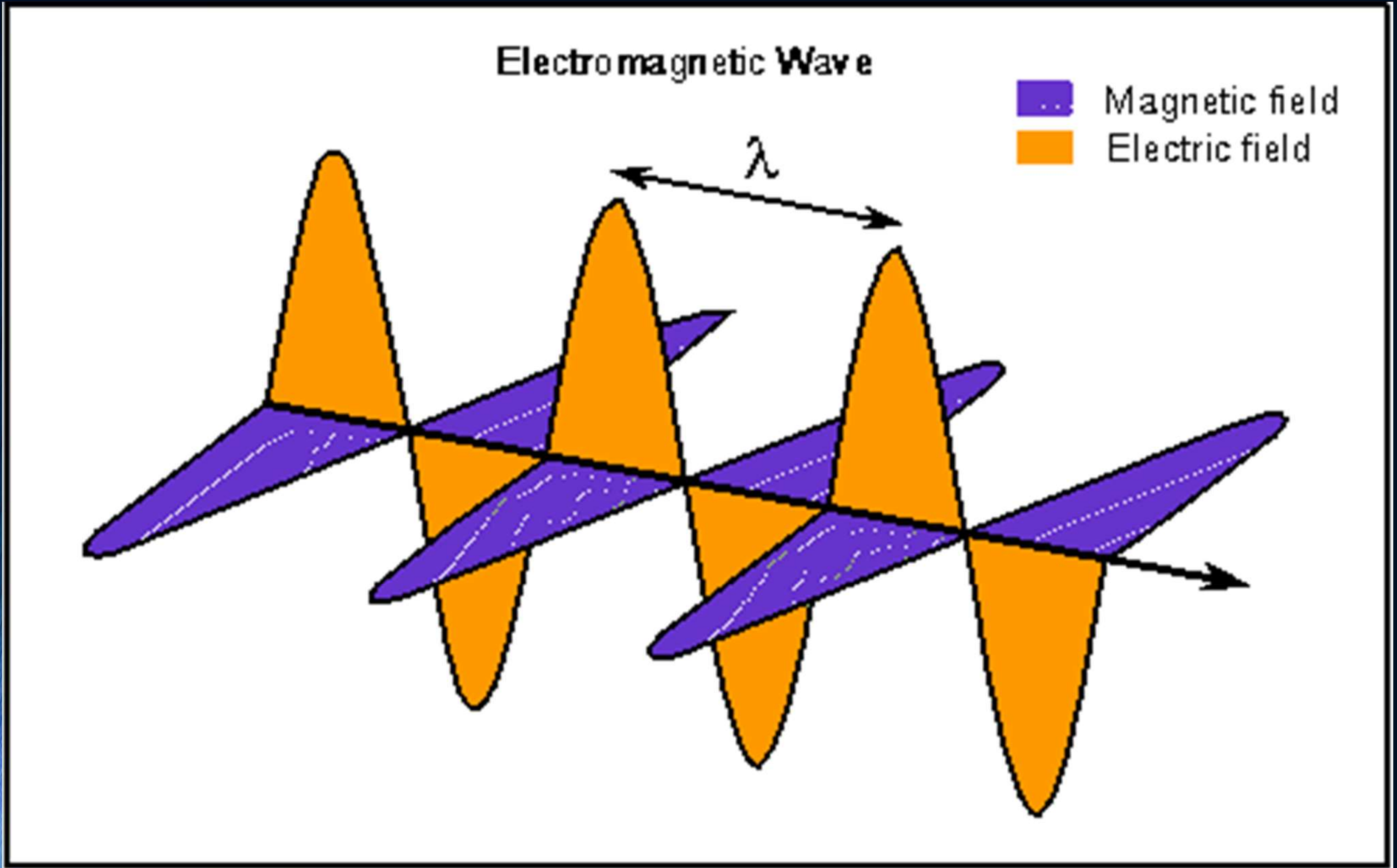

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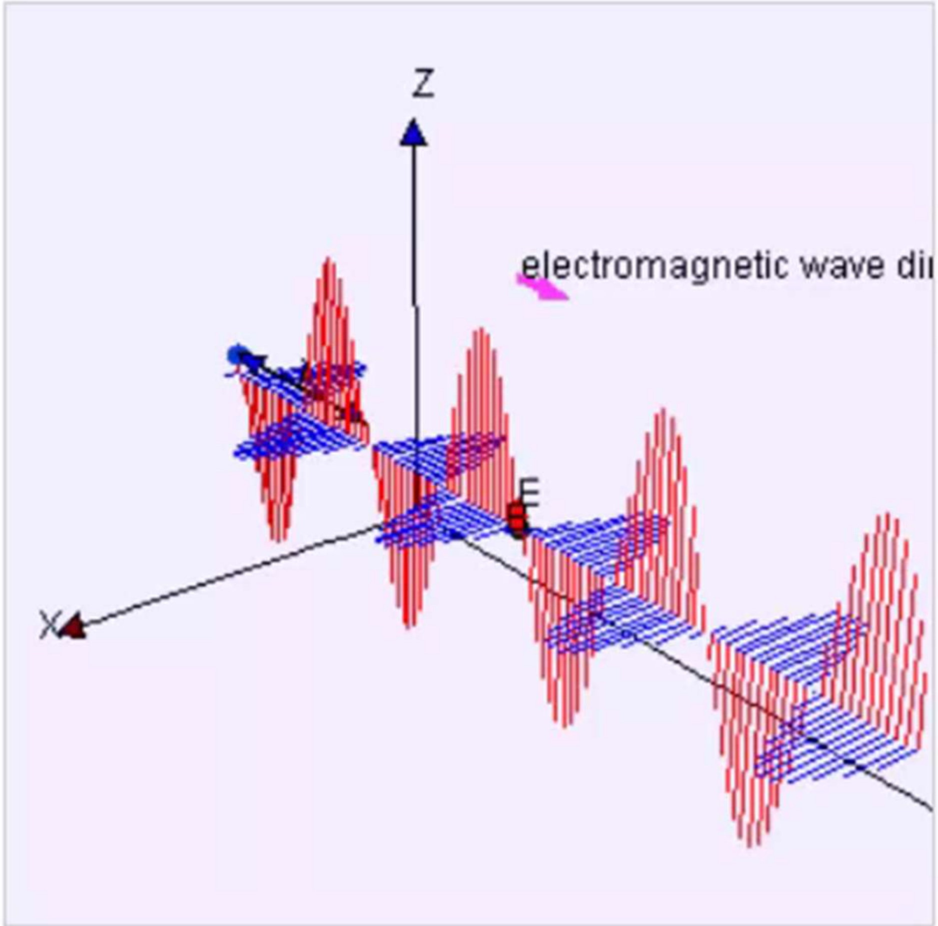

An alternate view of the wave shown above.

definition and dypothesis

“healing energy”, whether produced by a medical device or projected from the human body, is energy of a particular frequency or set of frequencies that stimulates the repair of one or more tissues.”

from “Energy Medicine: the Scientific Basis”, by James Oschman, 2000

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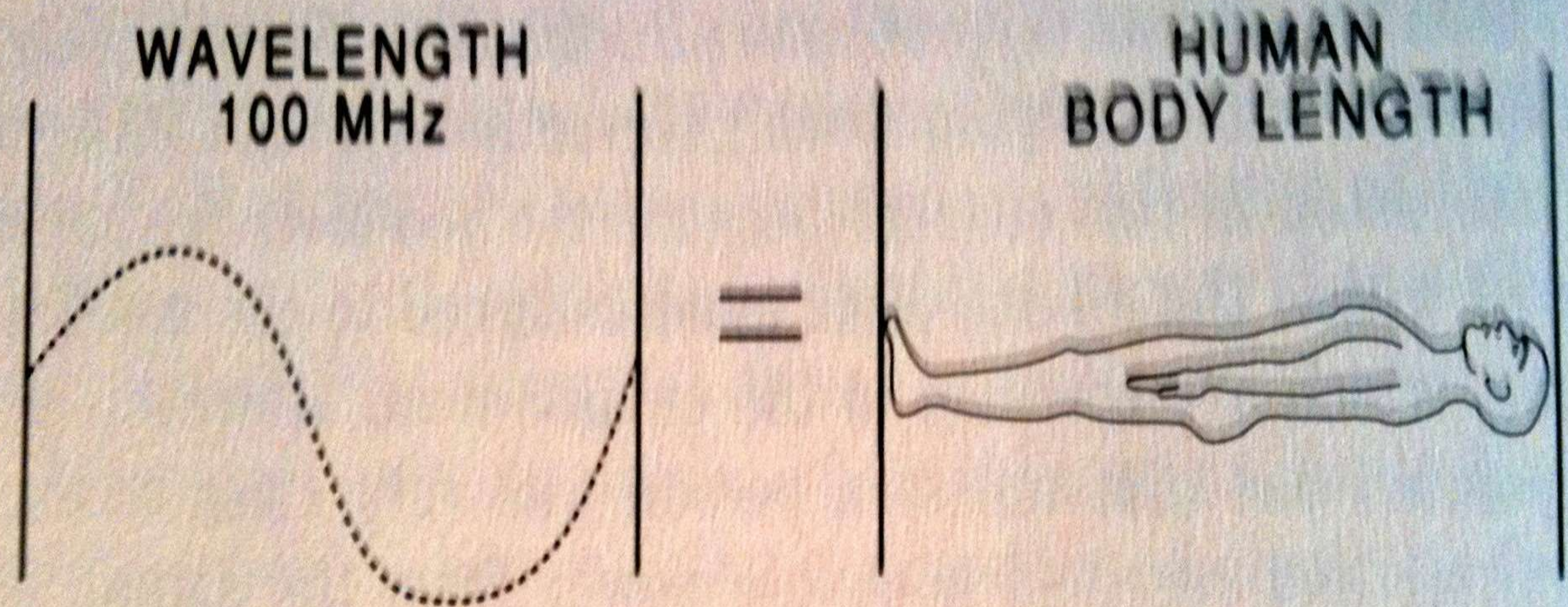

FIGURE 10-2. *Simple resonance between a 100-MHz electromagnetic wave and a six-foot human.*

1. the greater the energy, the larger the frequency and the shorter the wavelength
2. the higher the frequency, the shorter the wavelength
3. short wavelengths are more energetic than long wavelengths.

http://hubblesite.org/reference_desk/faq/answer.php.cat=light&id=73

wavelength in meters

frequency Hz	light	sound in air
1	3E+08	343
5	59,958,492	69
10	29,979,246	34
20	14,989,623	18
50	5,995,849	7
100	2,997,925	3

1609 m in a mile

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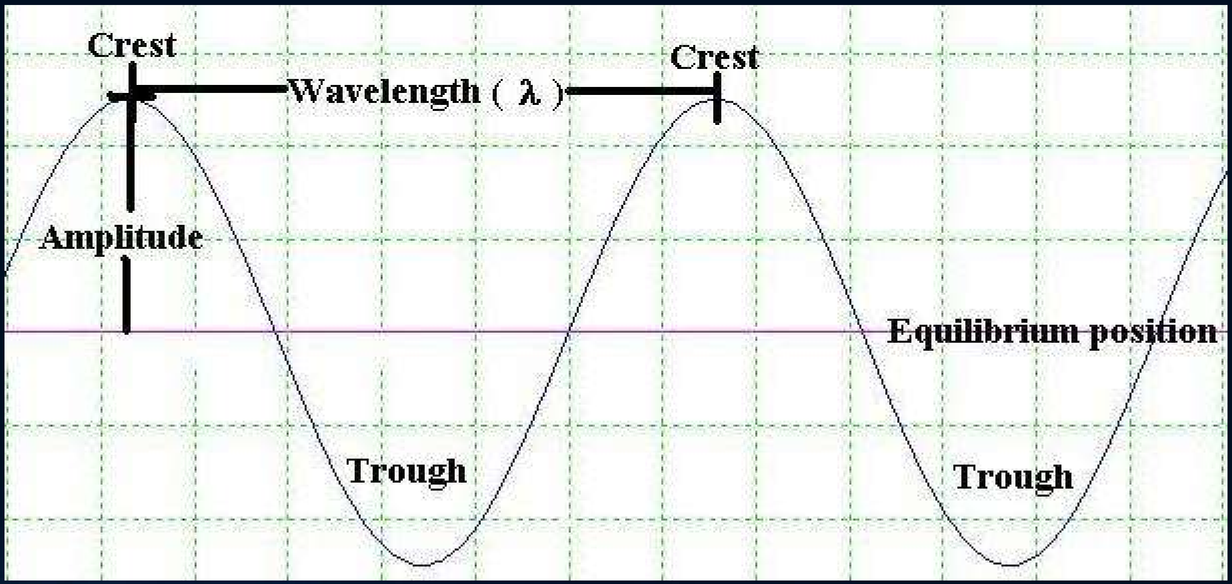

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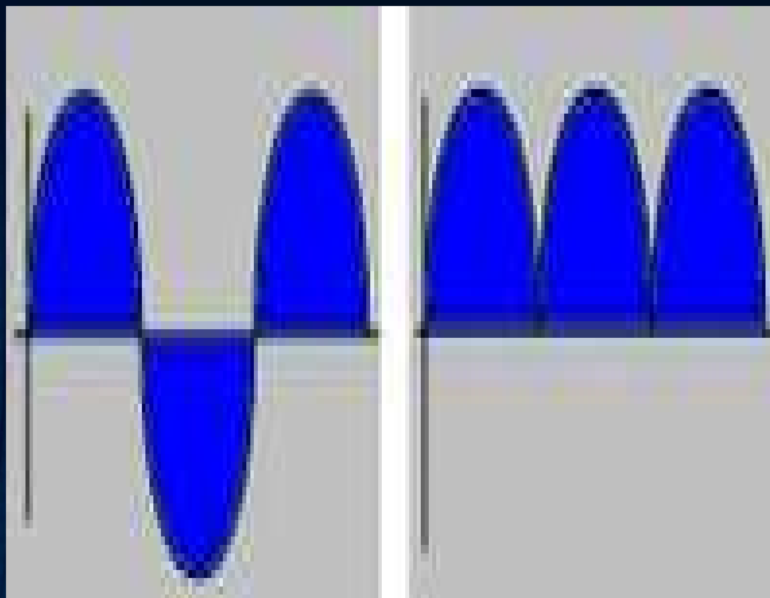

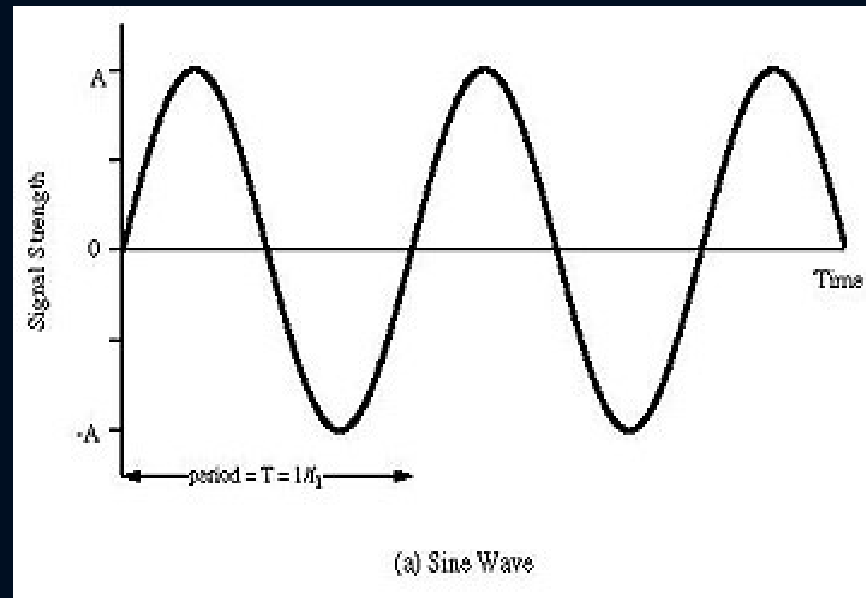

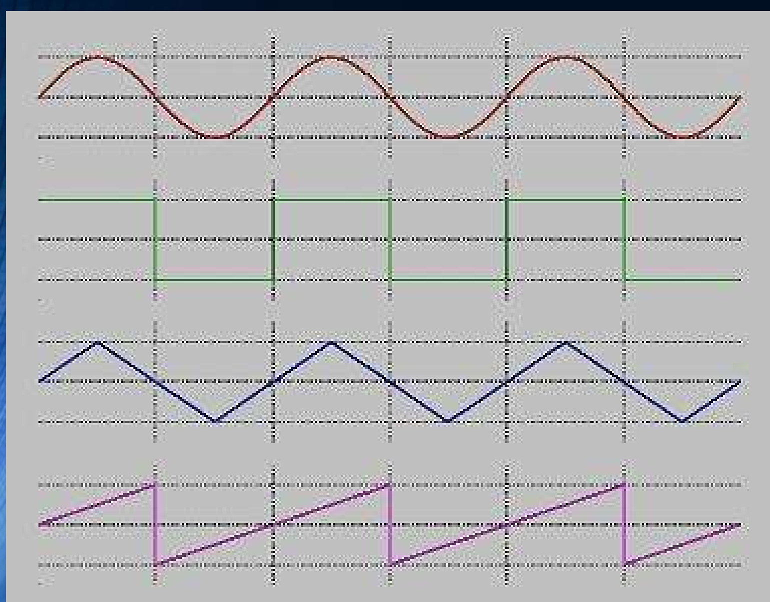

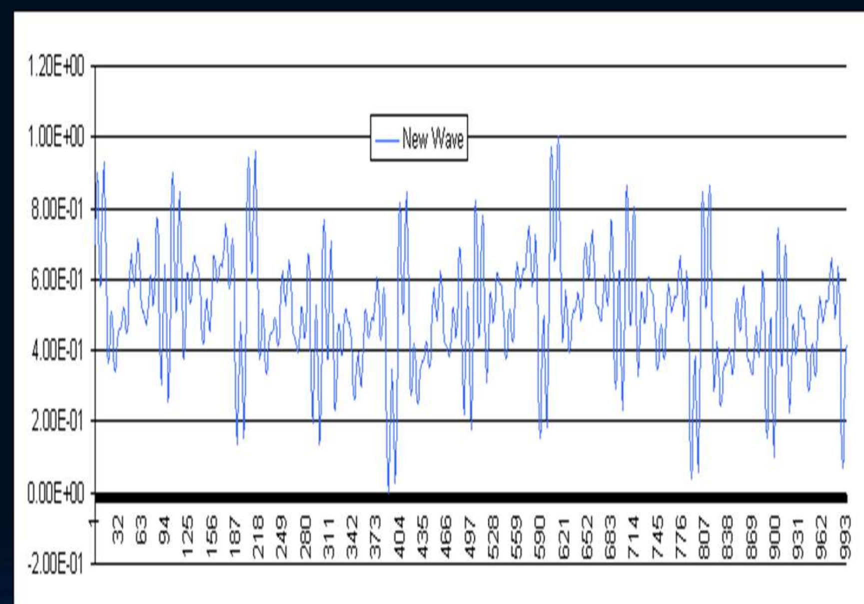

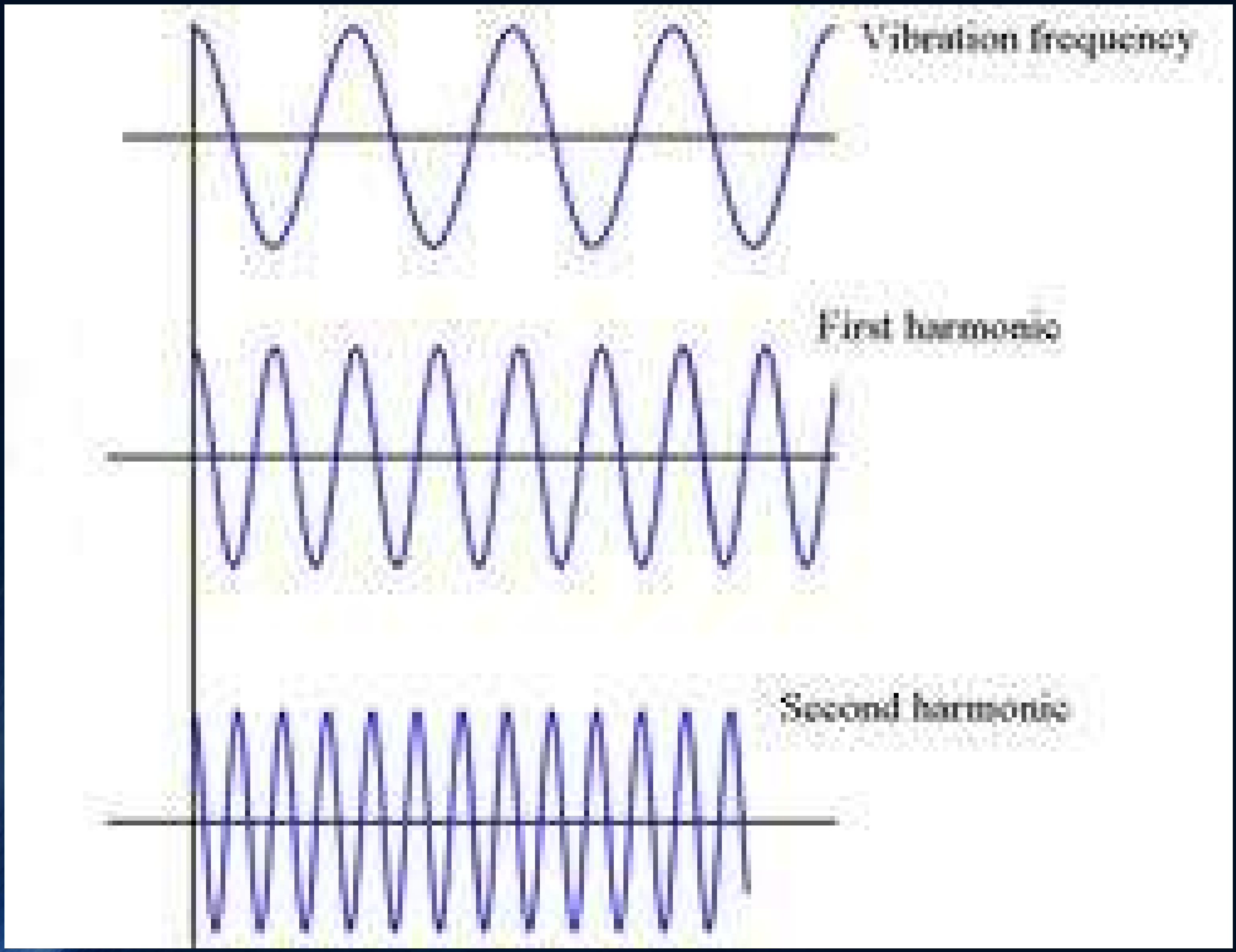
Vibration frequency
First harmonic
Second harmonic

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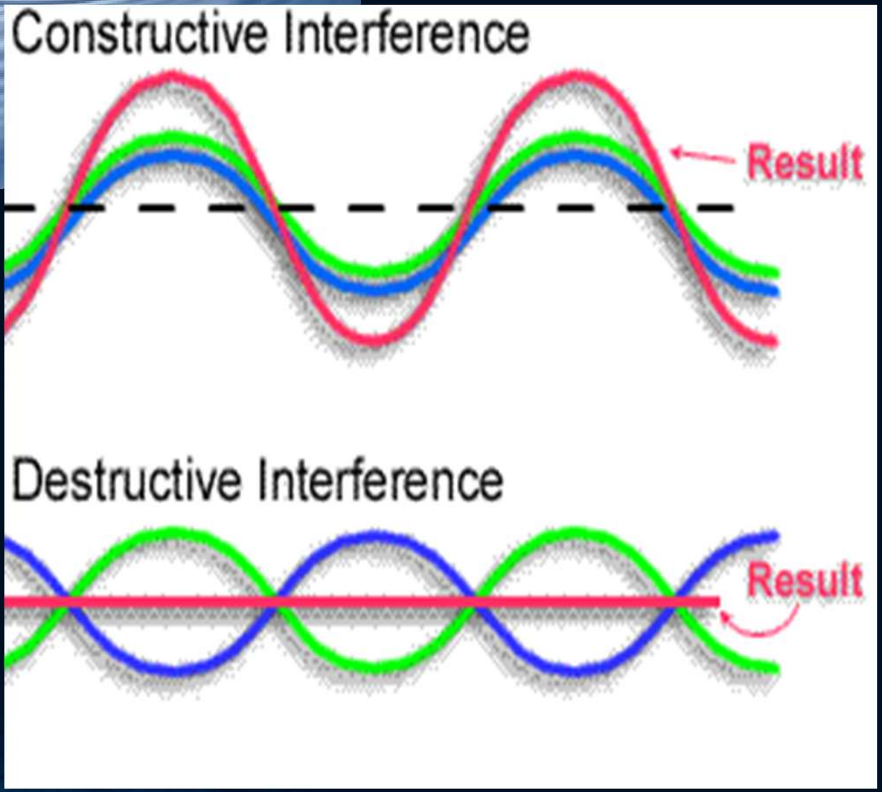

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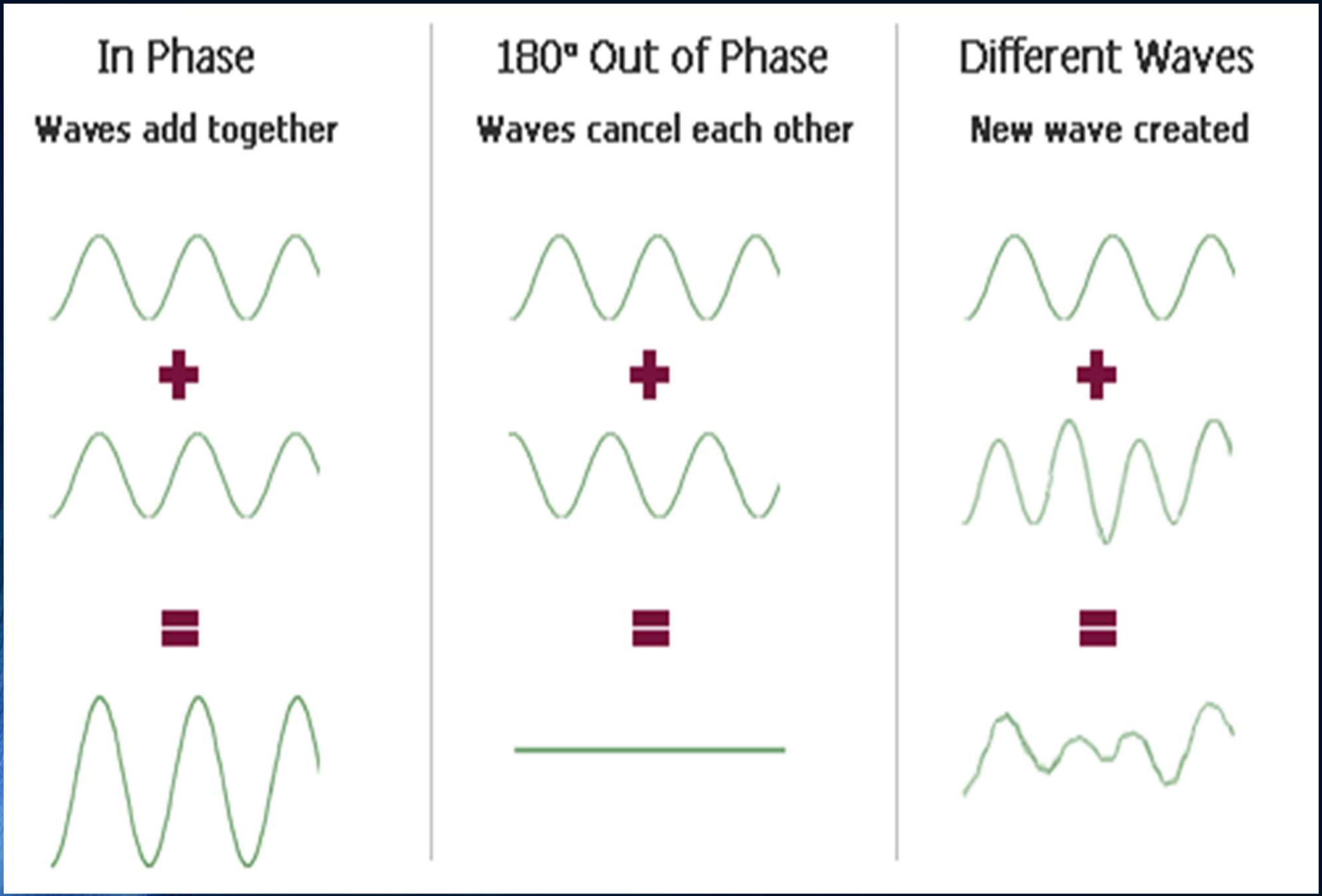

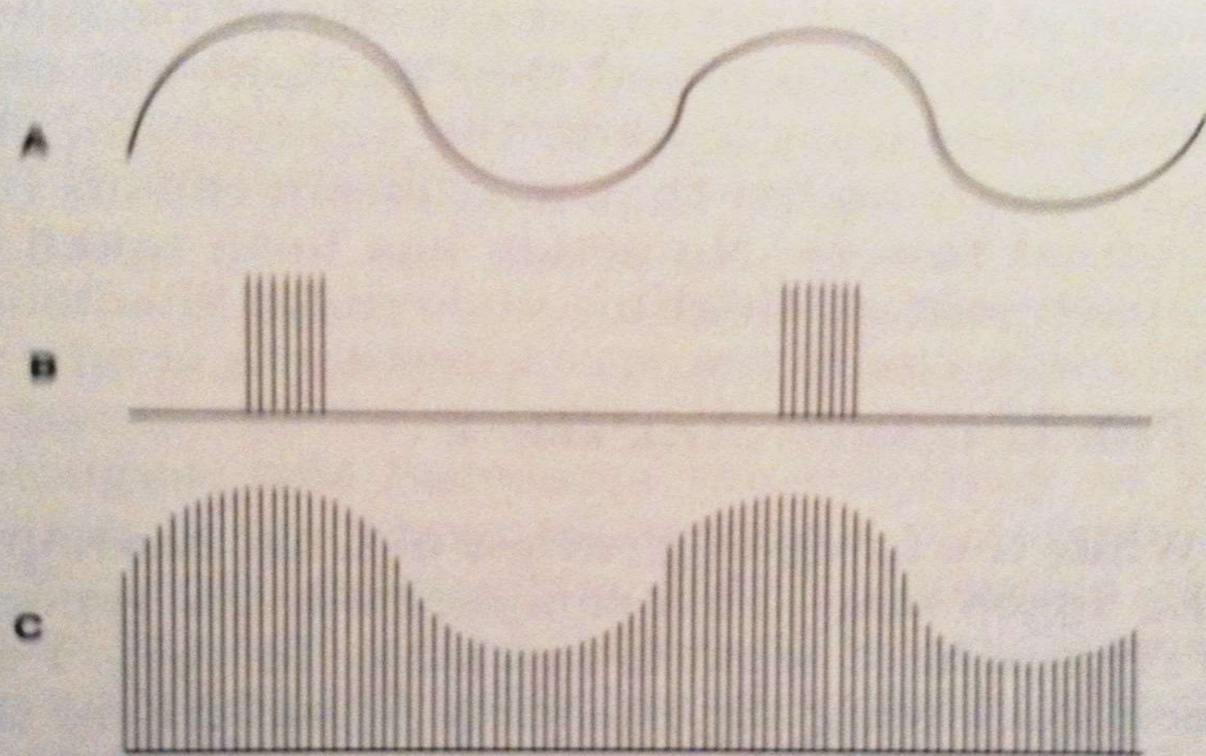

FIGURE 8-3. *Examples of modulation.* A *is a primary 16-Hz signal, oscillating at 16 times per second.* B *is pulse modulation (a microwave or radio-frequency signal, pulsed at 16 Hz). The microwave is turned on every* 1/16 *second and is off the rest of the time.* C *is amplitude modulation. This is the same microwave or radio-frequency signal oscillating continuously, but with the signal amplitude, or power, rising and falling smoothly at a 16-Hz period.*

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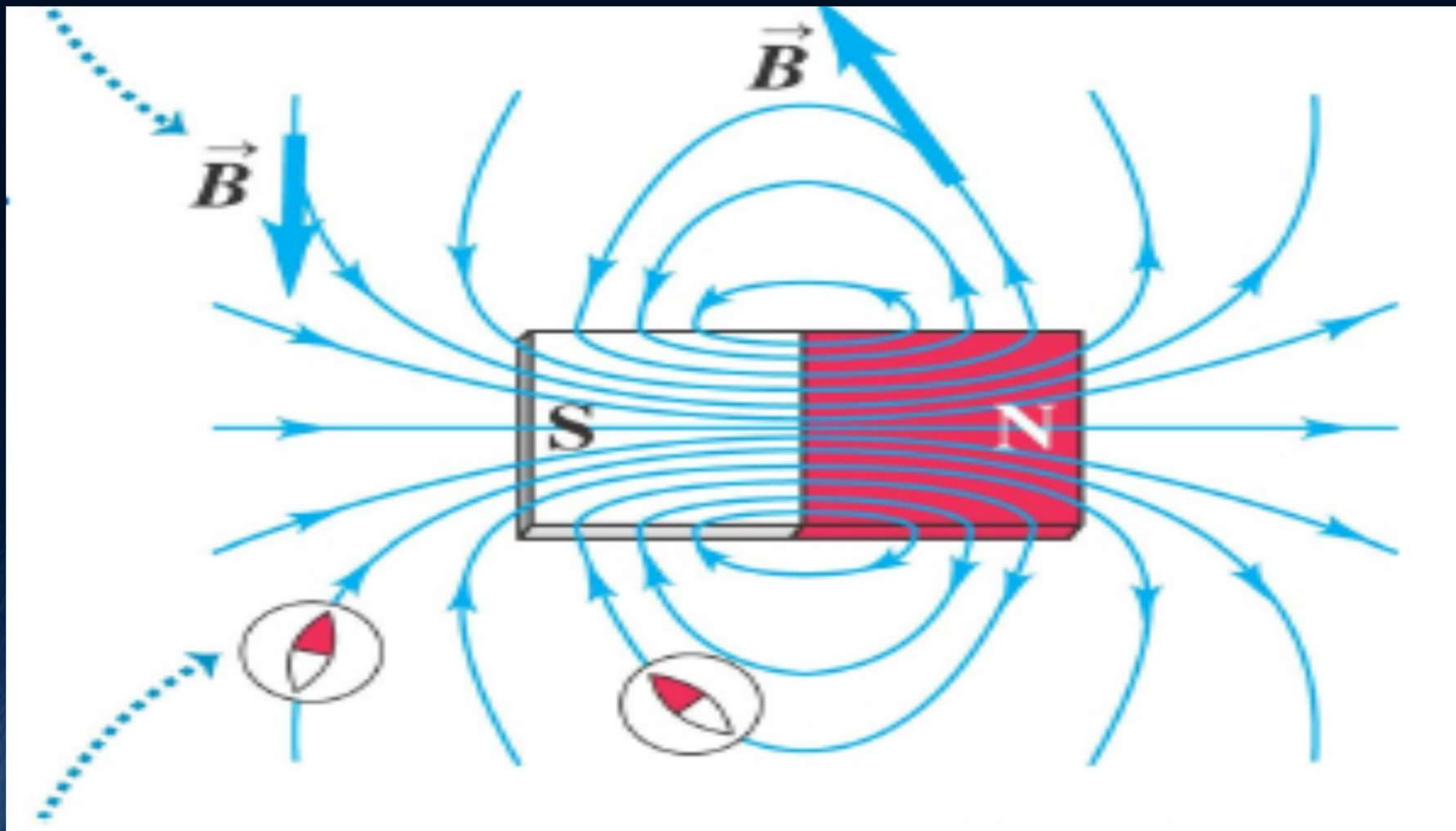
polarity of static magnetic fields



the field lines have no flow – they just have direction polarity of PEMFs

the polarization of the wave is the direction
(within a 2D plane) the field is moving in,
so there is no north pole vs south pole effect

applying a pulsed magnetic field to a body is like throwing a stone in a pond,

the waves go on and on for a long time

the body is transparent to a low frequency magnetic field

nothing in the body stops, slows or uses up a magnetic field

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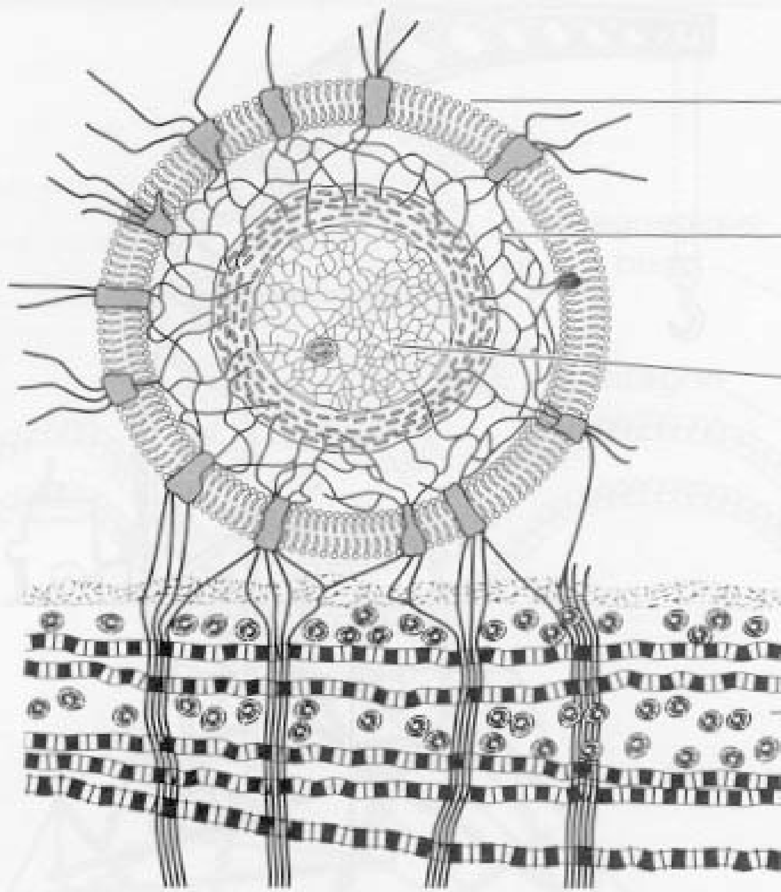

Fig. 4.6 The tissue matrix system as described by Pienta & Coffey 199
(Reproduced with permission from Medical Hypotheses.)

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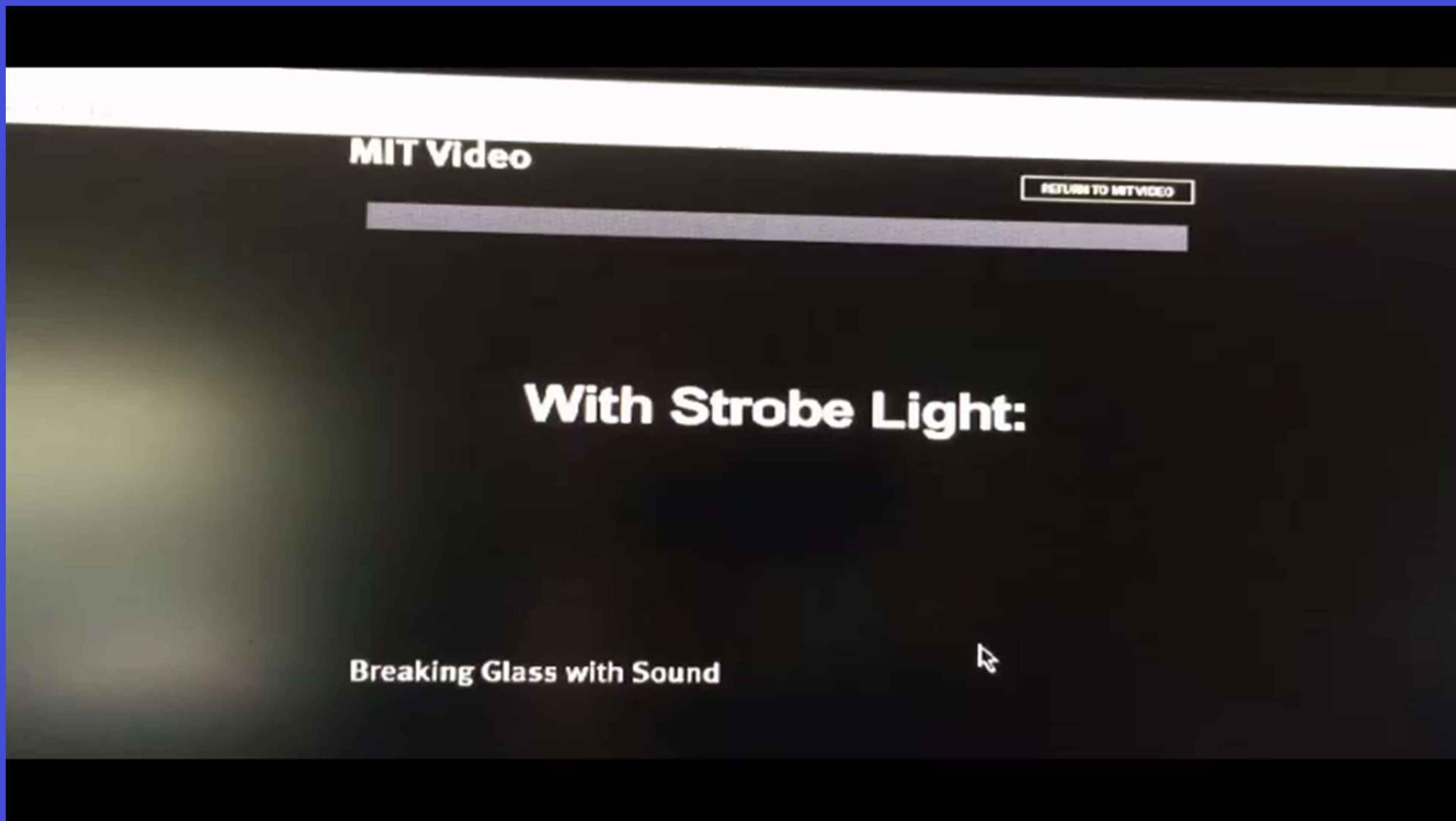

since the body is about 70% water …

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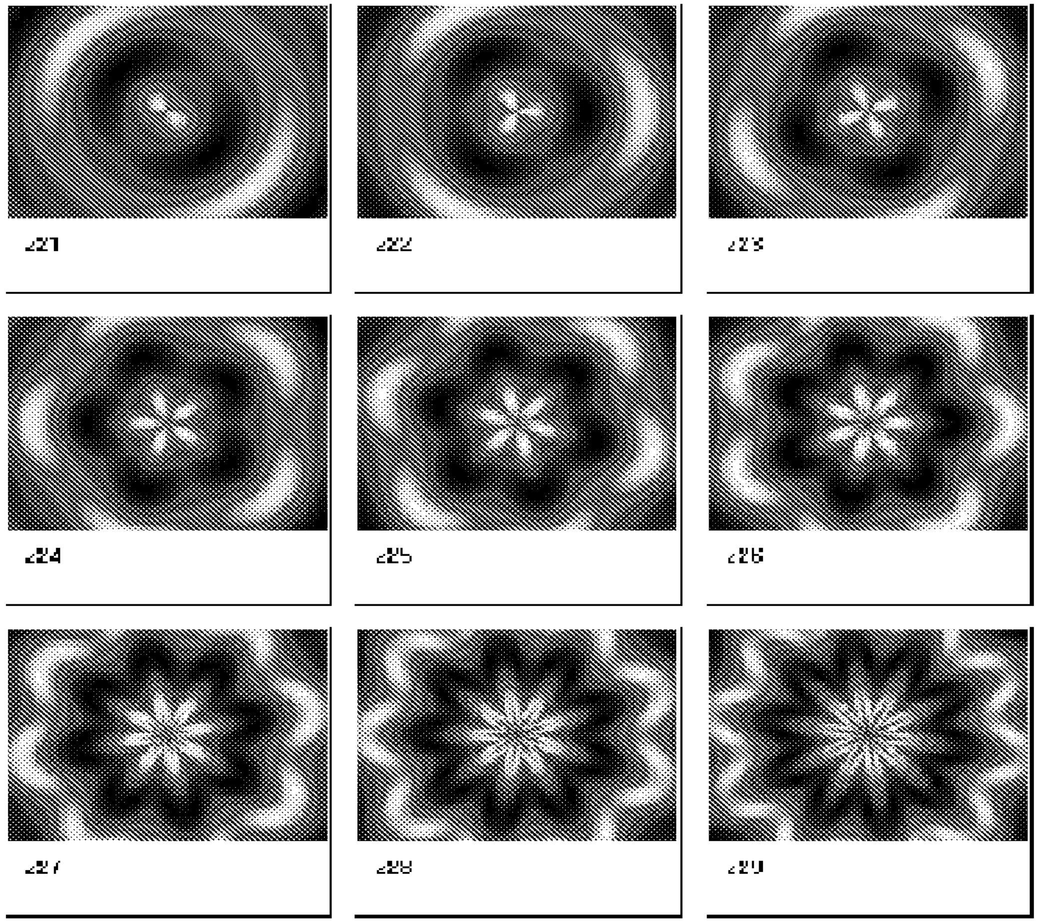
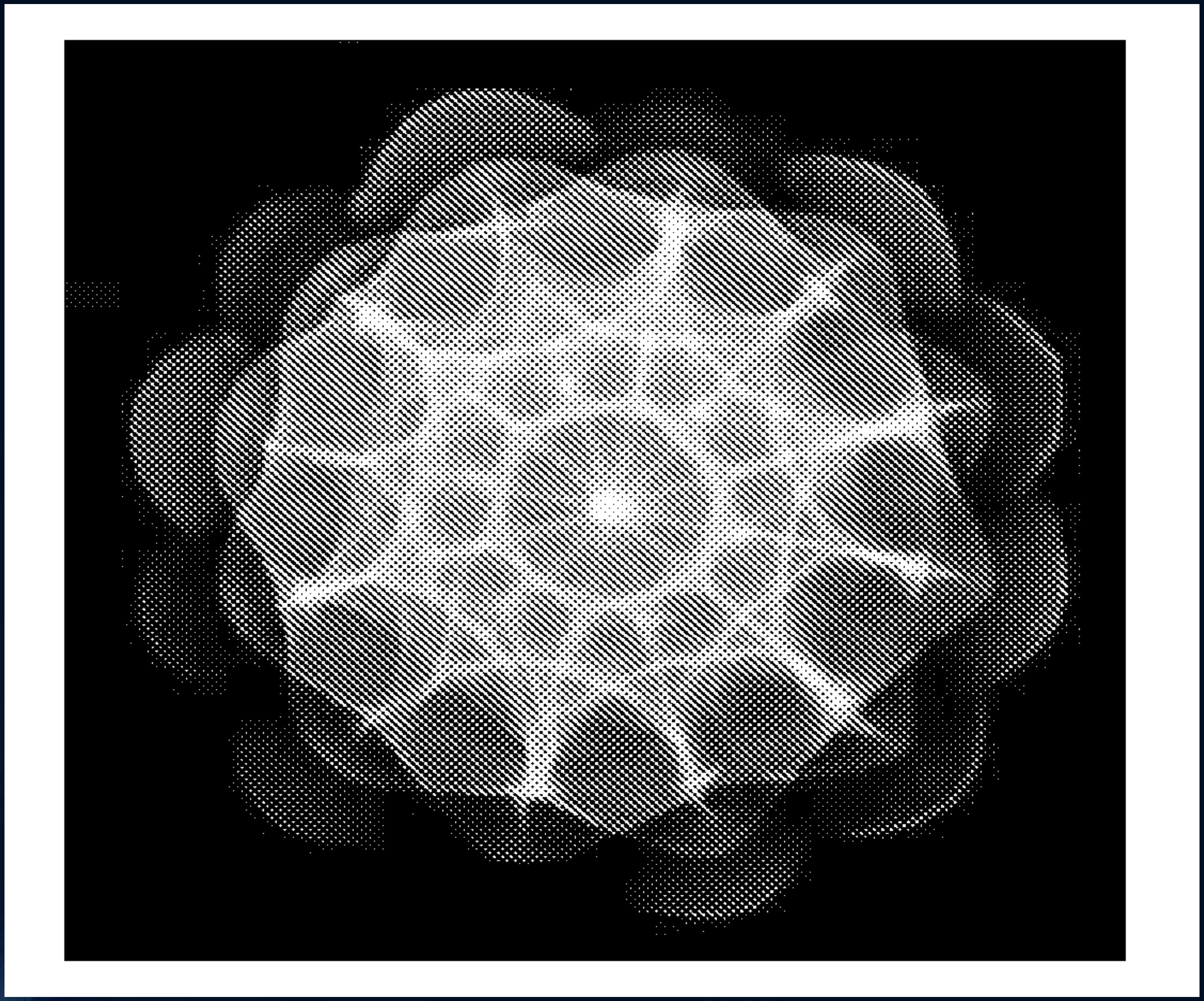
Cymatics, from Greek: κῦμα, meaning "wave", is a subset of modal vibrational phenomena

https://www.youtube.com/watch?v=Q3oItpVa9fs



Sound structures in the water drop as a function of the wavelength

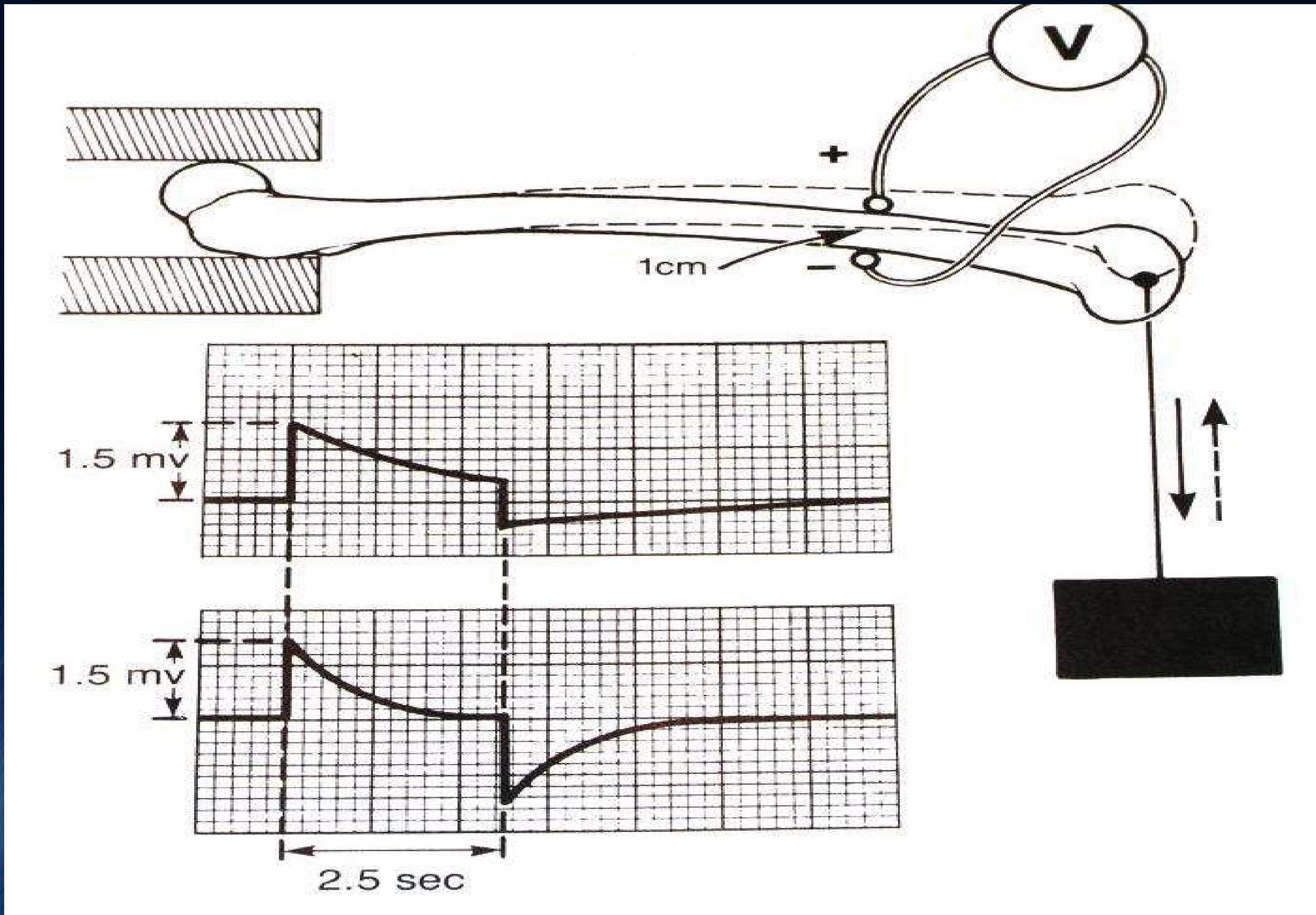
and a function of the extent



Chladni Figure – sound and sand

all magnetic fields, esp. strong magnetic fields, create pressure waves in tissues

one way PEMFs generate charge, because of these pressure waves, is the piezo-electric effect


V
+
1cm
–
1.5 mv
1.5 mv
2.5 sec

- every cell has its own frequency and a number of cells with the same frequency create a new frequency, in harmony with the original, in turn forming an organ that also creates a new frequency in harmony with the two preceding ones.

- the key to understanding how to heal the body with the help of frequencies lies in how different frequencies influence genes, cells and various structures in the body.

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ultrasound vs PEMF

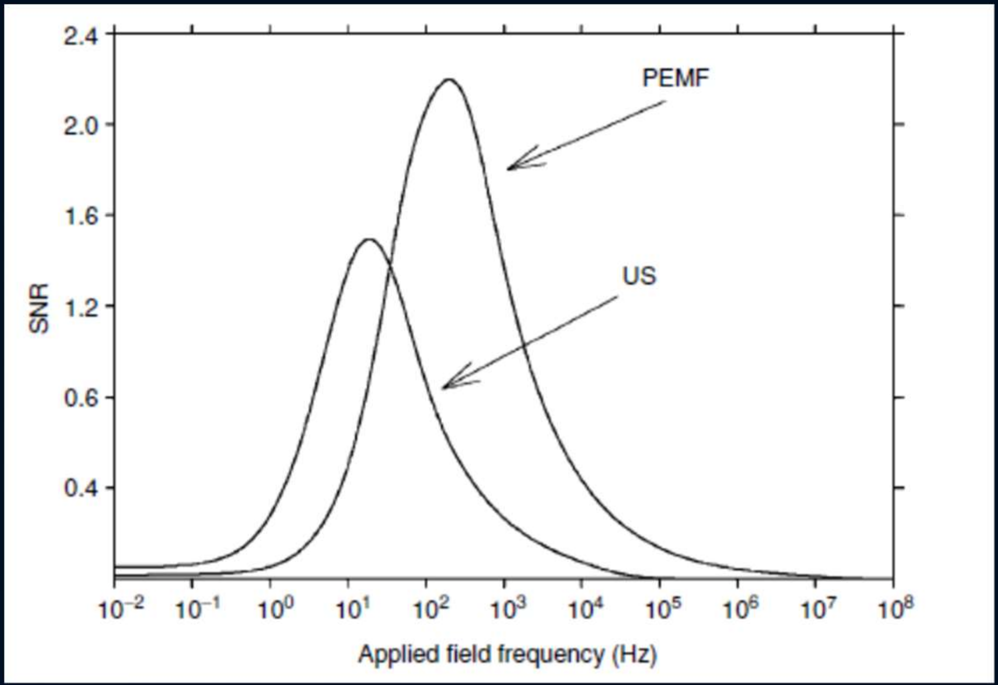

Figure 17: SNR in a Ca/CaM transduction pathway for a standard bone repair PEMF (see top, figure 2) and the streaming potential from a pulsing US signal, also in use for bone repair (see text for details). These curves show there is sufficient SNR produced by both signals in a transduction pathway which may be common to both signals. SNR peak for the US signal is shifted toward the lower frequency range reflecting the lower frequency content of the mechanically induced time-varying electric field.

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frequency windows

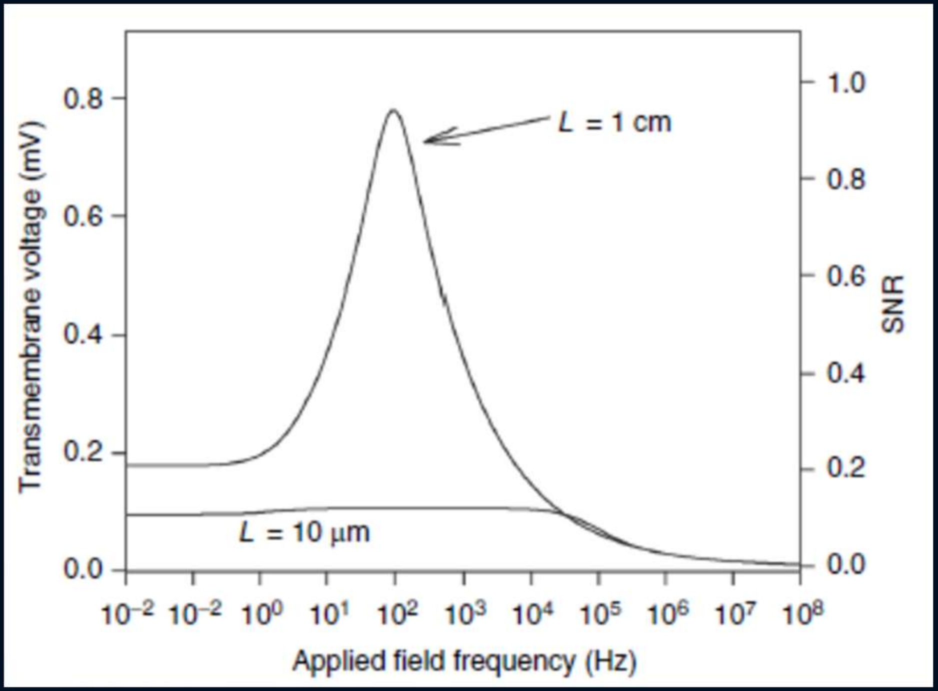

Figure 14: Response of cell array with K+ conductance membrane model to 10 mV/cm electric field at a given transmembrane resting voltage. Frequency response of array exhibits a wide resonance response for applied field frequencies in the 16 Hz range. K+ conductance at a given voltage is described in the Hodgkin–Huxley formulation as a series resistance–inductance branch in the membrane model. Note the broad resonance at frequencies in the 10-100 Hz range. SNR was calculated according to the method described in section 3.12. Note that resonance is not significant for a single cell, only for a long cell or cell array.

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Table 3. Comparison of Electromagnetic Field Parameters Among Various Electromagnetic Treatment Modalities Currently Used for Depression and LFMS

	Method	Field	Pulse	Frequency
ECT	Electrode	>200 V/m	1 msec	60 Hz
DBS	Implant	100 V/m	60 µsec	120 Hz
rTMS	Coil	100 V/m	500 µsec	10 Hz
LFMS	Coil	1 V/m	256 µsec	1 kHz

The delivery method, electric field strength, and pulse characteristics for these electromagnetic therapies are shown. Most treatment modalities feature electric fields well over the 50 V/m threshold required for axonal stimulation. Note that the small voltage used in DBS results in a large electric field when applied over the small distance between electrodes positioned in the brain.

DBS, deep brain stimulation; ECT, electroconvulsive therapy; LFMS, low field magnetic stimulation; rTMS, repetitive transcranial magnetic stimulation.

Rohan ML, Yamamoto RT, Ravichandran CT, et al. Rapid mood-elevating effects of low field magnetic stimulation in depression. Biol Psychiatry. 2014 Aug 1;76(3):186-93.

As for thermal effects, the temperature increase of biological tissue rises from direct radiofrequency energy absorption. The deposition and distribution of energy within the body is highly non-uniform and depends on the frequency range of the incident electromagnetic radiation. As for energy absorption properties of the human body, electromagnetic frequency spectrum can be divided into four ranges [67]:

1. from 100 kHz up to 20 MHz, the absorption in the trunk decreases rapidly with decreasing frequency and significant absorption may occur in the neck and legs;

2. form 20 MHz up to 300 MHz, relatively high absorption can occur in the whole body, and to even higher values if partial body resonances are considered;

3. from 300 MHz up to several GHz, significant local, non uniform absorption occurs;

4. above 10 GHz, energy absorption occurs primarily at the body surface.

It must be noted that electromagnetic waves normally utilized in MRI techniques are in the second range of absorption, at which high absorption occurs in the whole body.

Many EMF signals have the capacity to achieve a physiologically meaningful bioeffect.

Why should different “doses” be effective?

Are any signal parameters better than others?

Is it the magnetic or electric field, or both?

Does the state of the target tissue play a role?

EMF signals may appear to have been chosen in an arbitrary manner; EMF dosimetry is critical to explaining these effects.

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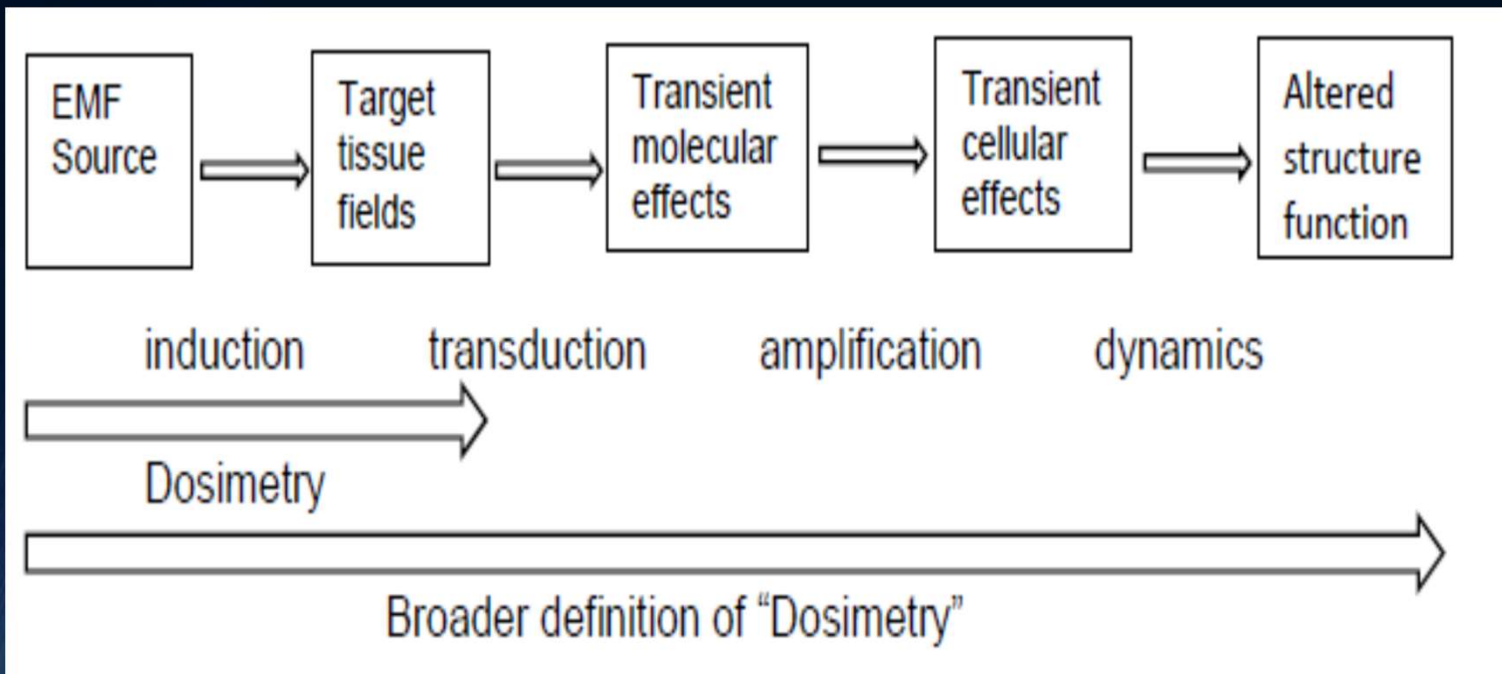
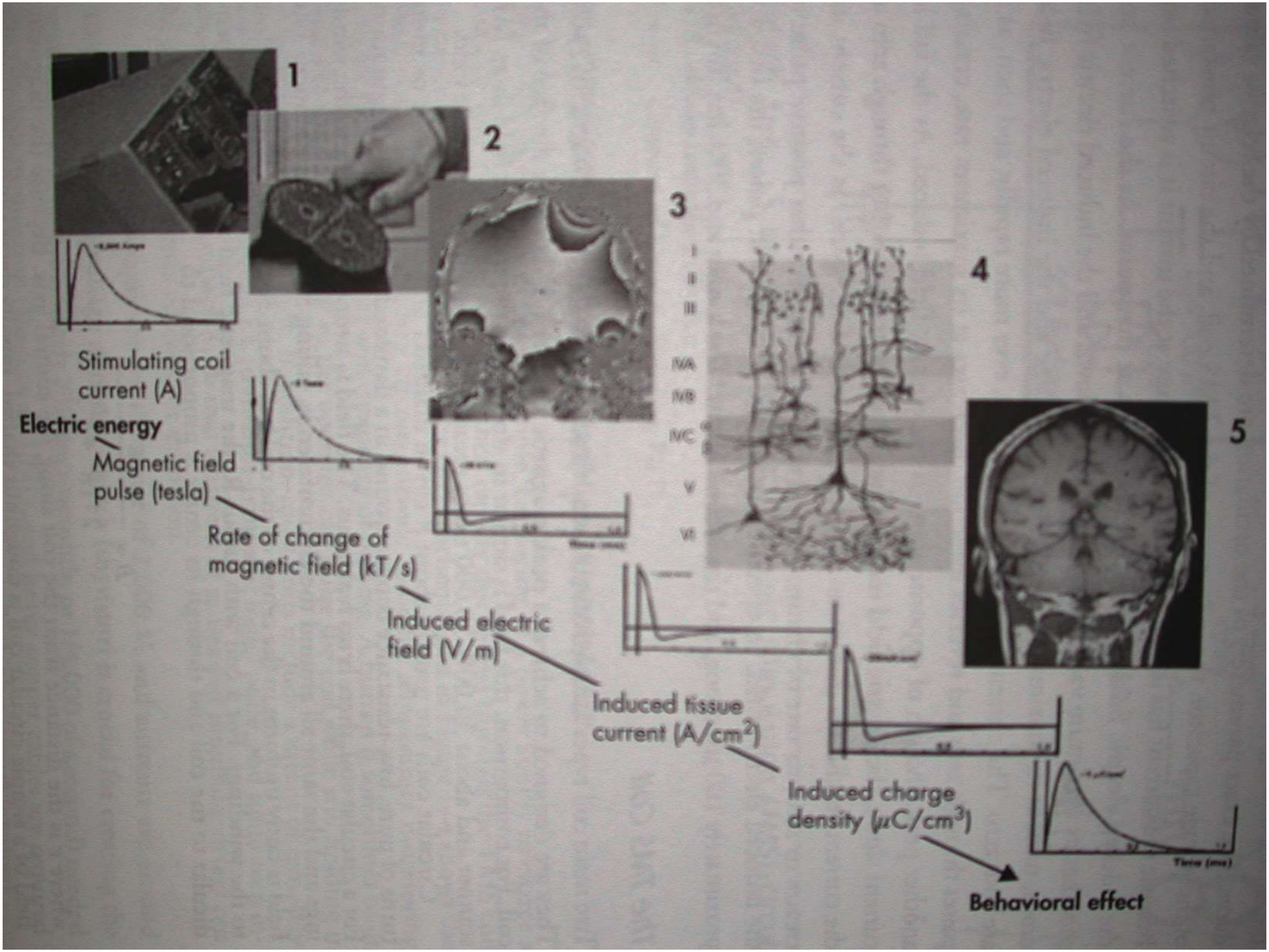
clinical dosimetry model



Bowman J. RF exposures to the general public: lessons from “dosimetry” for ELF – EMF epidemiology. Joint NIOSH/DOE Workshop. EMF exposure assessment and epidemiology: hypotheses, metrics, and measurements. Cincinnati Ohio, September 1994.



1
2
3
4
5
I
II
III
IVA
IVB
IVC
V
VI
Stimulating coil current (A)
Electric energy
Magnetic field pulse (tesla)
Rate of change of magnetic field (kT/s)
Induced electric field (V/m)
Induced tissue current (A/cm²)
Induced charge density (μC/cm³)
Behavioral effect

induced currents

most of the actions of PEMFs have been considered to be the result of induced charge or current by the magnetic field, i.e they generate

inductively coupled electrical stimulation

induced currents

- electromagnetic bioeffects from relatively weak (below heating and excitation thresholds) signals can be produced with a time-varying electric field, E(t), induced from an applied time-varying magnetic field, B(t).
- a large number of electromagnetic clinical devices in present use (particularly for bone and wound repair) induce 1–100 mV/cm peak E at the treatment site

induced currents

- the induced E field will be greater when the magnetic field intercepts a greater cross-sectional treatment area, i.e., maximum E field in the target depends upon target size
- peak E field and it's current density is in Joules, J
- dB/dt (in T/s) is also a measure of the peak induced electric field, for a given EMF signal.
- eg, a common clinical bone repair signal produces 20 G peak magnetic field in 20 μsec. dB/dt = 106 G/sec & peak Eφ(t) = 1 V/m = 10 mV/cm at a radius of 2 cm in the target

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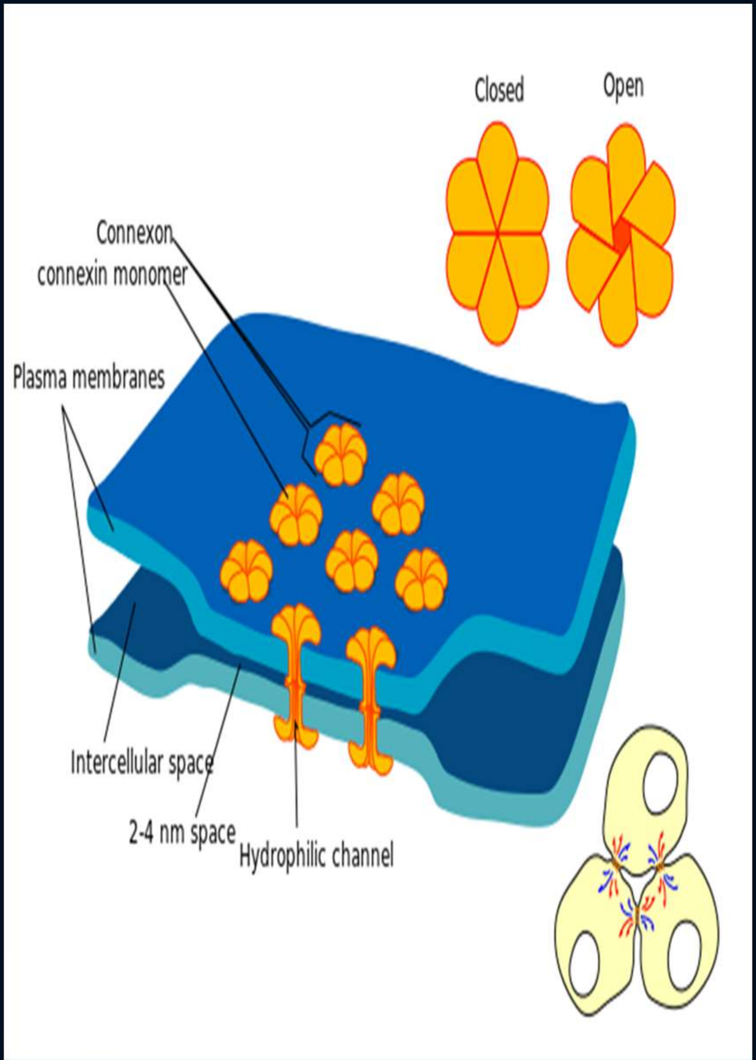
gap junctions

- pathways for ions/molecular intercellular communication in all tissues including bone
- cooperative organization of cells is important for EMF sensitivity of biological systems
- provide ionic coupling and metabolic cooperation, without which disorders in growth control, tissue repair, neoplastic transformations could occur
- EMFs and PEMFs generate functional modification of gap junctions



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induced currents

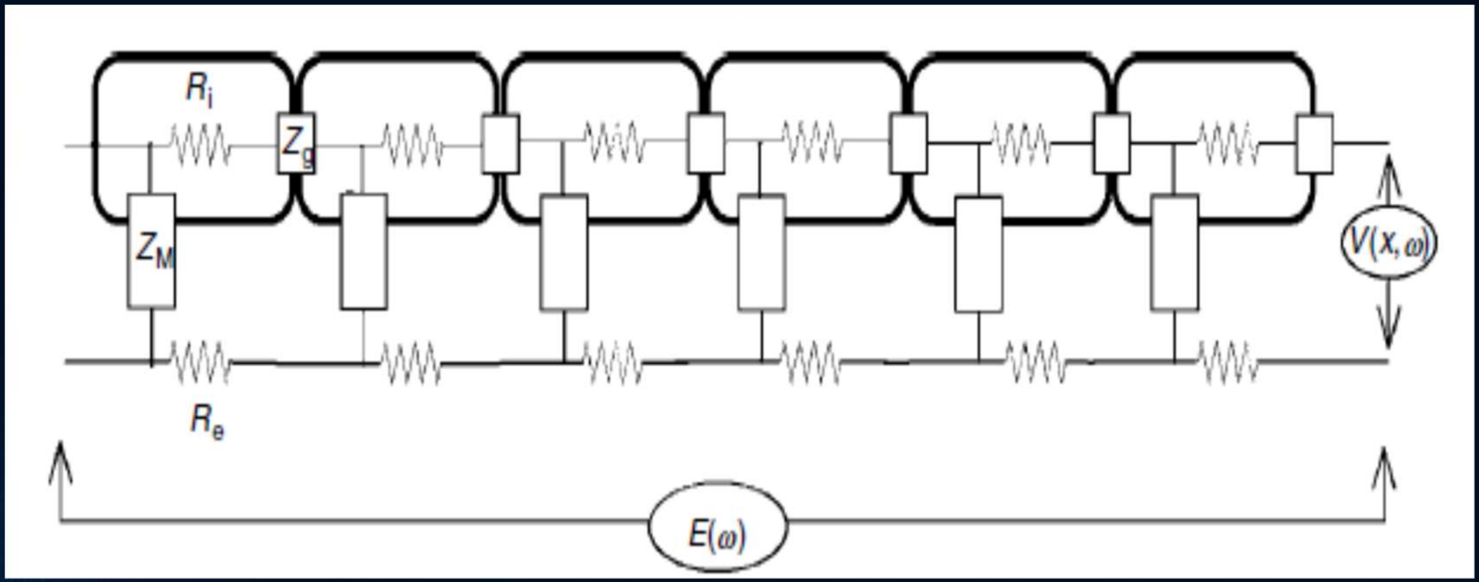

Figure 10: Distributed-parameter cell array model showing cells in gap-junction contact via impedance Zg. This model behaves electrically identical to a transmission line wherein the applied electric field E(w) propagates throughout the array causing progressively higher changes in induced transmembrane voltage V(x,w). ZM, Ri and Re are the membrane impedance, and intracellular and extracellular resistances per unit length, respectively. Zg represents the gap junction impedance.

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induced currents

all organized tissue is developed and maintained by an ensemble of complex geometry cells which have coordinated activity.

the most prevalent cell shape in living system tissue is elliptical and flattened, with processes extending in at least two directions.

human fibroblasts can typically exceed 100 μm when attached to a substrate (connective tissue). Nerve axons can be tens of centimeters in length

induced currents

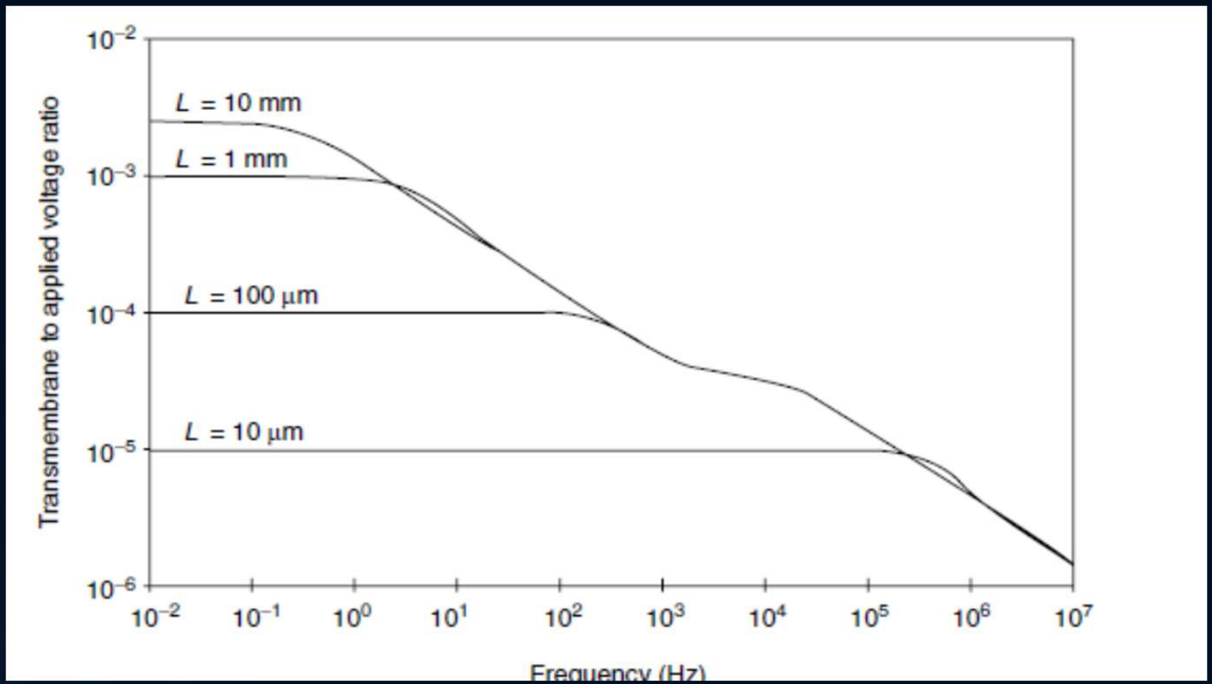

Figure 11: Frequency dependence of induced transmembrane voltage VM for various cell array lengths. As predicted by the cell array model, there is a substantial increase in transmembrane voltage as array length L increases, but at significantly lower frequencies vs that for a single molecule or cell, reflecting the increased propagation time (low pass filter behavior) for longer array lengths.

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induced currents

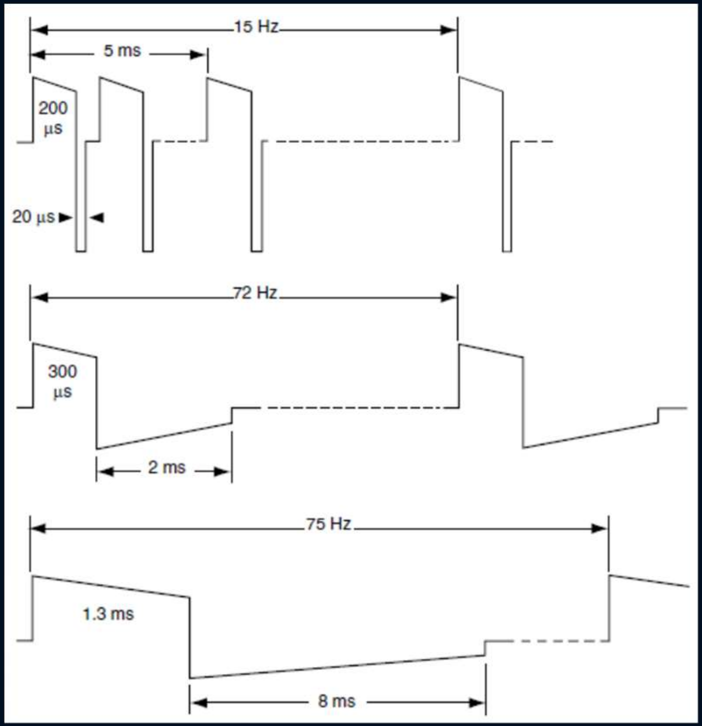

FIGURE 11.2 Induced electric field, E(t), in tissue from the time-varying magnetic fields utilized in EMF devices for clinical applications. The top waveform consists of bursts of asymmetrical pulses; the others are wide asymmetrical single pulses. For all signals peak E is 1–10 mV/cm in a 2 cm target. All are detectable by some tissue targets. Positive clinical effects have been reported for all signals.

Mechanisms and therapeutic applications of time-varying and static magnetic fields. Pilla AA. In: Handbook of Biological Effects of Electromagnetic Fields, 3rd Edition. Barnes F, Greenebaum B, eds, CRC Press, 2006.

there is no physiologic difference between the action potential initiated by an electric field delivered by surface electrodes and the action potentials that can be induced by specific PEMFs, except that PEMFs don’t shock the body and go much deeper

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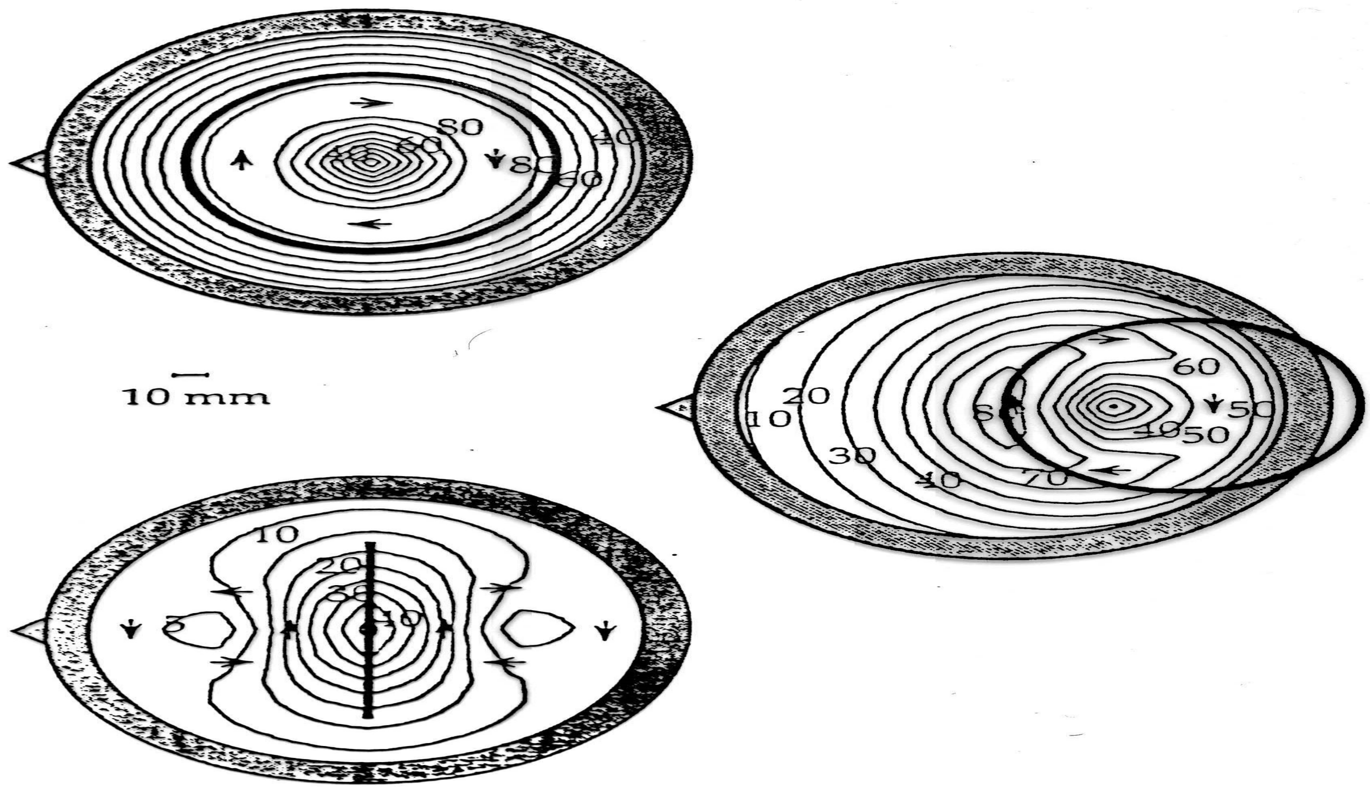

Fig. 5. The magnitude of the electric field 3 mm below the surface of the cortex produced by a circular coil (bold circle or line) with a radius of 50 mm, 8 turns, a current changing at a rate of 100 A/μsec. and with its edge 10 mm above the vertex. Three different coil orientations are shown. arrows indicate the approximate direction of the electric field. and the field strength is given in units of V/m (adapted from Roth et al. 1991).

susceptibility of the body to PEMFs

the body is very susceptible to magnetic fields

tissues/molecules in the body are

- diamagnetic - react
- paramagnetic - accept

in aggregate the body’s cells/molecules are diamagnetic – that’s why magnetic therapy works

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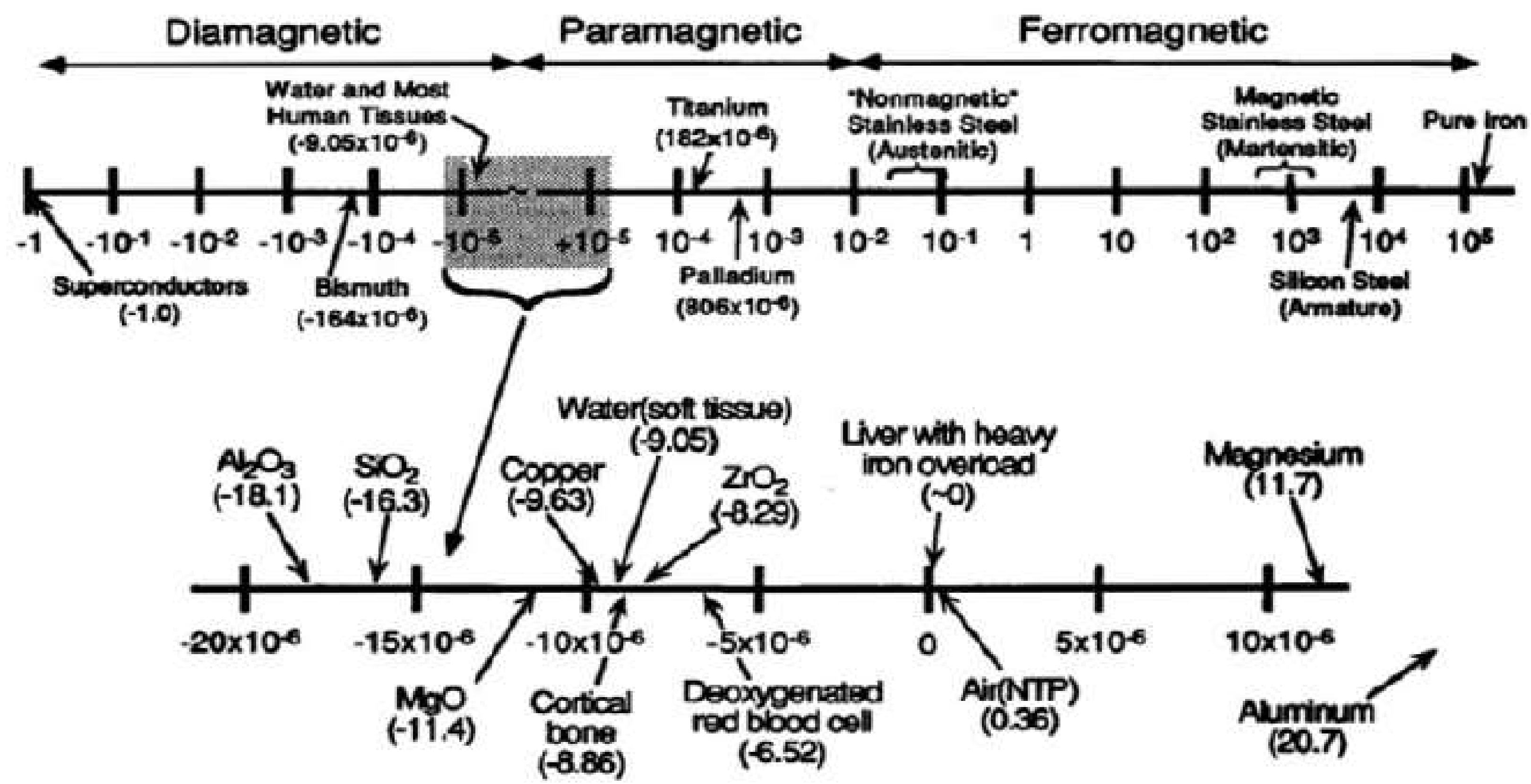


Figure 2

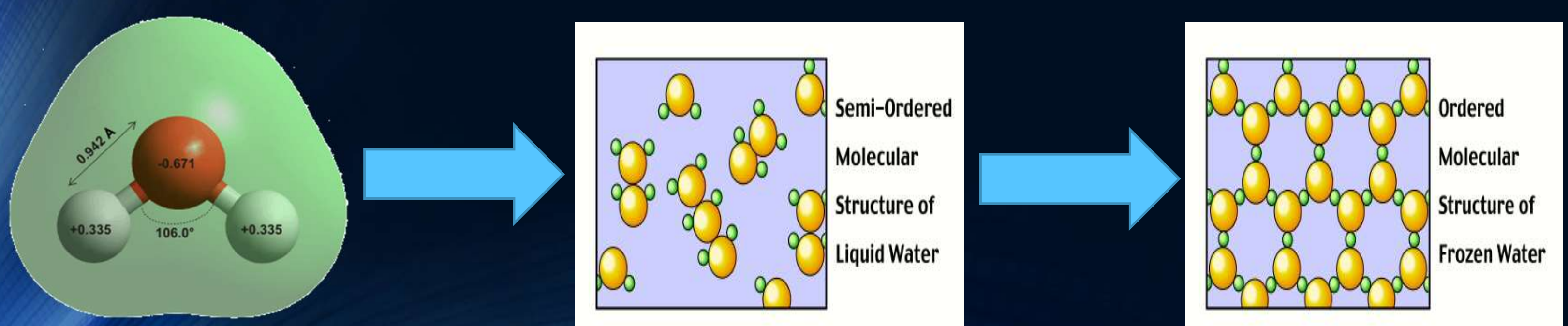
Spectrum of magnetic susceptibilities. The figure shows that the majority of human tissues is diamagnetic or weakly paramagnetic. (from Ref. [17])

water

- water subjected to a PEMF has unusual properties - it becomes structured.
- Dr. EV Utekhin, from Russia proved magnetized water is biologically active and can have therapeutic effect
- health benefits of magnetically structured water have been known since early 60s

water

- dipoles of water molecules lineup in a magnetic field
- this makes water more structured and orderly
- increases crystallization and chemical reaction rates of solutes; more slippery
- intensifies adsorption, coagulation of impurities and improves their loss in the sediment
- cell membrane channels pass structured water molecules faster
- possibly due to closer resemblance to the structure of the cell membrane



water

effects of structured water:

- antibacterial
- cleanses blood of foreign proteins
- reduces cholesterol in blood and liver
- increases metabolism
- promotes soft fragmentation of gallstones
- regulates blood pressure
- increases tone of the body
- stimulates immune system, cell regeneration

- only 25 minutes on a medium intensity PEMF device structures a 2 liter bottle of water
- food cooked with this water tastes softer and carries the same health value as water alone
- plant seeds grow better and faster

how are PEMFs generated?

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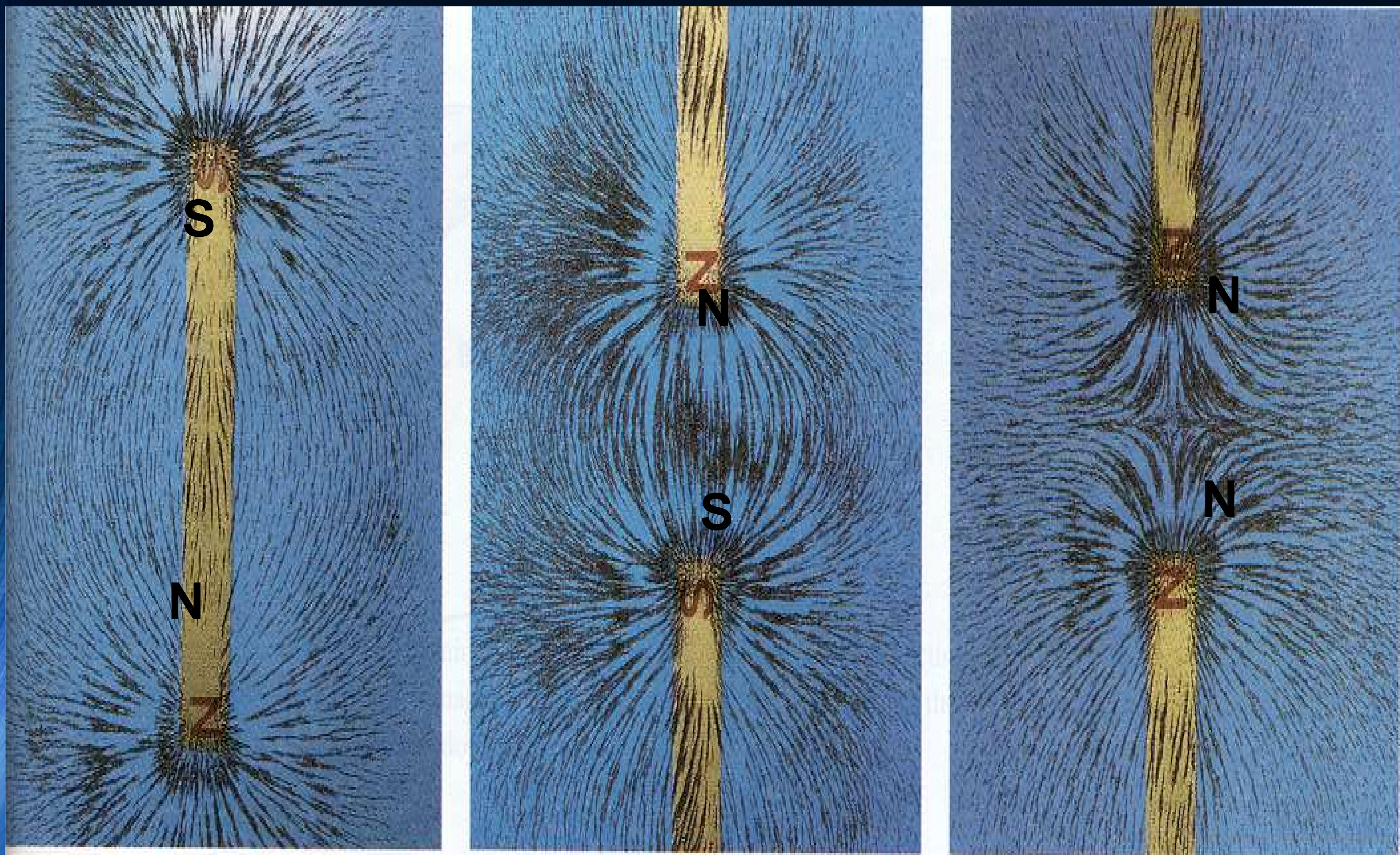
magnetic field patterns show the distribution of magnetic lines of force



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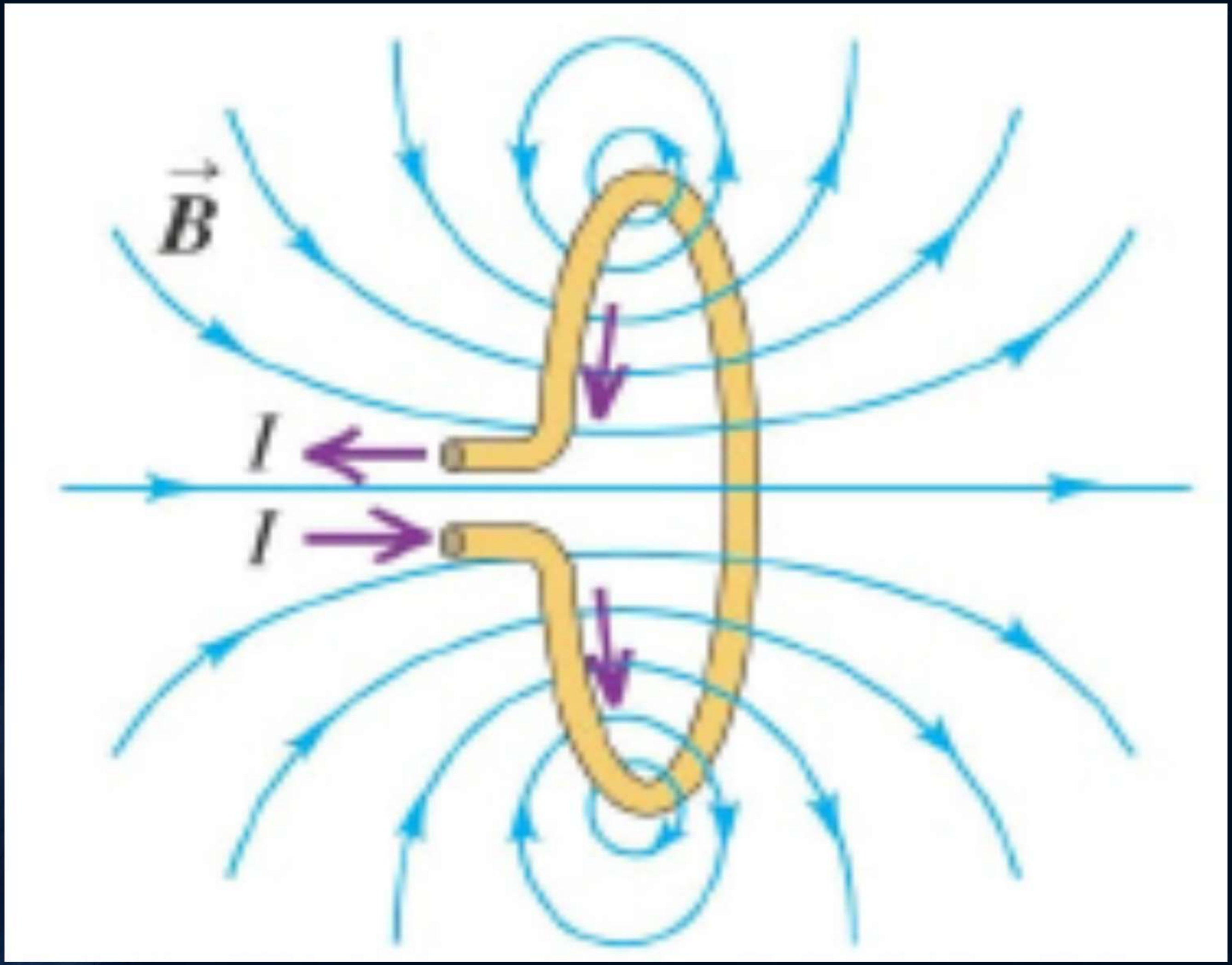

https://physics.ucf.edu/~roldan/classes/Chap27_PHY2049.pdf

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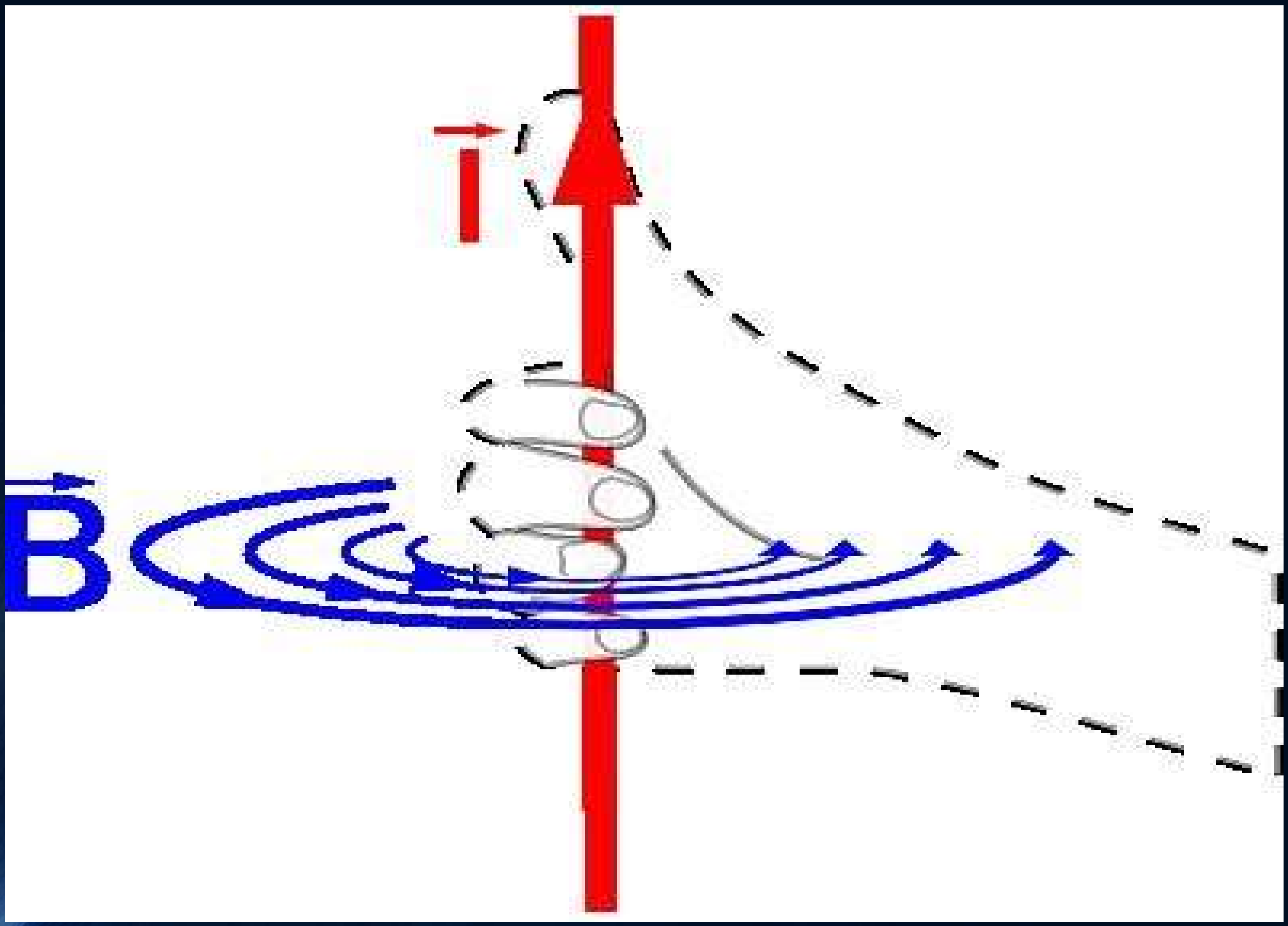
right hand rule



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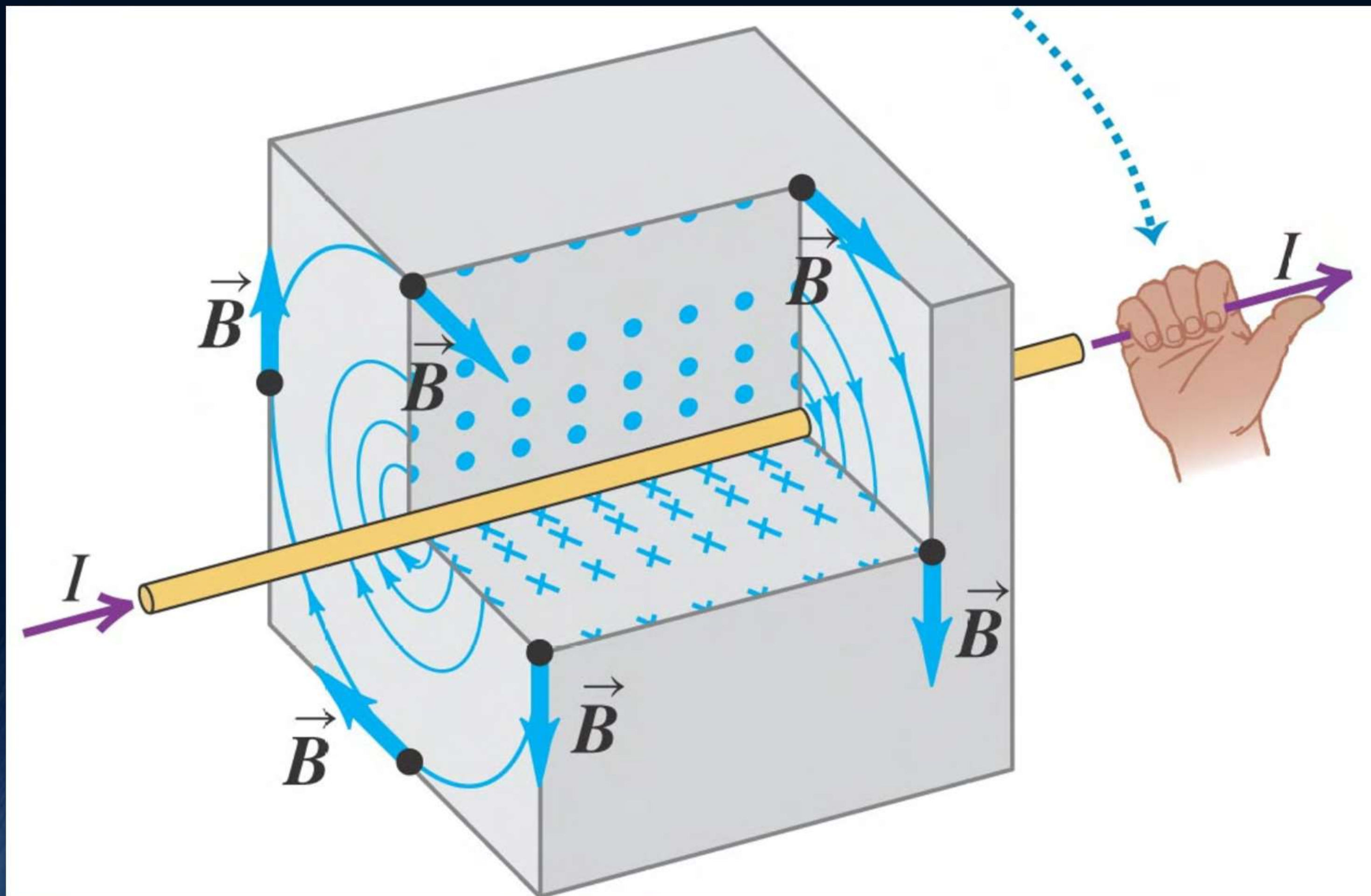
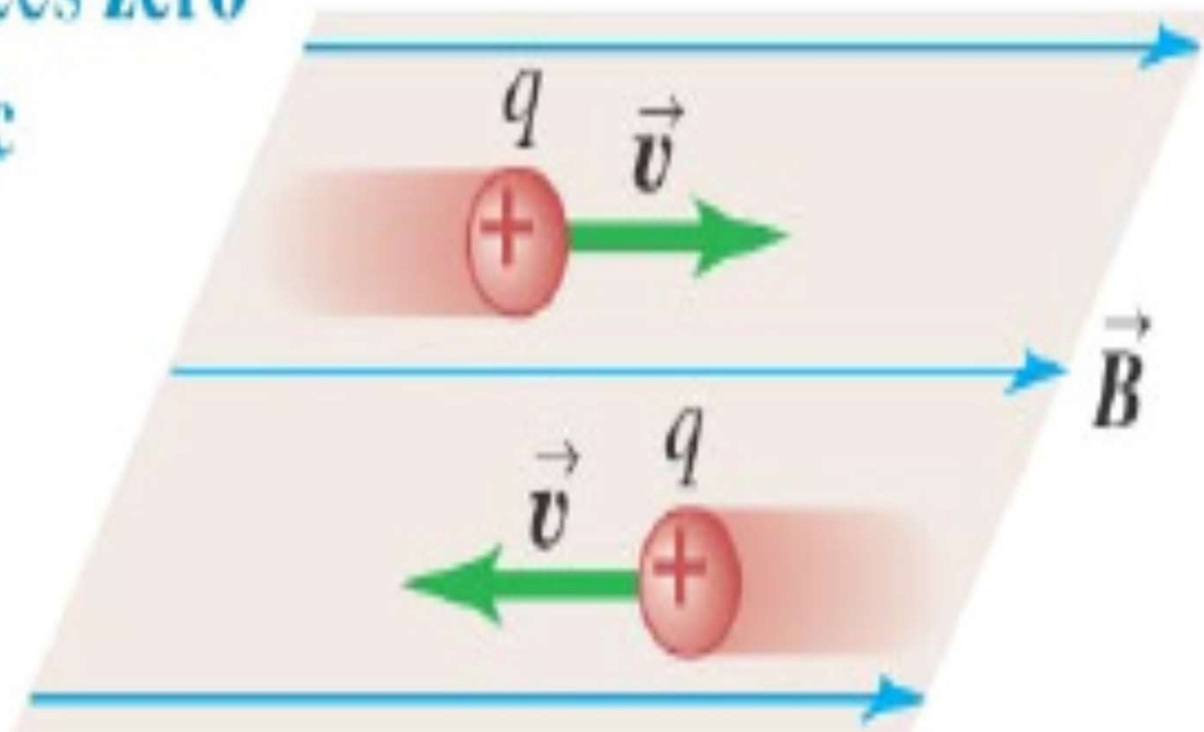
right hand rule



Magnetic field lines encircle the current that acts as their source. They form closed loops and never have end points

https://physics.ucf.edu/~roldan/classes/Chap28_PHY2049.pdf

A charge moving **parallel** to a magnetic field experiences **zero magnetic force.**



https://physics.ucf.edu/~roldan/classes/Chap27_PHY2049.pdf

how can they affect the body?

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the body

is

transparent

to an elf

magnetic field

to have a magnetic field act on an object, the field must move past the object or the object must move past the field

- the field must move past the object
  - PEMFs are active & the body is active

or

- the object must move past the field
  - statics are passive & the body is active

static vs PEMF

- static fields are “softest”
- alternating, more pronounced
- pulsed fields are “strongest”
- statics act on parasympathetics
- time varying, on para/sympathetics
- chronic diseases, time varying

intensity matters

time varying magnetic fields induce an electric field whose magnitude is proportional to its rate of change

dB/dT

inverse square rule

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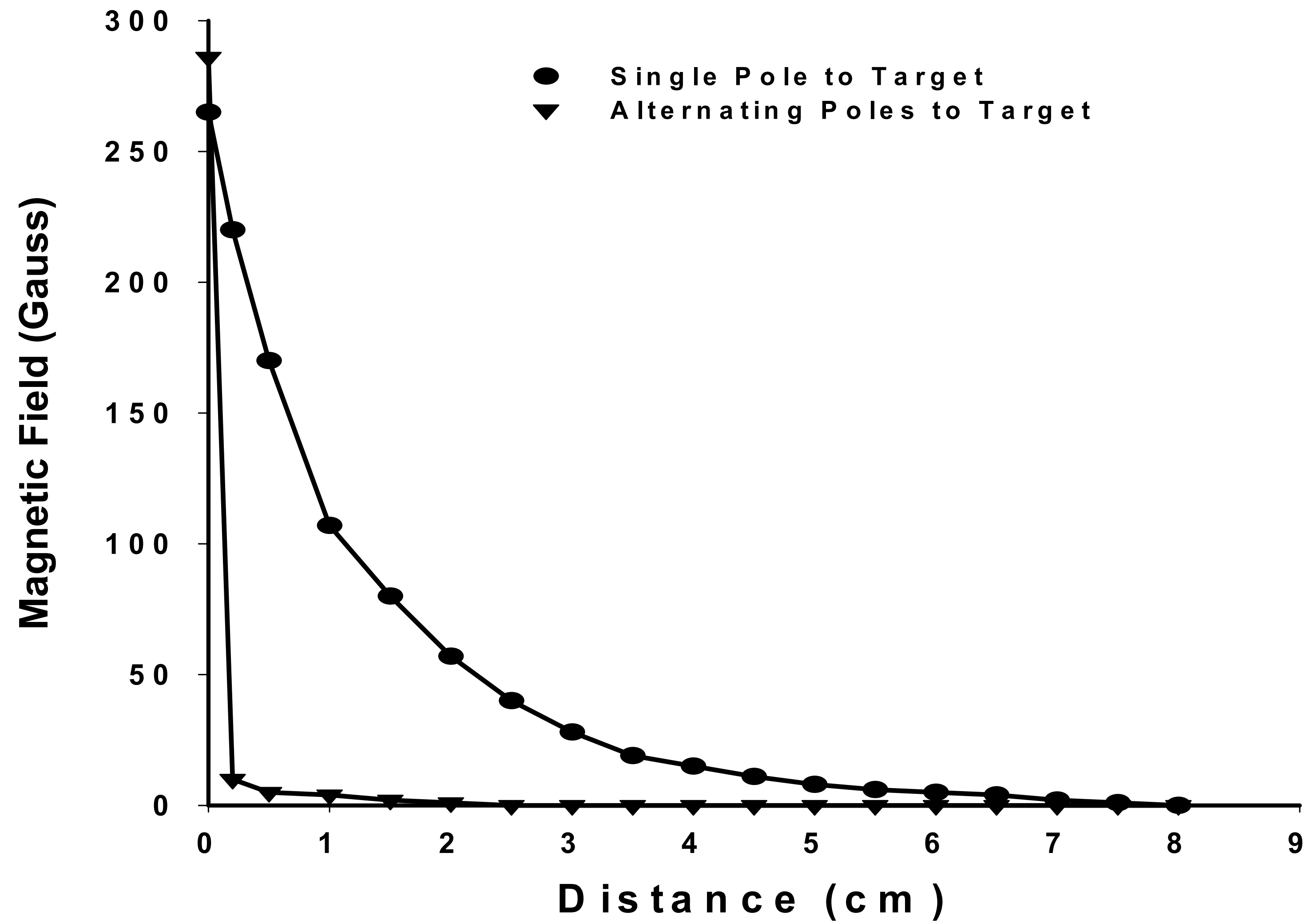

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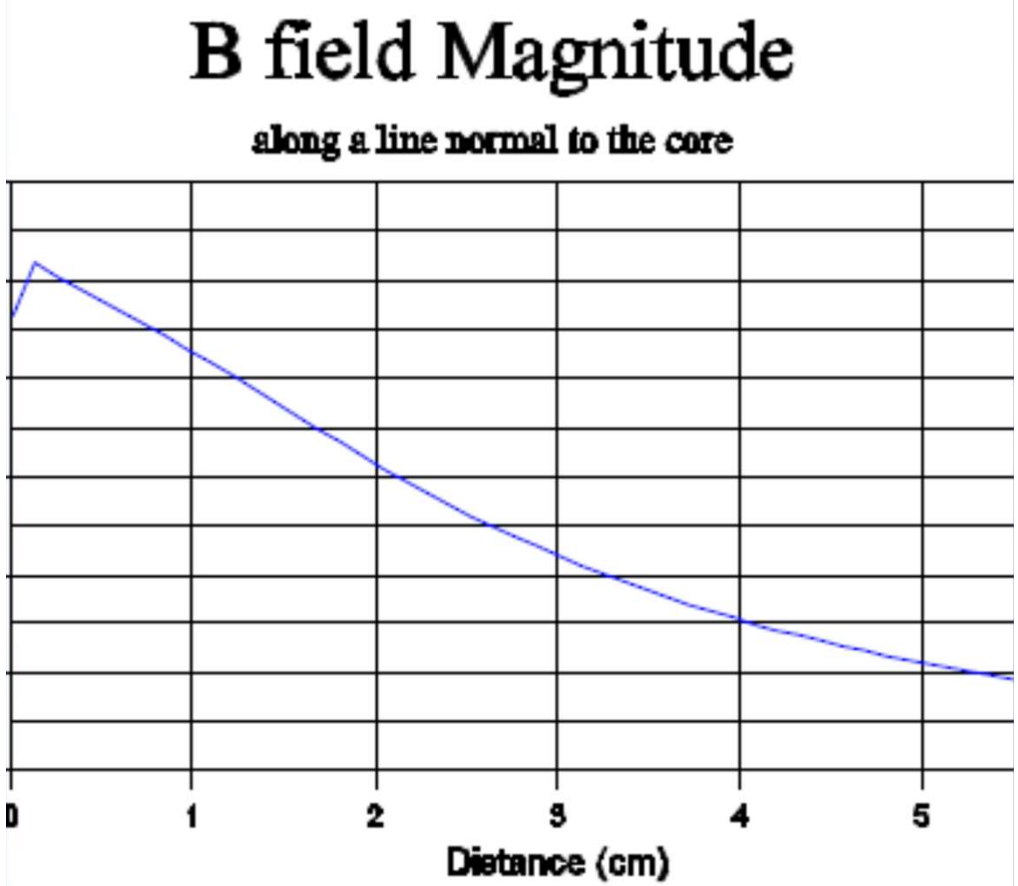

Figure 9 Rapid B field decay away from the core.

action potentials can be expected at a depth of 5 cms

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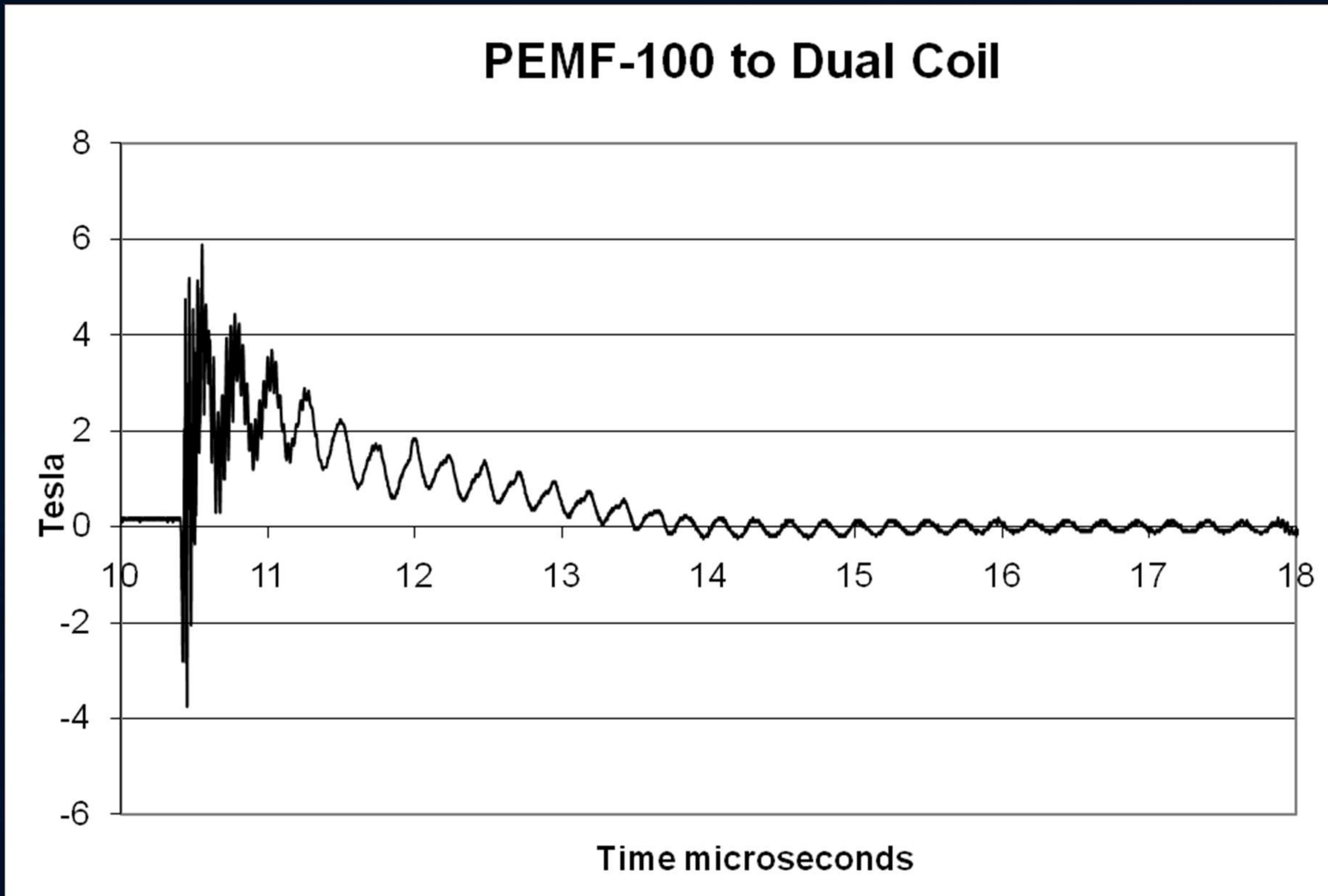

5.75 T max, 5.3 T/microsecond max rate of change (dB/dt)

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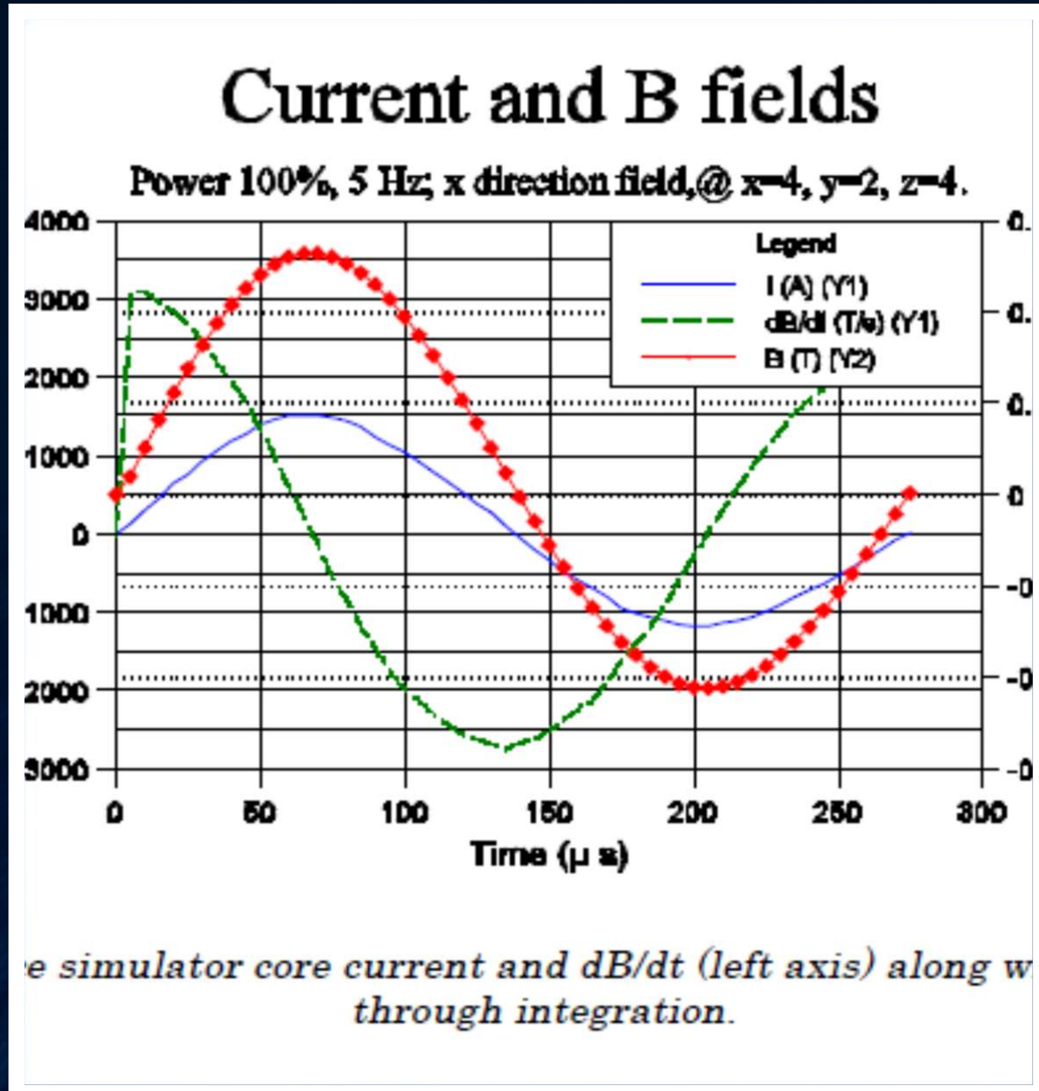

may produce in excess of 3,000 T/s at 100% power, enough to induce muscle contractions. The stronger the intensity the stronger the contractions

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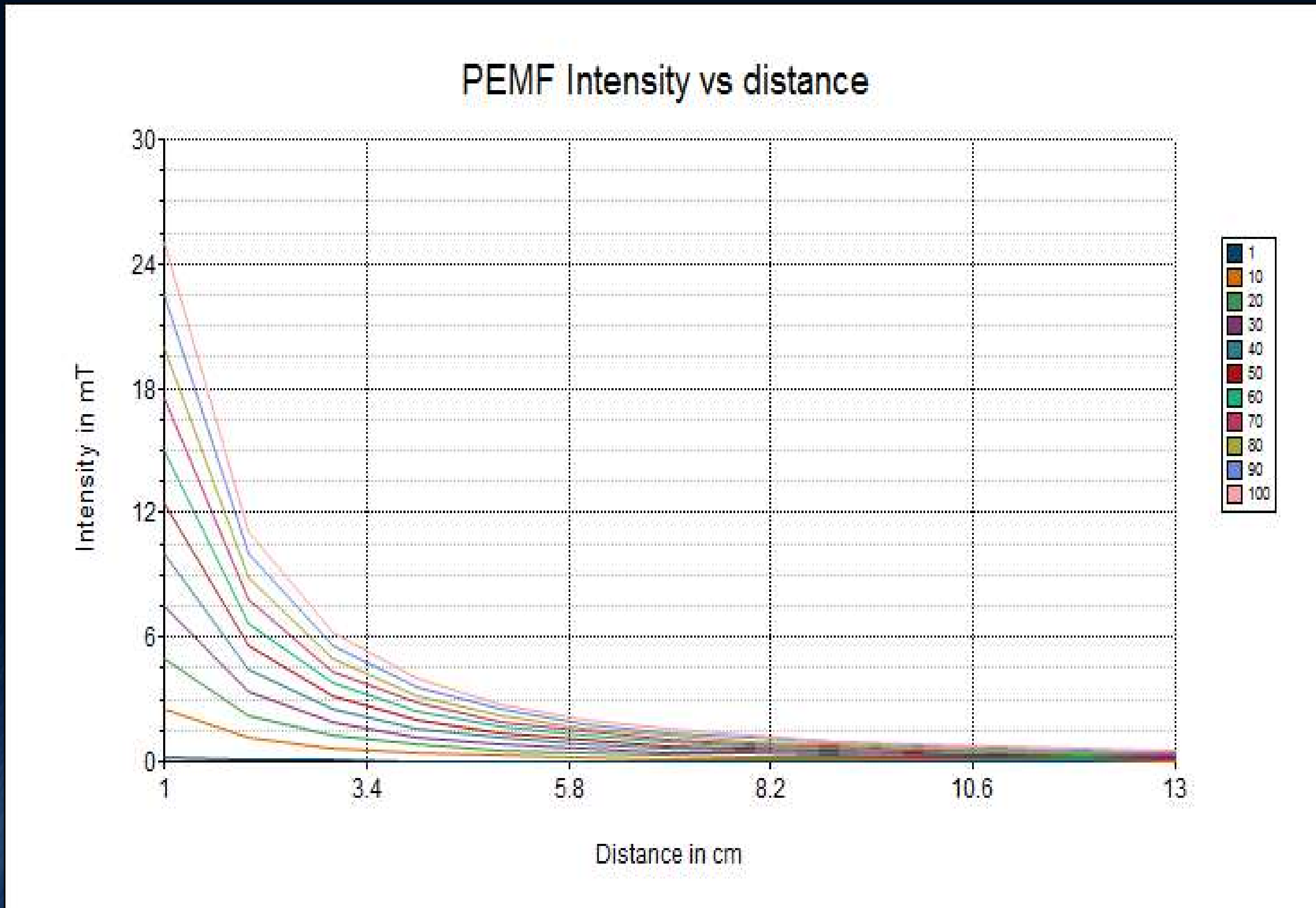

graphically represented this is what rapidly declining intensities look like. The color codes for the intensities are in the legend to the right on the graph.

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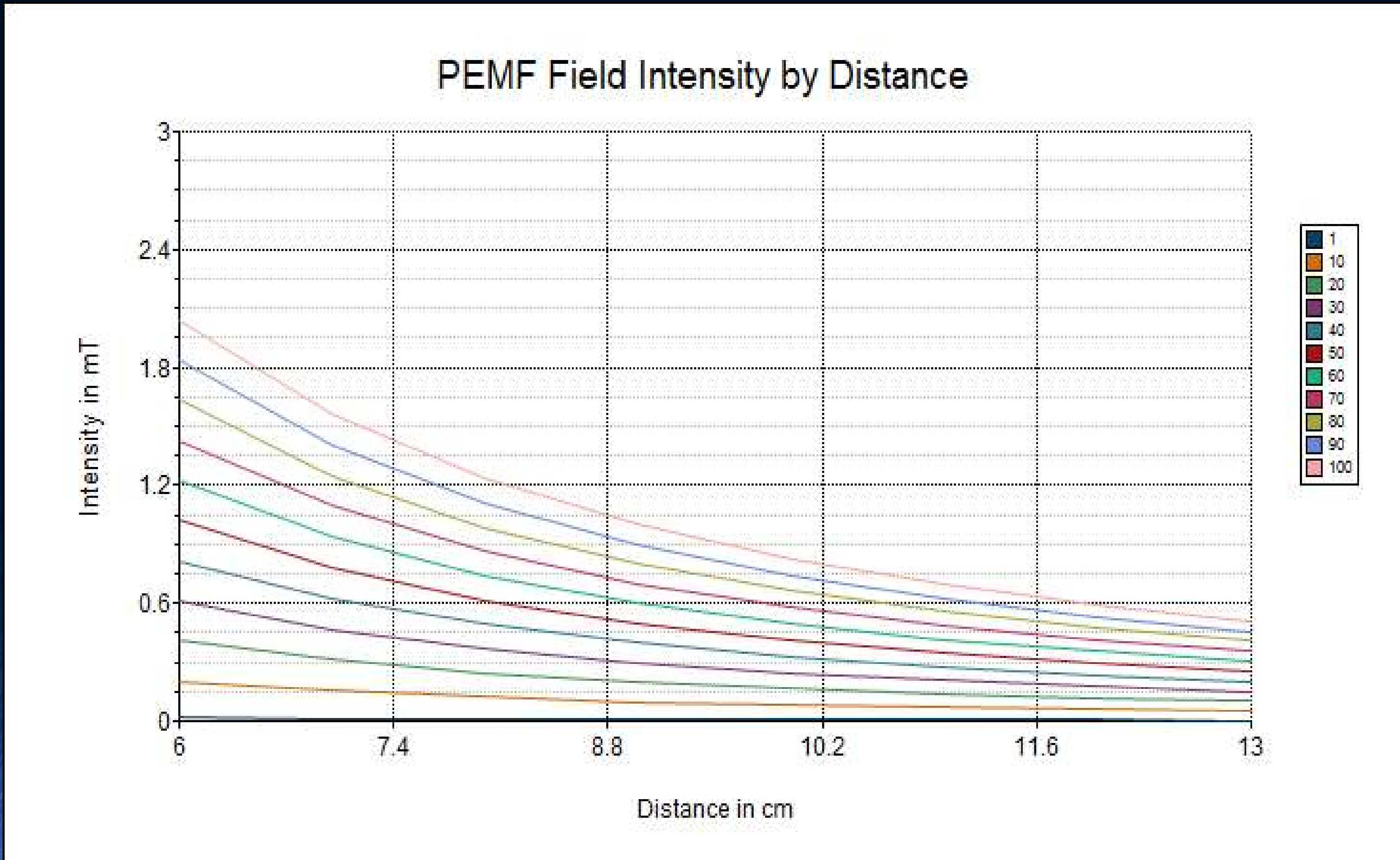

graphed to start intensity measurements at 6 cm away from the applicator, it’s easier to see how the intensities at 10 cm and more separate out based on initial intensity.

actions of PEMFs on the body

public awareness

Dr Oz Show on PEMFs and pain

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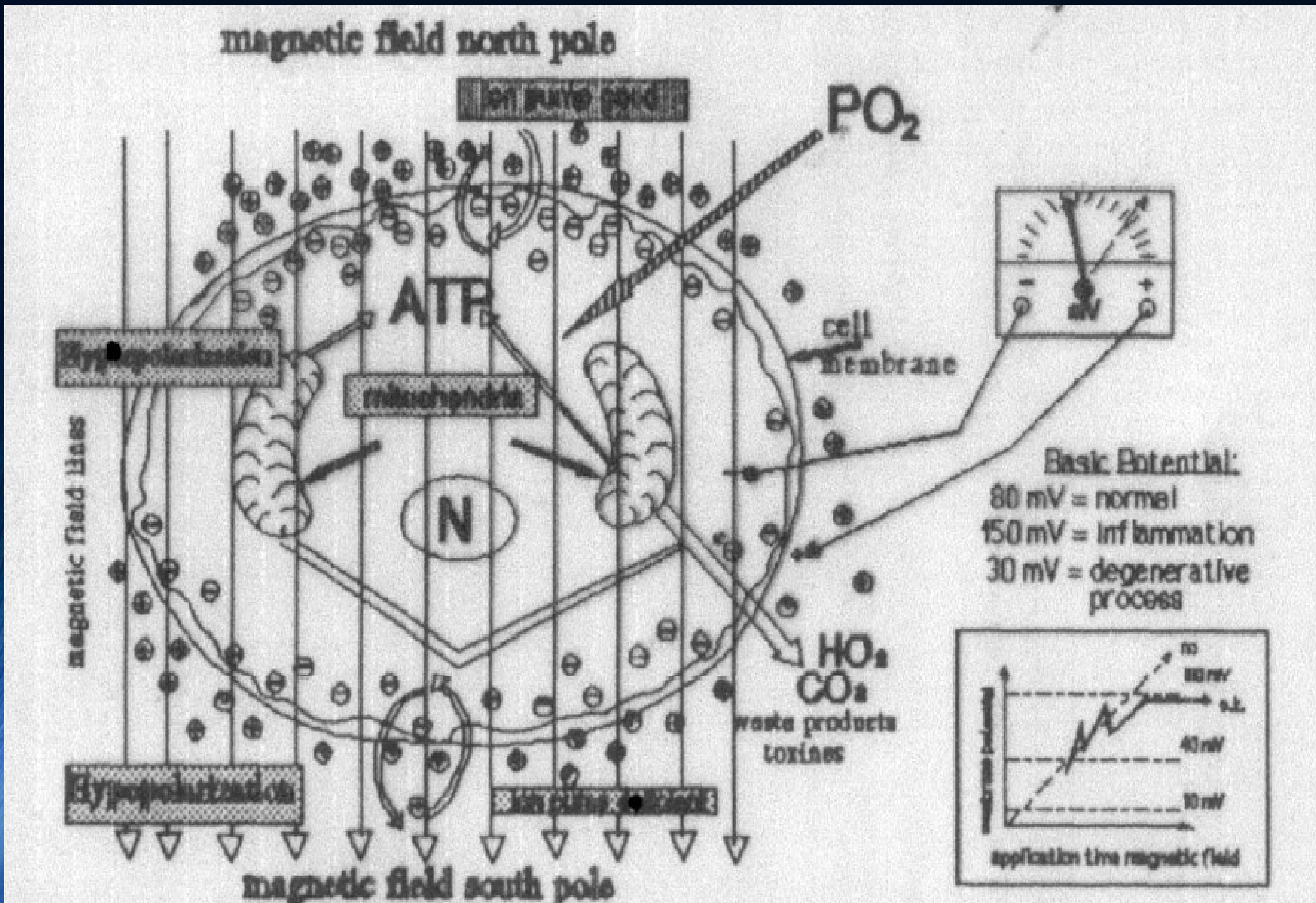

acupuncture effects

a time-varying field outside the body is an emitted electromagnetic wave with an appropriate frequency so that its energy is absorbed …. the EM energy emitted by a (magnetic field generator) may be absorbed by (a) … person's birdcage (the so-called Er-Yin-Hui-Shen phenomenon); if the two circuits are synchronized in frequency and in phase, i.e. a case of coupled oscillation between two oscillators … energy exchange occurs.

A birdcage model for the Chinese Meridian System: part III. Possible mechanism of magnetic therapy. Am J Chin Med. 2005;33(4):589-97.

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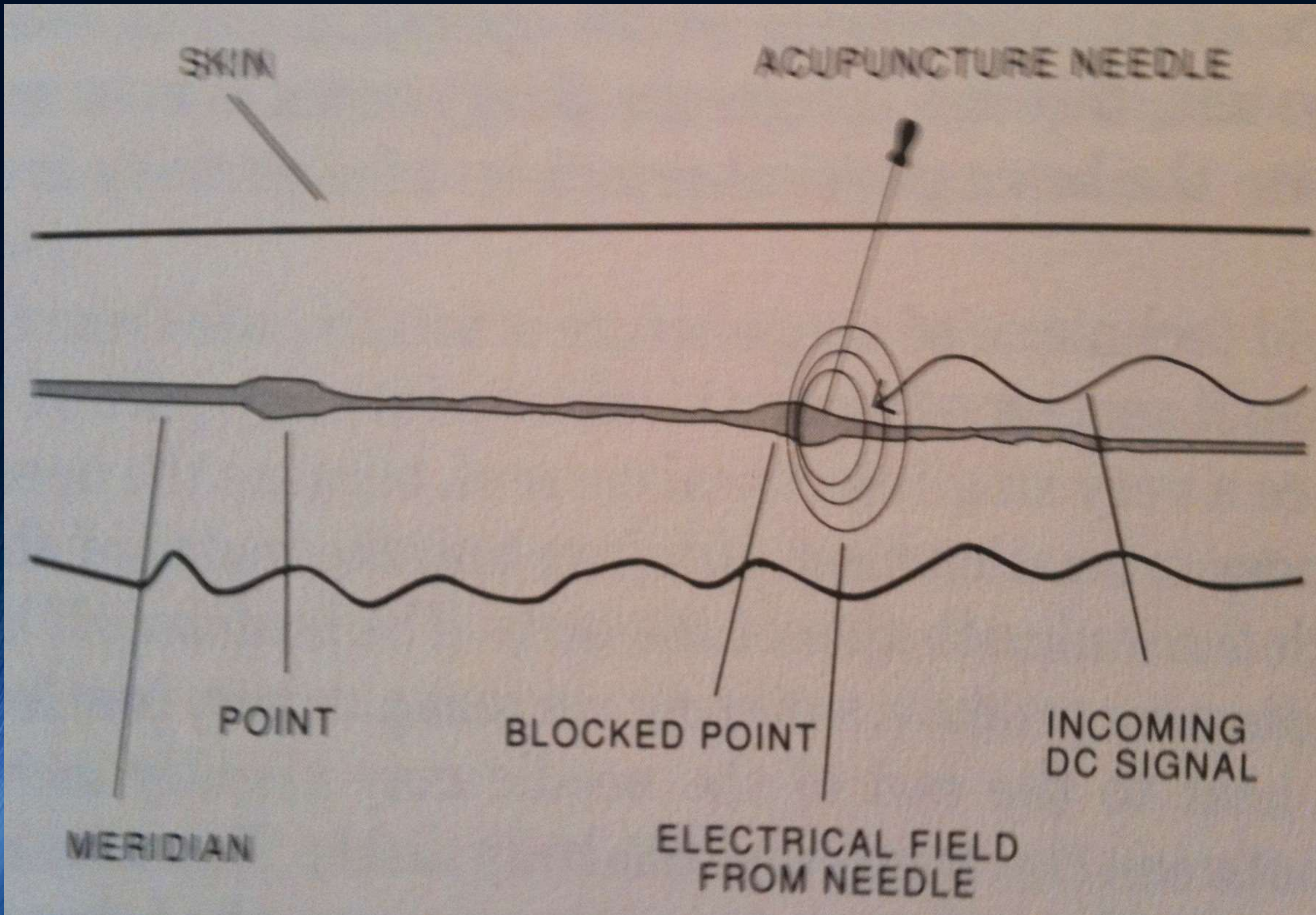

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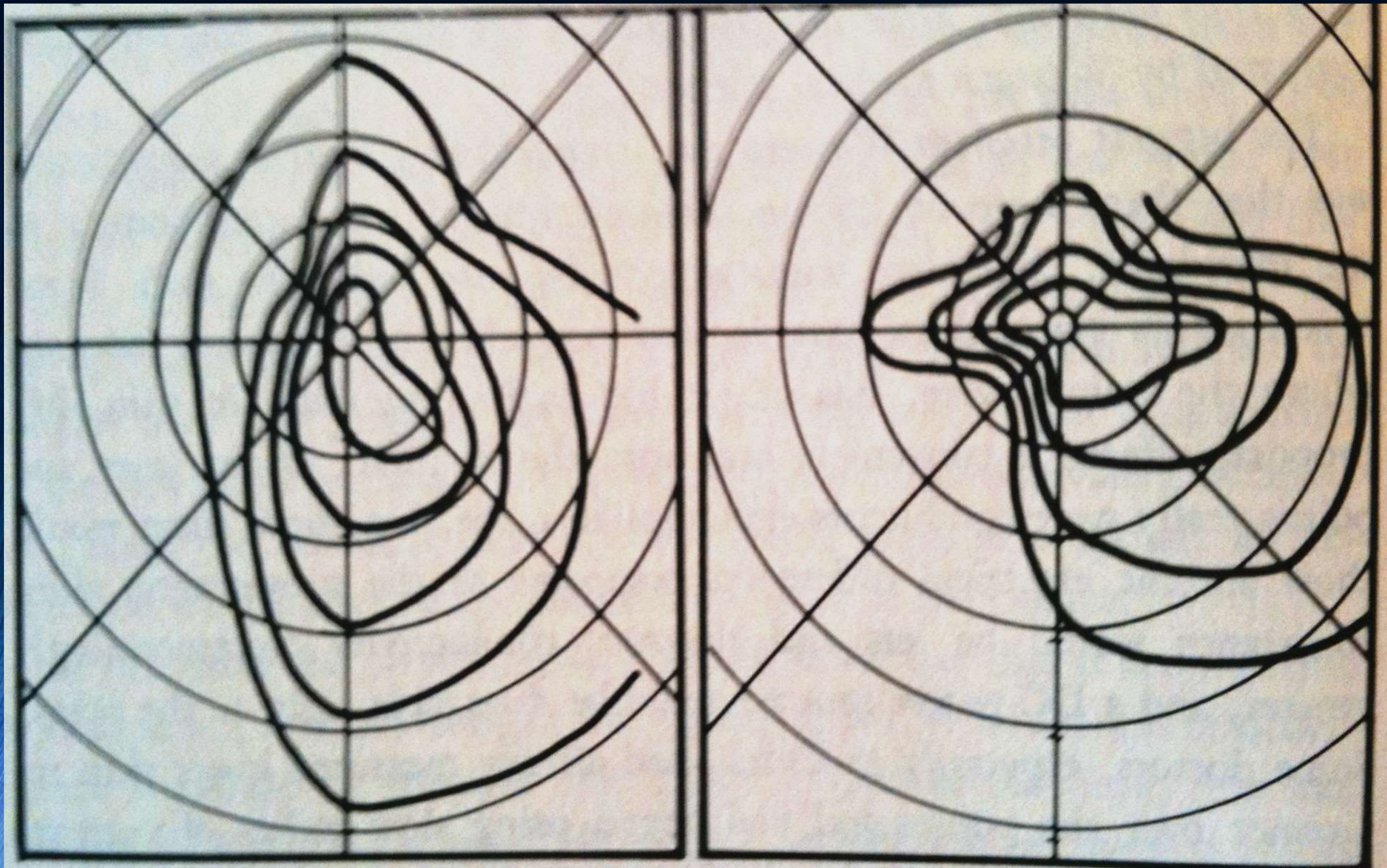

ELECTRICAL CONDUCTIVITY MAPS OF SKIN AT ACUPUNCTURE POINTS

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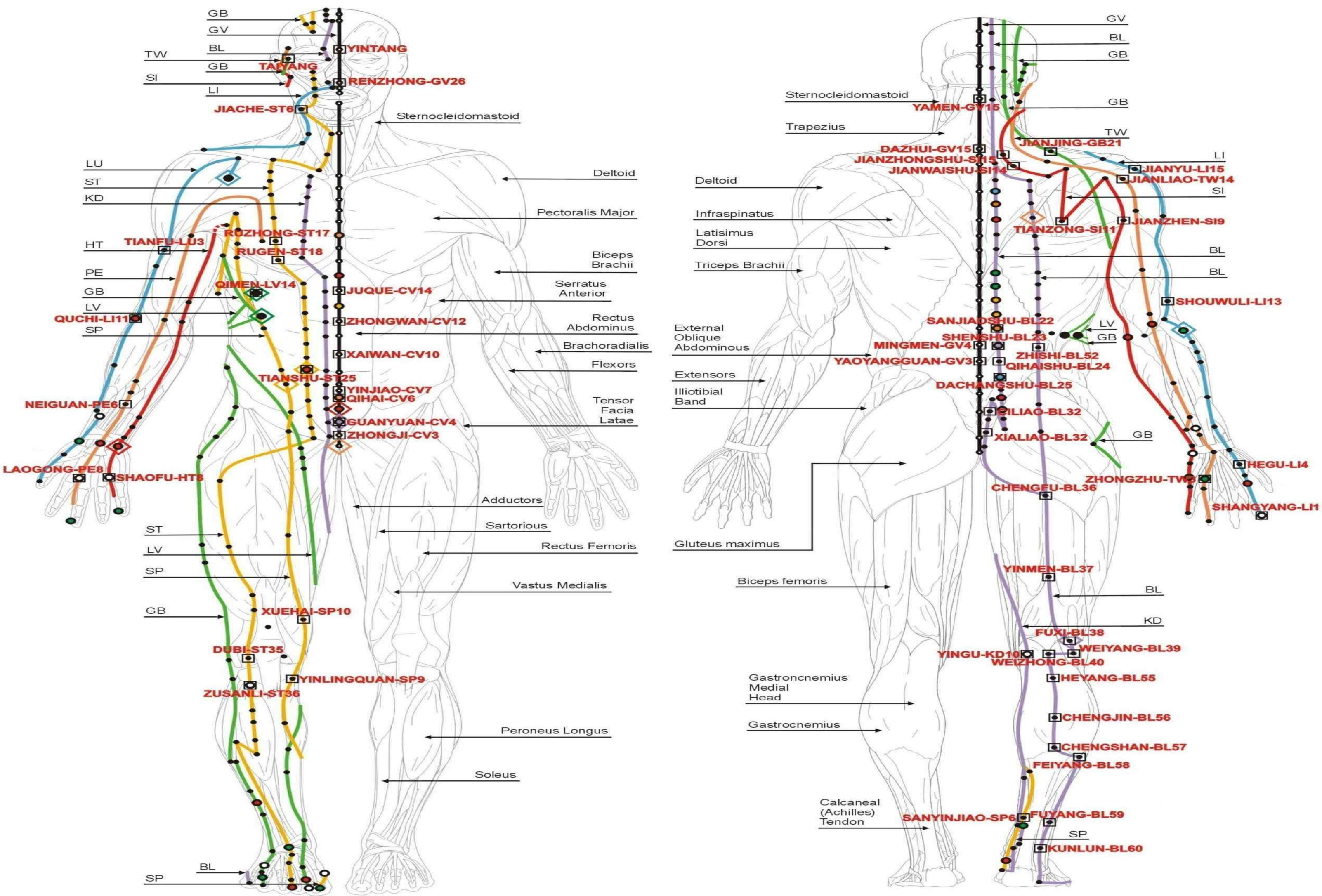
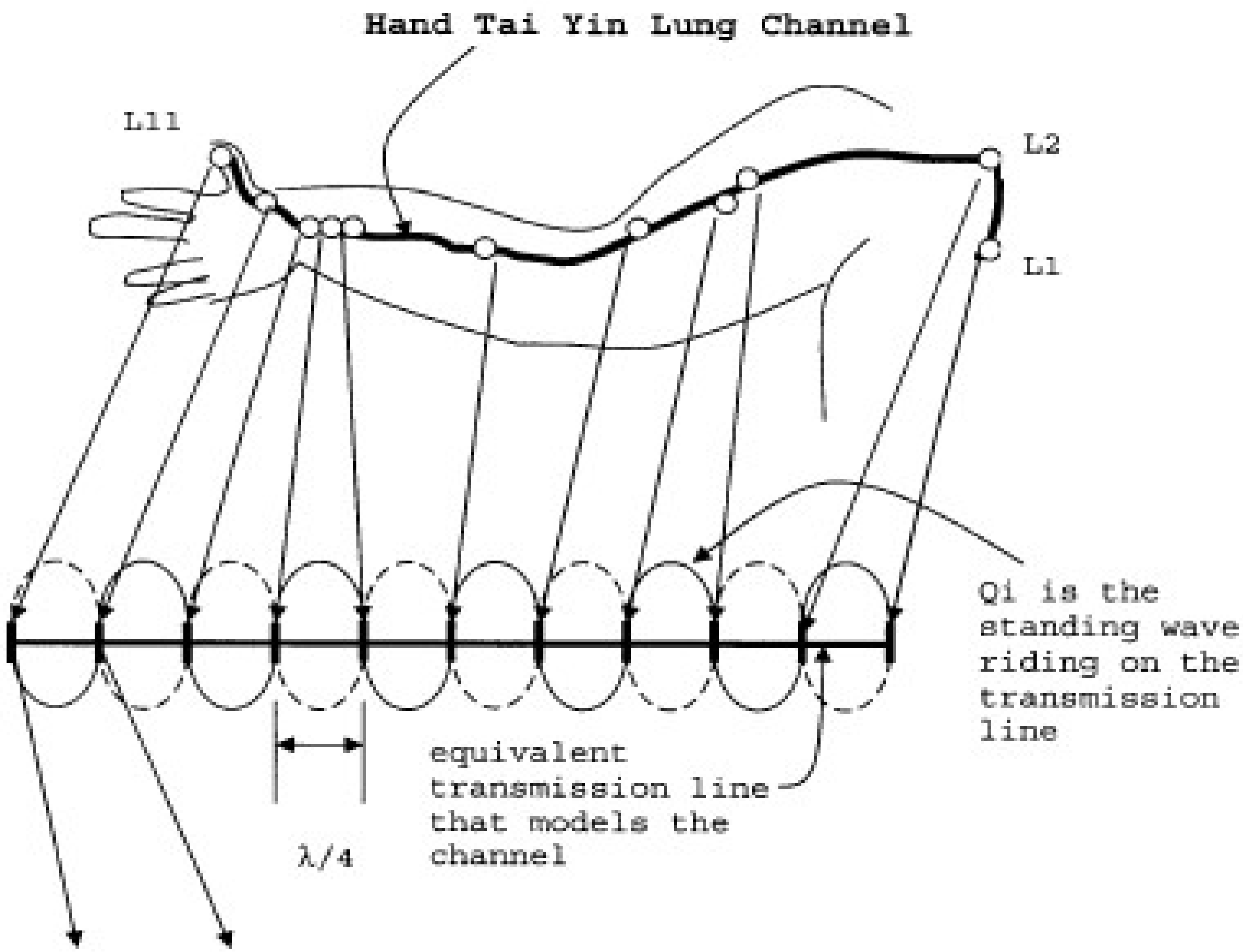
Human body meridians





A birdcage model for the Chinese Meridian System: part I. A channel as a transmission line. Yung KT. Am J Chin Med. 2004;32(5):815-28.

a meridian channel is equivalent to a lossless electromagnetic transmission line and Qi is equivalent to the standing wave riding on the line, with acupoints as its nodes. The Chi standing wave within each segment of the channel separated by acupoints is in natural oscillation.

A birdcage model for the Chinese Meridian System: part I. A channel as a transmission line. Yung KT. Am J Chin Med. 2004;32(5):815-28.

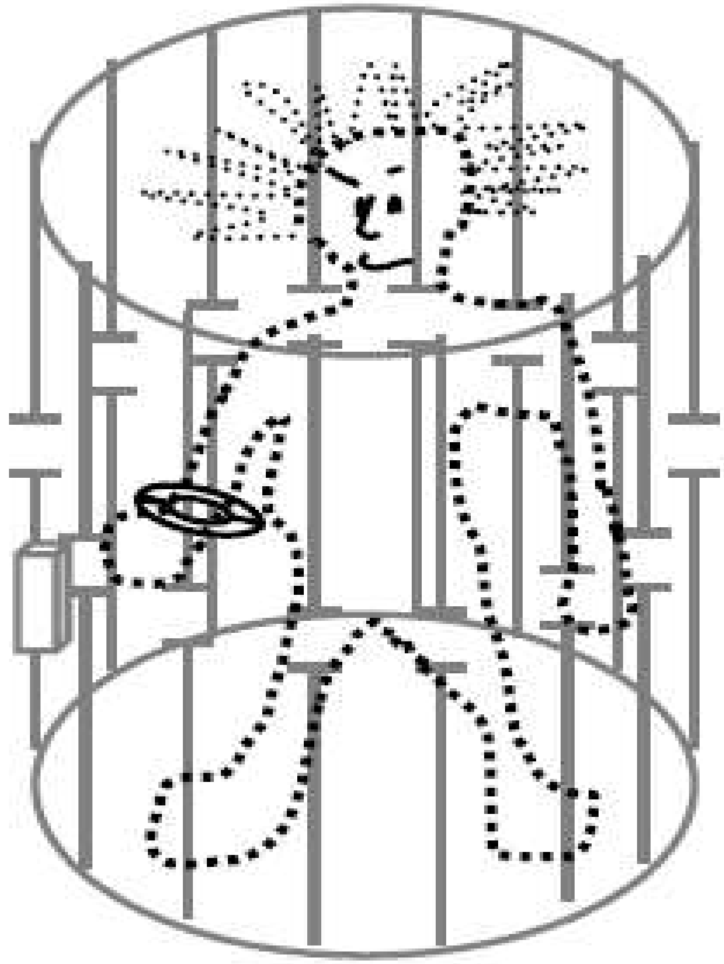


Figure 1. A birdcage coil (in light color) is imposed on a human body (in dark color) wearing a bracelet magnet on her right wrist. This setup is represented by a static magnet attached to one leg of the coil. Obviously the presence of this strong magnet will greatly influence current flows on the six channels that run through her wrist.

A birdcage model for the Chinese Meridian System: part III. Possible mechanism of magnetic therapy. Am J Chin Med. 2005;33(4):589-97. Review.

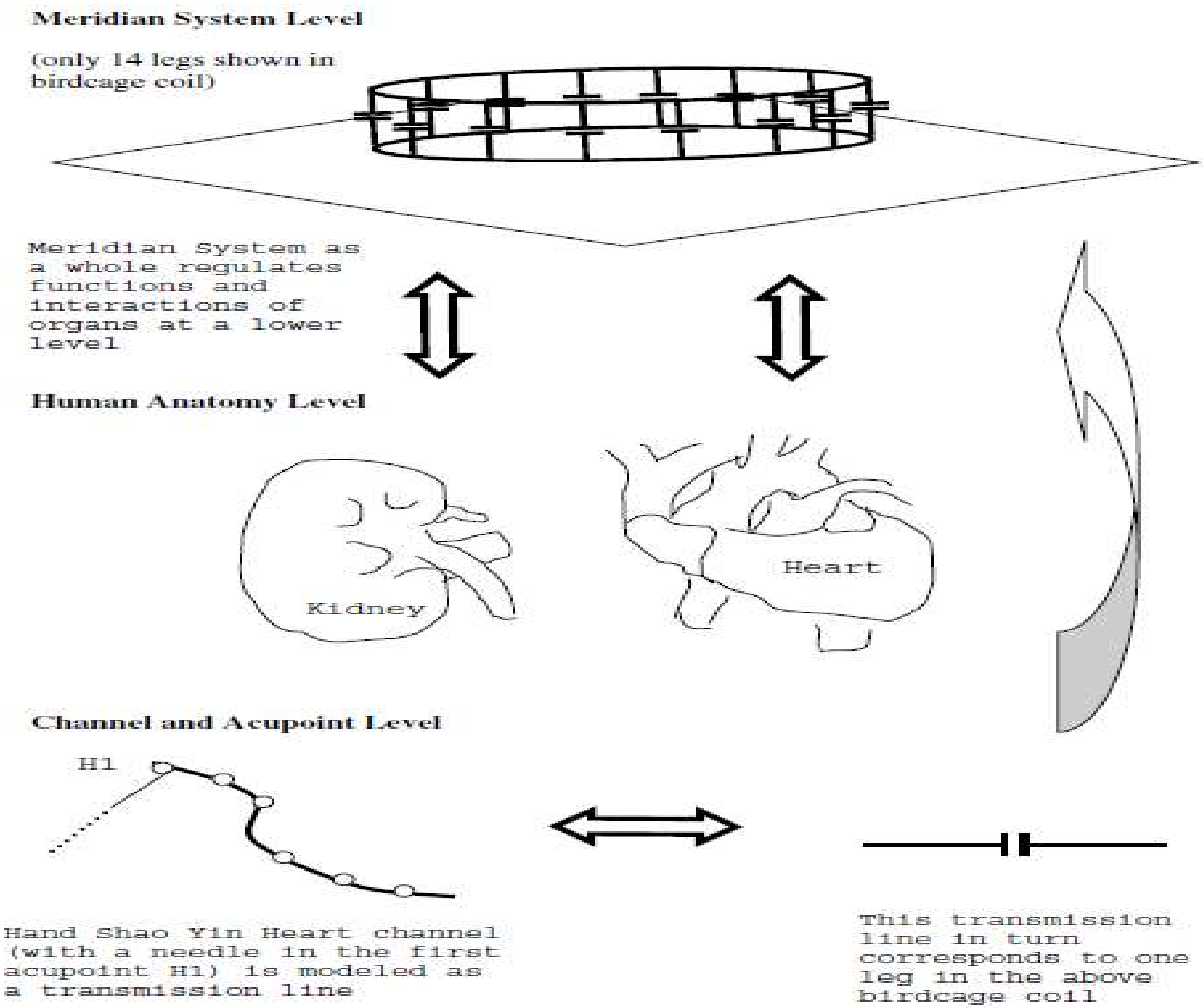


Figure 1. The jing luo network is the most fundamental system of the body, governing the collective functions of all internal organs. Functions of and interactions among organs at the human anatomy level, such as that between the heart and the kidney, are regulated at the meridian system level above, whose functions are represented by the birdcage coil.

Birdcage model for the Chinese meridian system: part VI. meridians as the primary regulatory system. Yung KT. Am J Chin Med. 2005;33(5):759-66.

other effects

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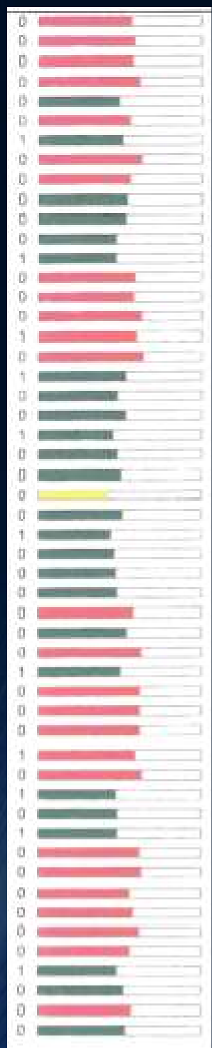

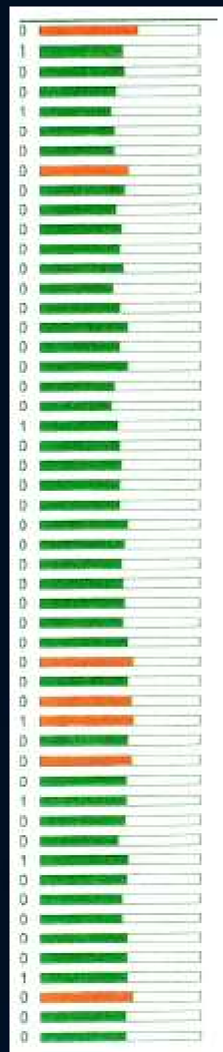

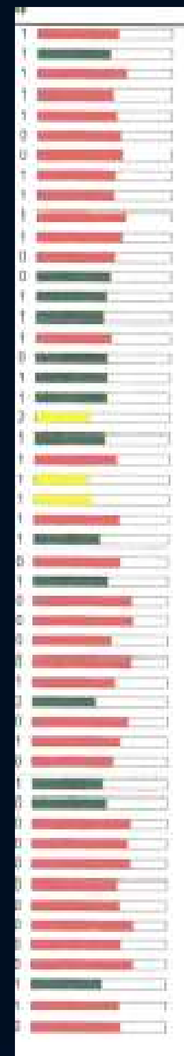

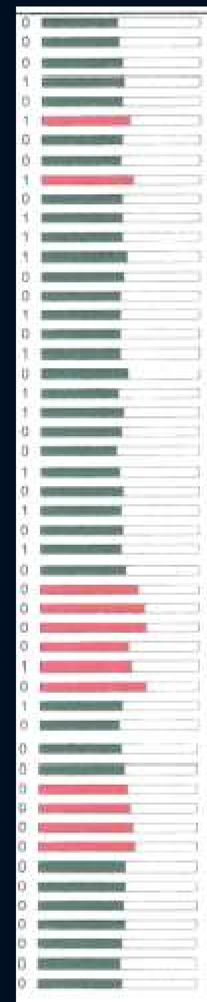

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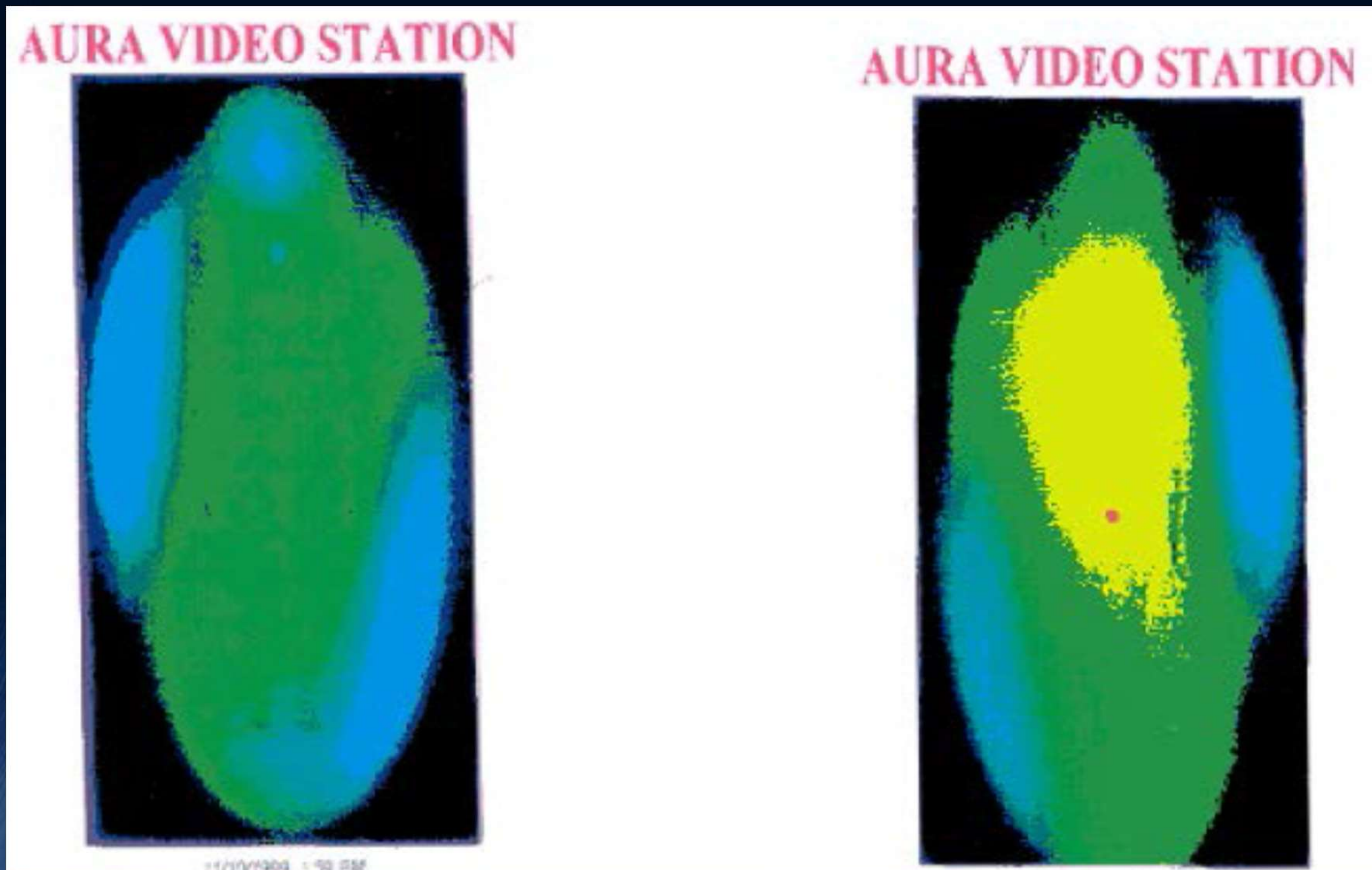

pre post
8 mins of whole body low intensity PEMF

cell injury, damage, imbalance

"It isn't the mountains ahead
to climb that wear you out;
it's the pebble in your shoe"

Mohammed Ali

cell injury reduction:

life is a cell injury opportunity

aging is “death” by a 1000 “cuts“

each cell injury is a “cut”

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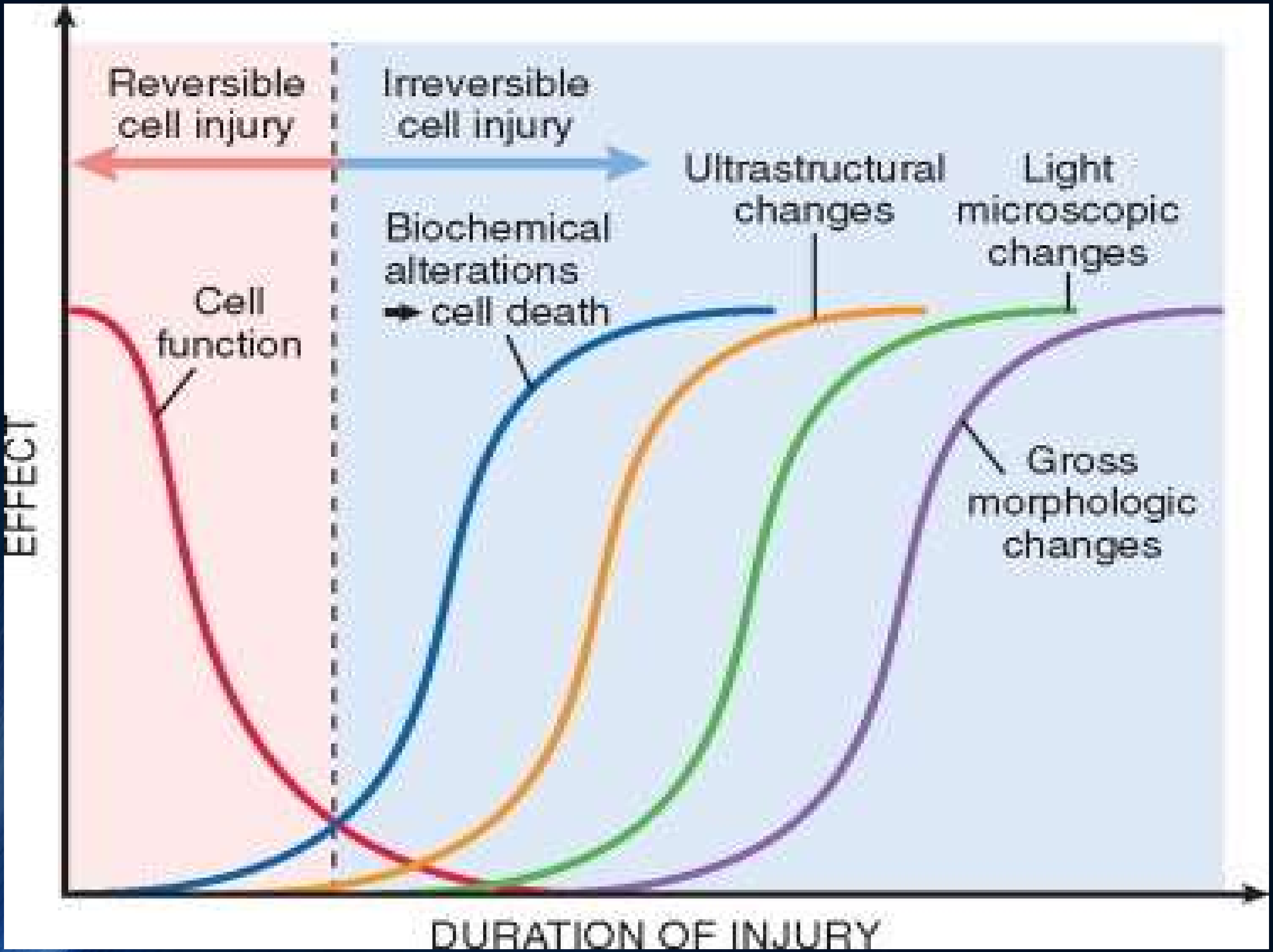

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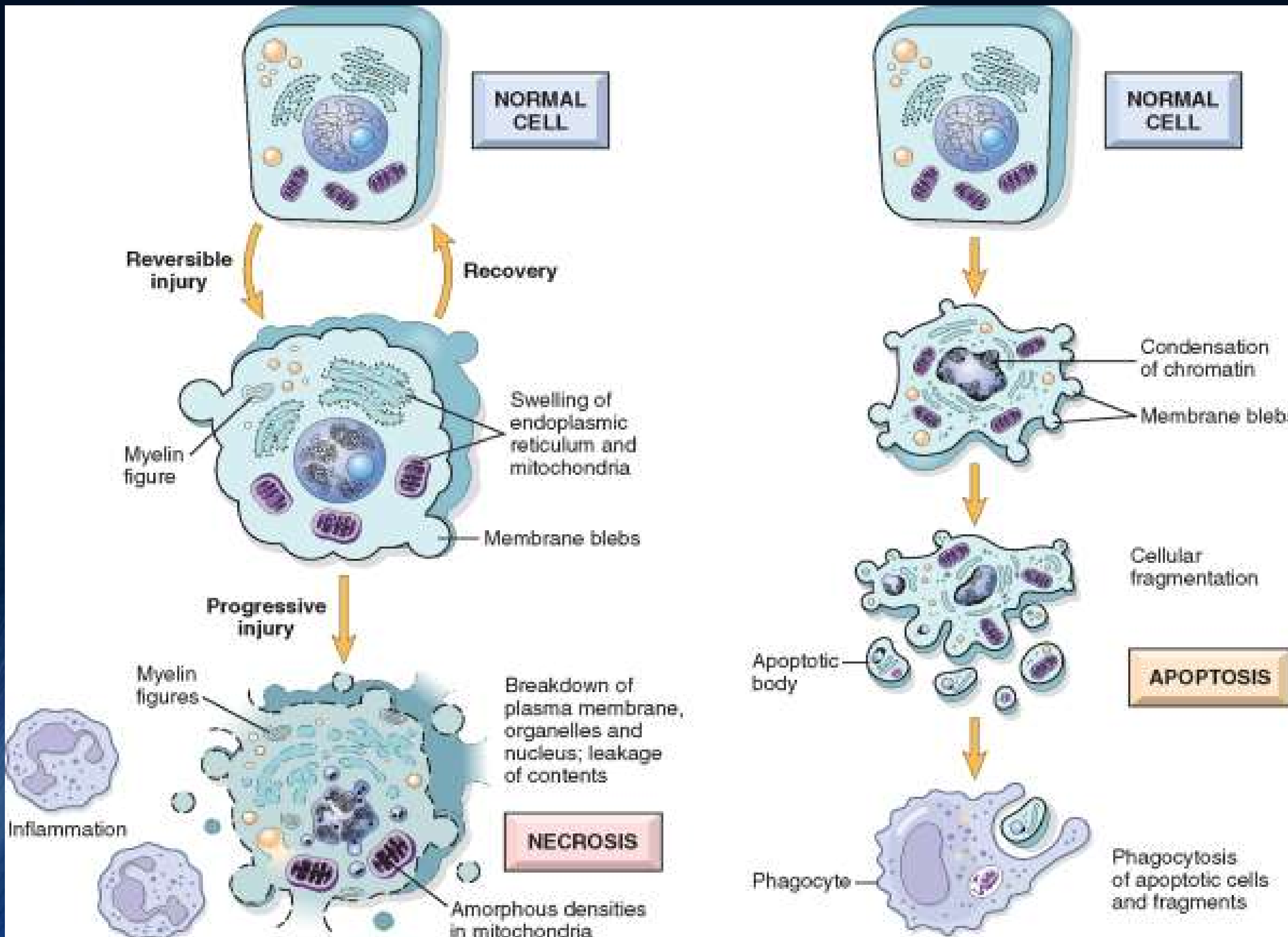

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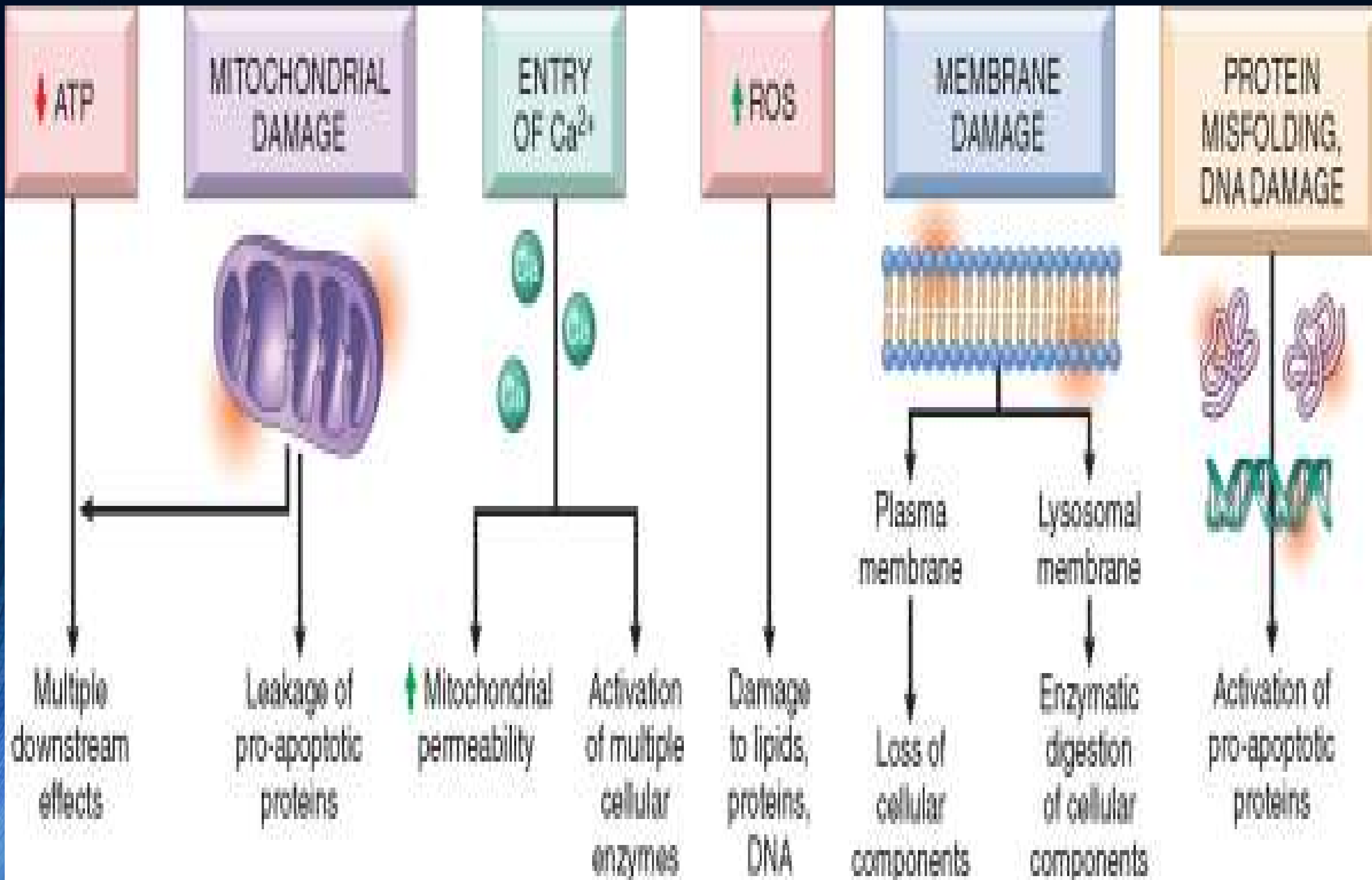

cell injury results when:

- cells can no longer adapt to stress,
- have unrecoverable exposure to damaging agents or
- suffer from intrinsic abnormalities, whether genetic or nutrient-based

in the stages of reversible injury:

- reduced oxidative phosphorylation with depletion of ATP
- cellular edema caused by changes in ion and water flows
- mitochondrial and cytoskeleton alterations
- DNA damage.

within limits, the cell can repair these derangements and, if the injurious stimulus is removed, it can return to normal.

with continuing damage, the injury

- becomes irreversible,
- the cell cannot recover and
- it dies, either through necrosis or apoptosis.

the major causes of cell injury are:

- oxygen deprivation
- physical agents
- chemical agents and drugs
- infectious agents
- immunologic reactions
- genetic derangements
- nutritional imbalances

most of the effects of PEMFs on various “disease” conditions are mediated through the basic actions of PEMFs on biology

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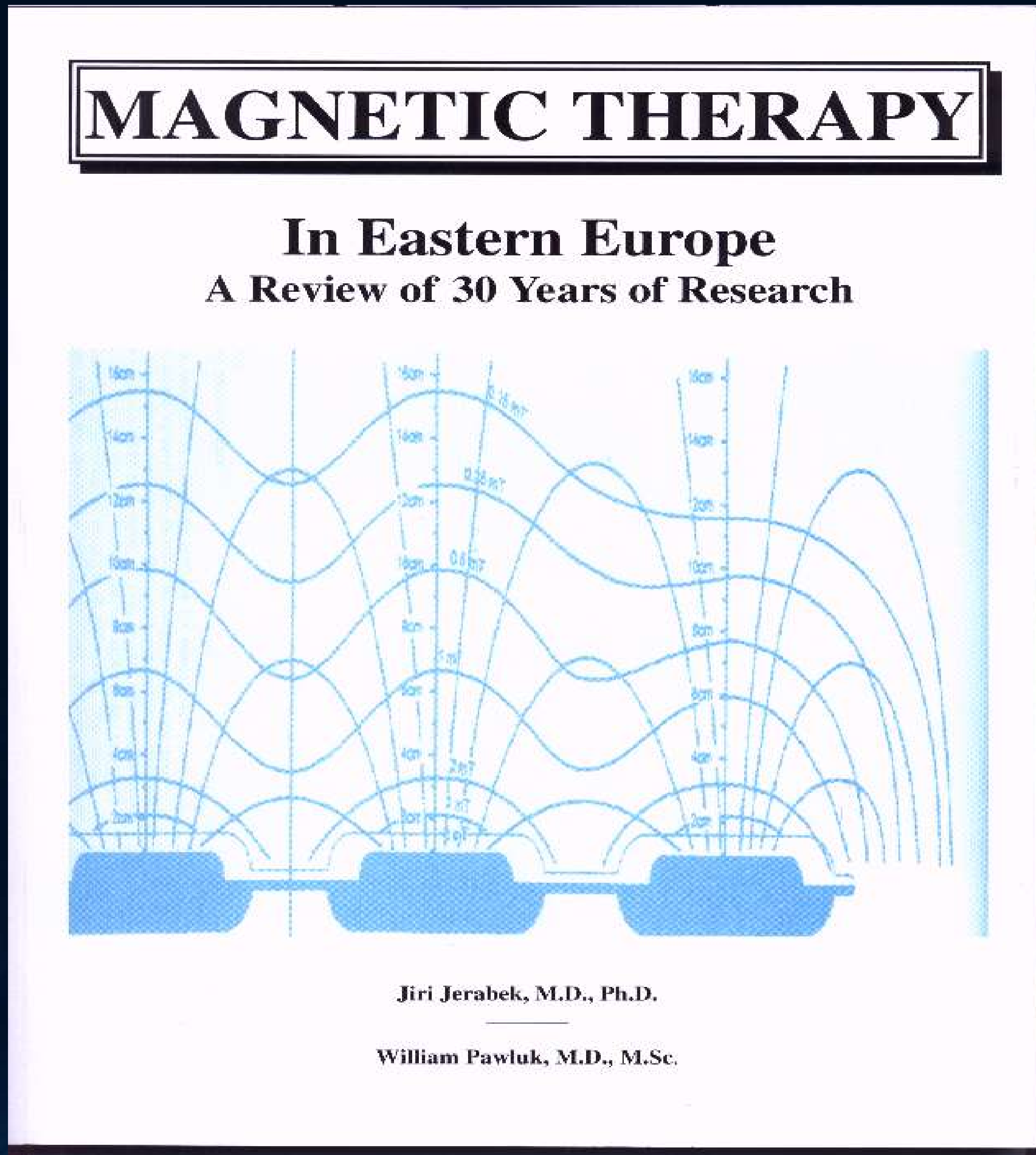

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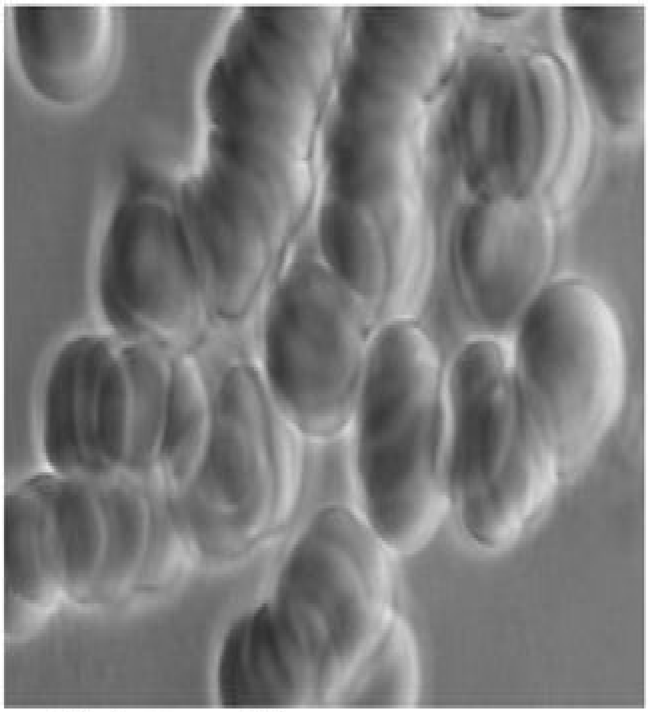
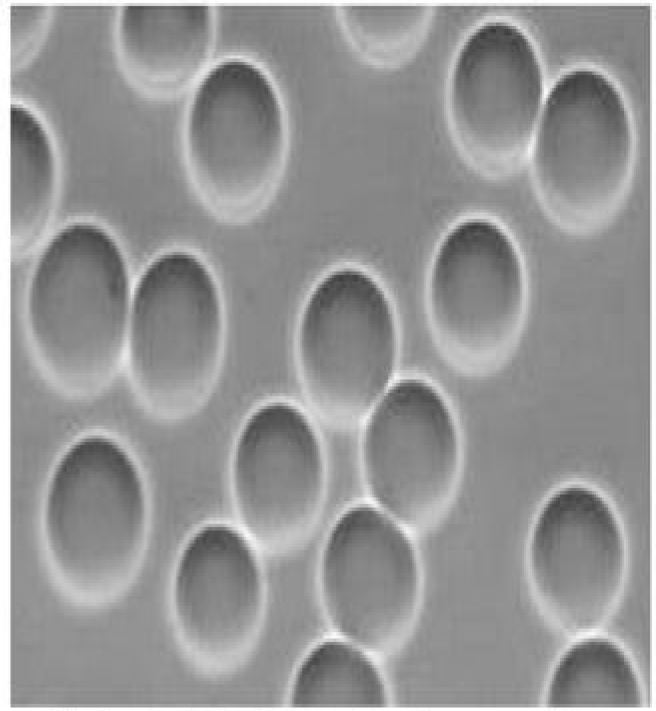
PEMF effects on RBCs



Slide 1. working on computer



Slide 2. MRS 2000, 8 min. sensitive

Overall PEMF Mechanism

PEMF

Ca^{2+} + CaM ⟶ Ca^{2+}CaM

PEMF increases Ca^{2+} binding to CaM (milliseconds)

Ca^{2+}CaM + eNOS ⟶ NO

Ca^{2+}CaM binds to eNOS, catalyzes NO release (seconds)

Anti-inflammatory: increased Blood & Lymph Flow
Pain/Edema Decrease (seconds/minutes)

(seconds/minutes)

NO ⟶ cGMP ⟶ Growth Factors (hours/days)

FGF-2 (VEGF)	Angiogenesis (hours/days)
TNF-α	Collagen/Granulation (days)
TGF-β	Remodeling (days/weeks)

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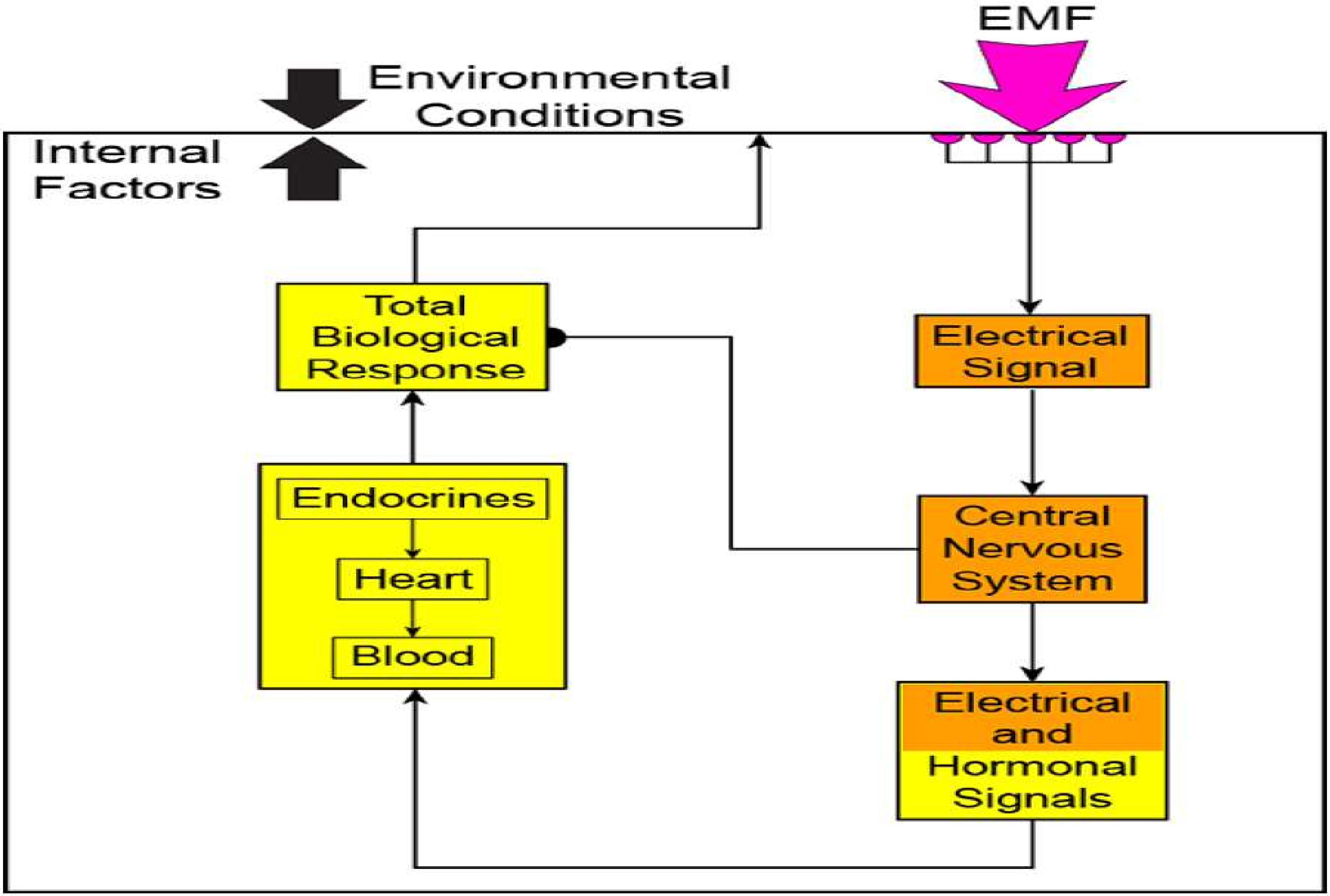
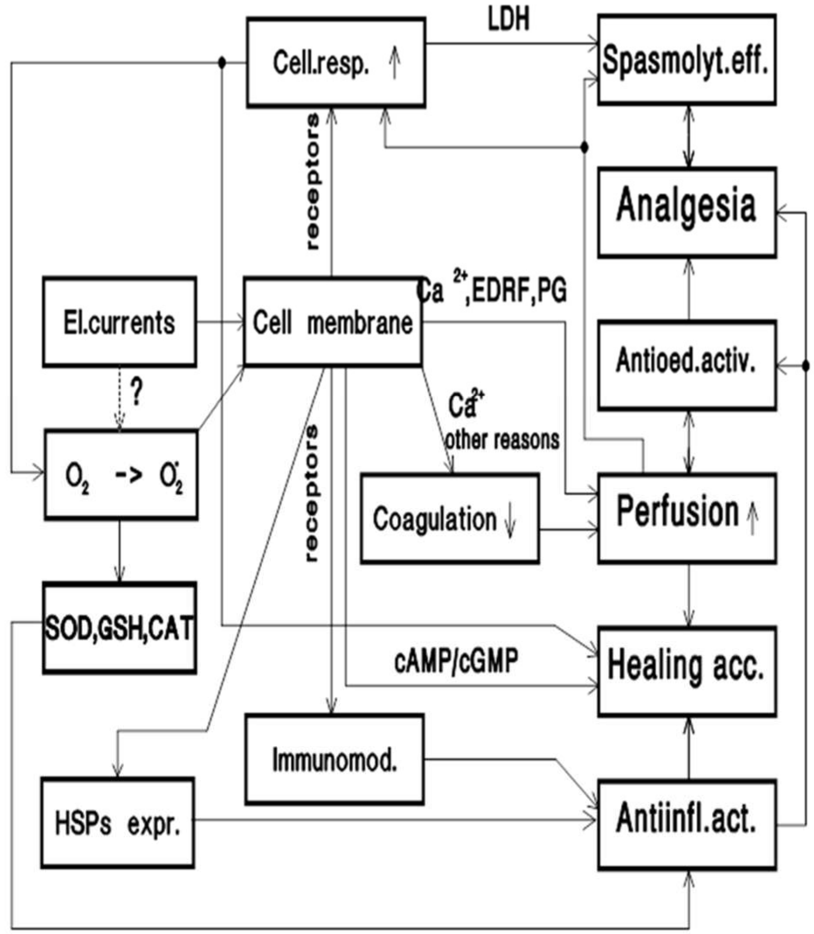


http://andrewamarino.com/laststudyfig01.html

Local action of magnetic fields



magnetic field effects

1. vasodilatation
2. analgesic action
3. anti-inflammatory
4. spasmolytic activity
5. healing acceleration
6. antiedema activity
7. reduced bruising
8. acupuncture
9. anti-coagulant effect

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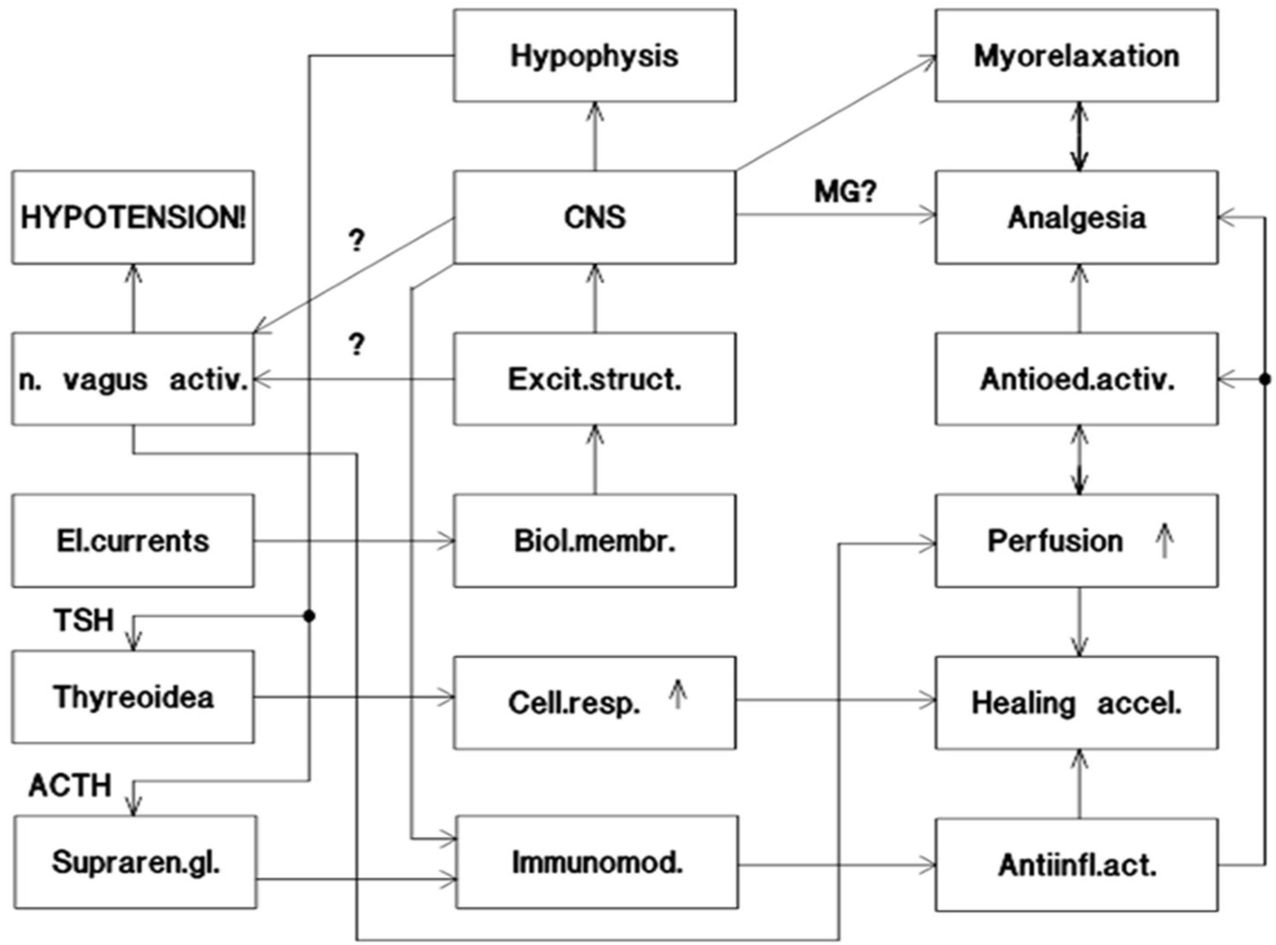
Systemic action of magnetic fields



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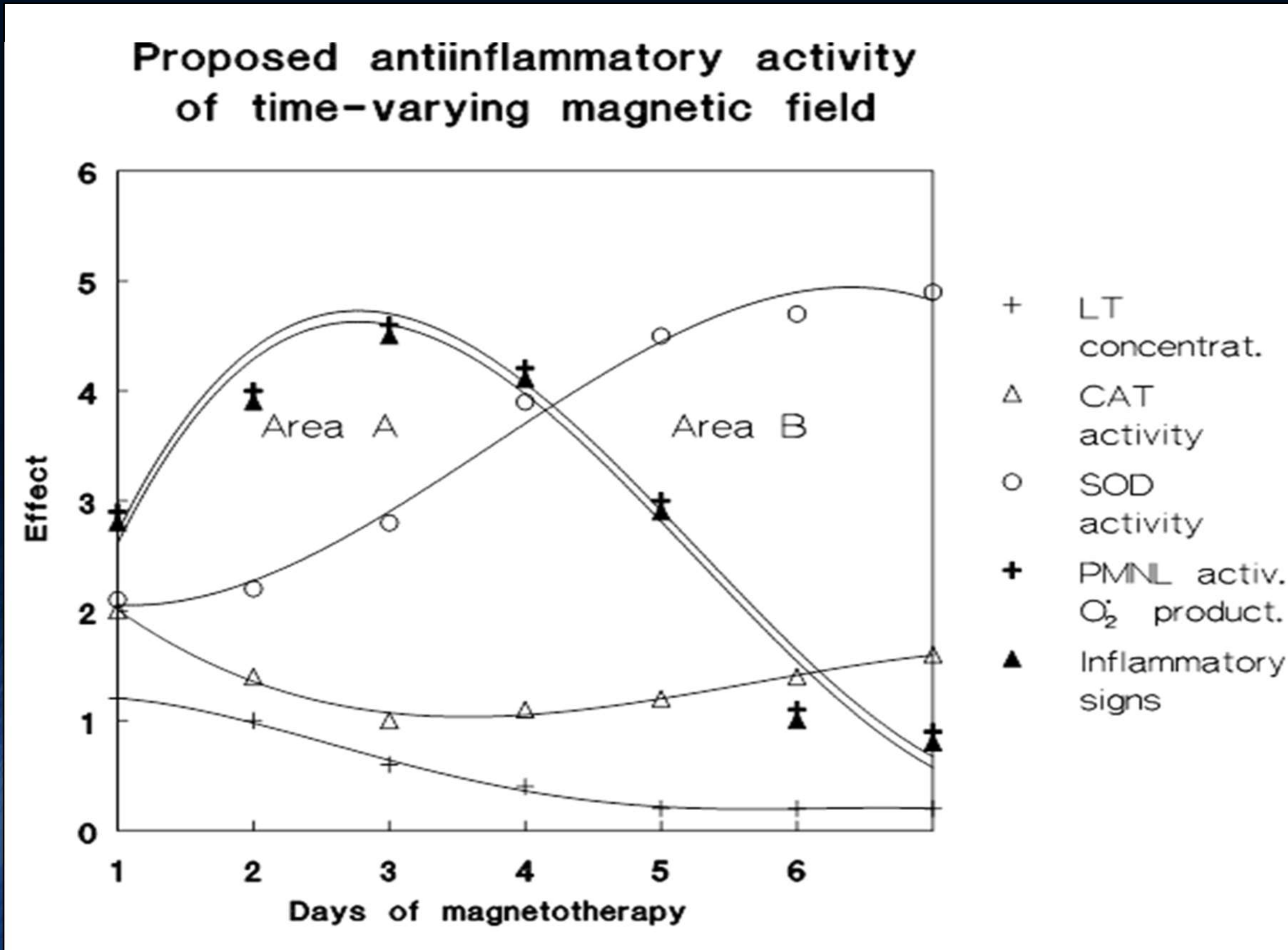

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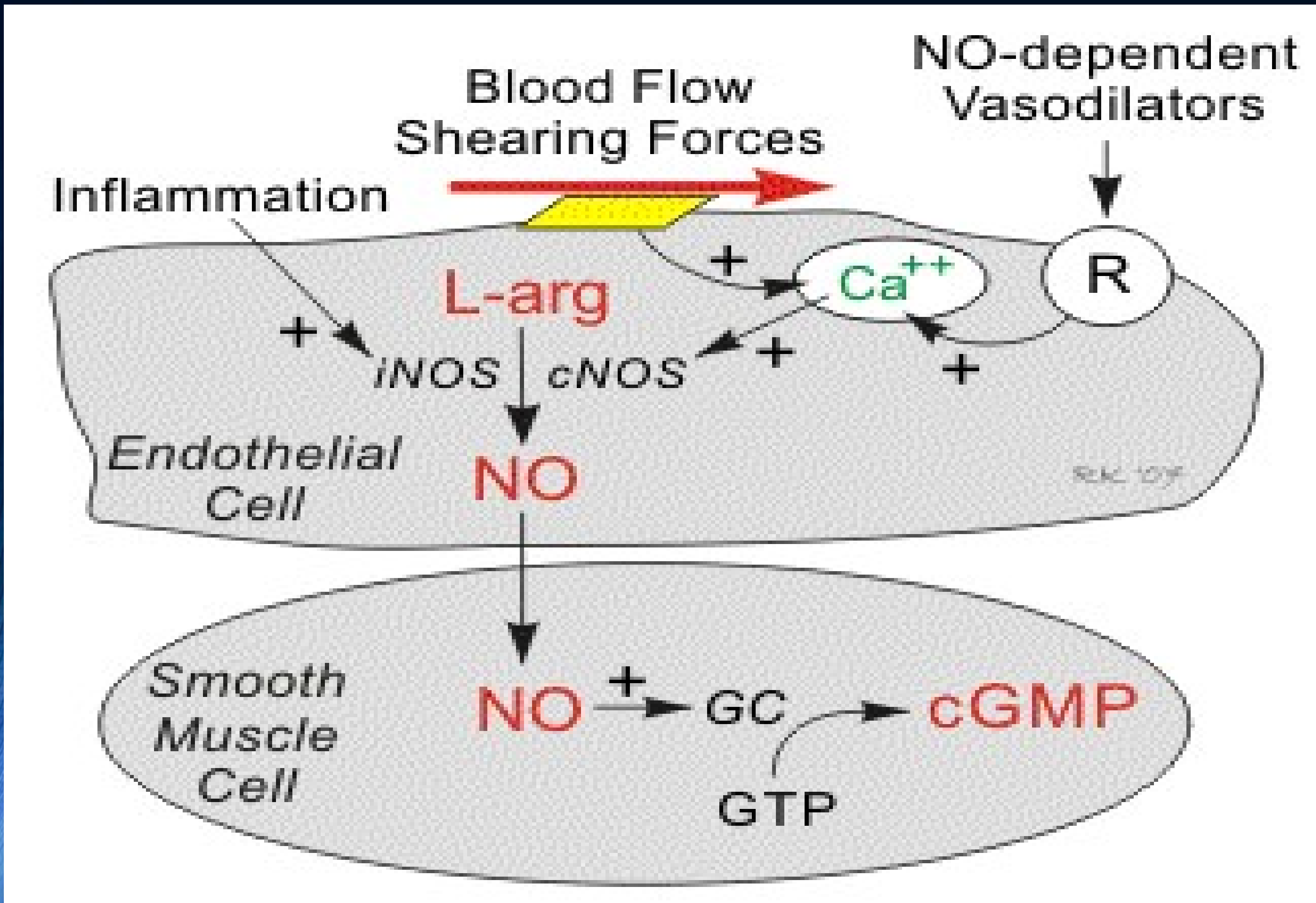

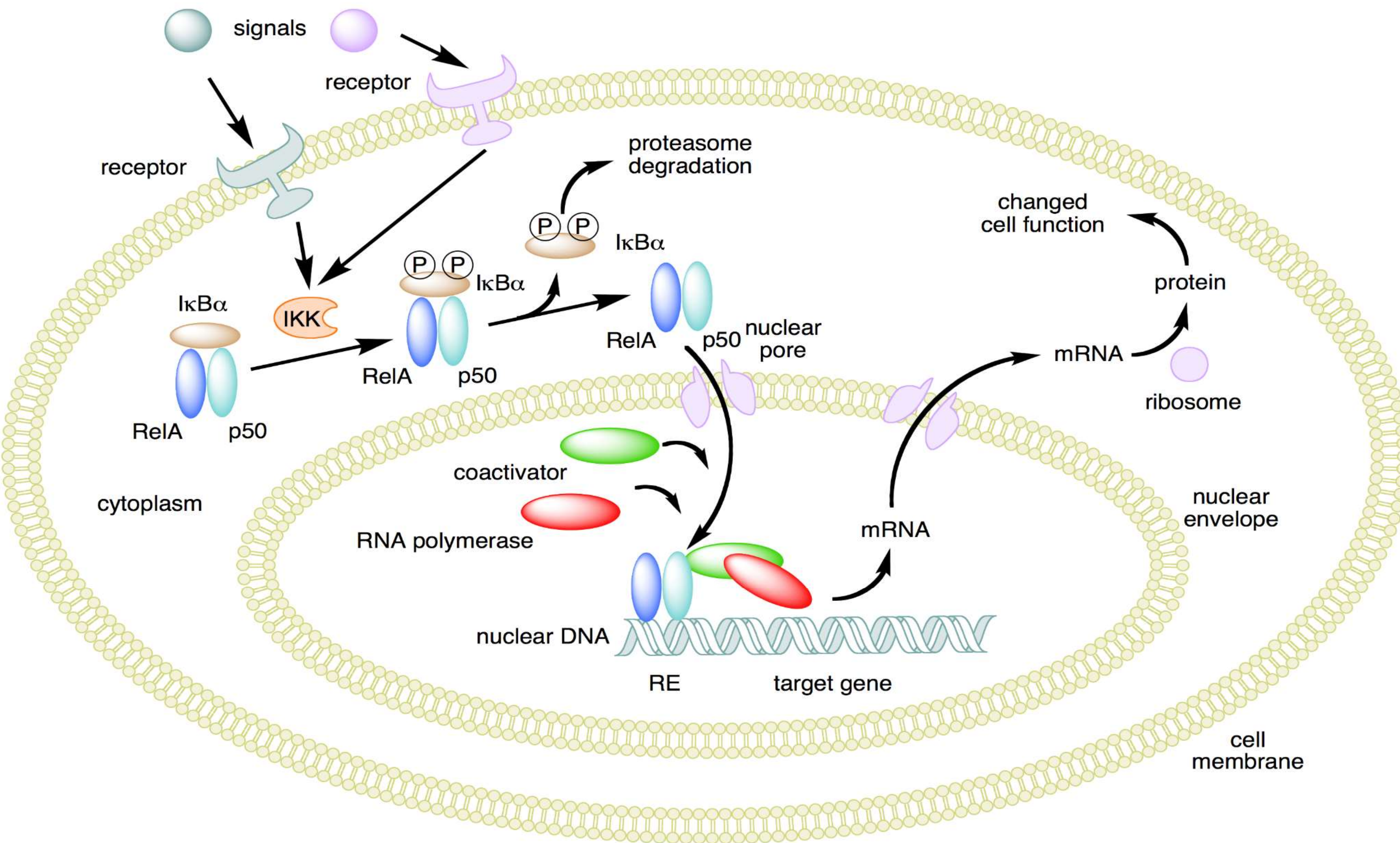
signals
receptor
receptor
proteasome
degradation
P P
IκBα
changed
cell function
IκBα
IKK
P P
IκBα
RelA
p50
nuclear
pore
protein
mRNA
ribosome
RelA
p50
RelA
p50
coactivator
cytoplasm
RNA polymerase
mRNA
nuclear
envelope
nuclear DNA
RE
target gene
cell
membrane

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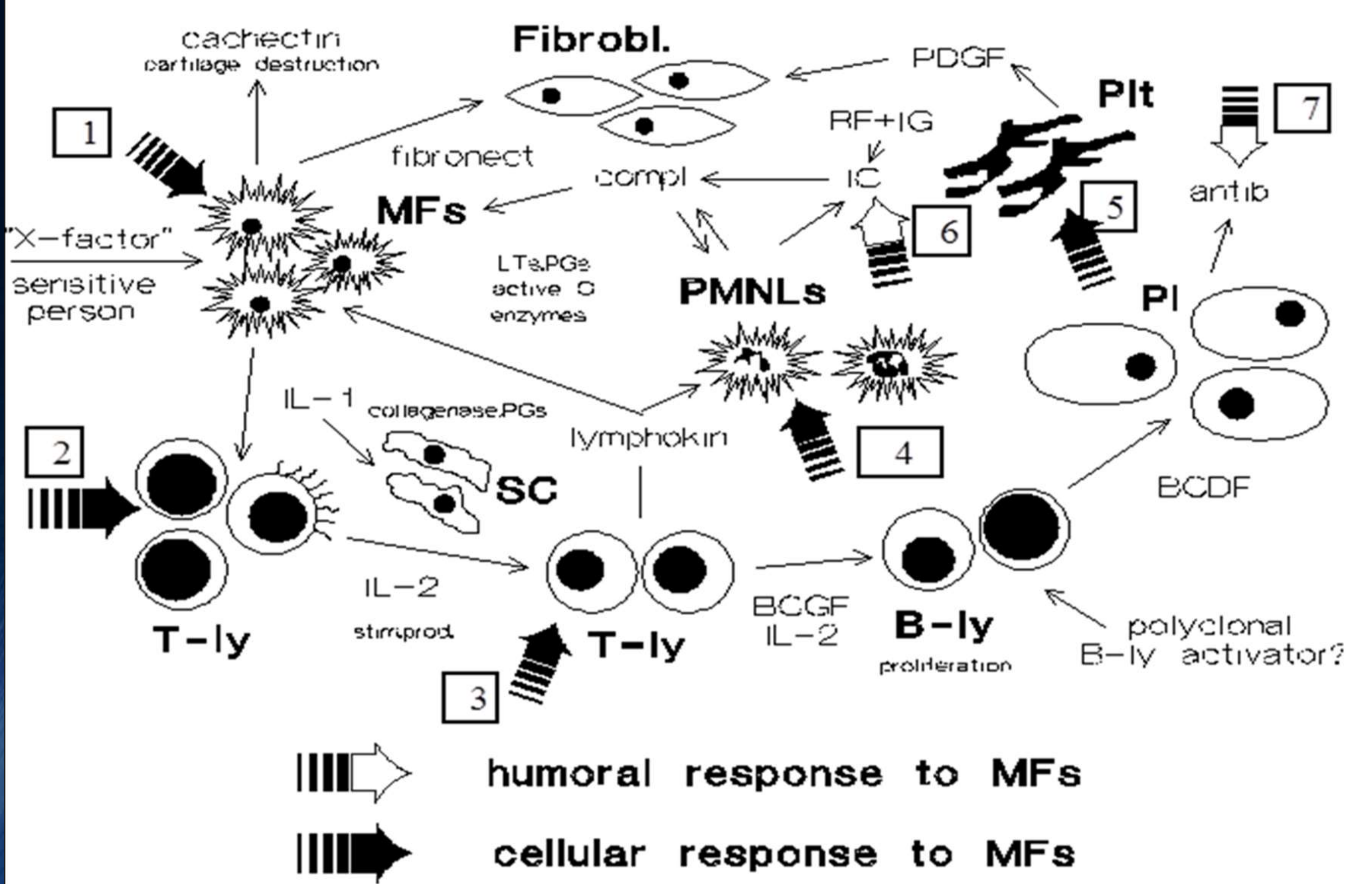
Proposed action of MFs in RA



mechanisms of action

- vascular effects
- coagulation
- fractures
- psychological/cognitive
- immunology
- muscle actions
- nerve conductivity
- EEG effects
- intestinal motility
- skin respiration
- antioxidant activity

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10 Hz PEMF rat paw inflammation study

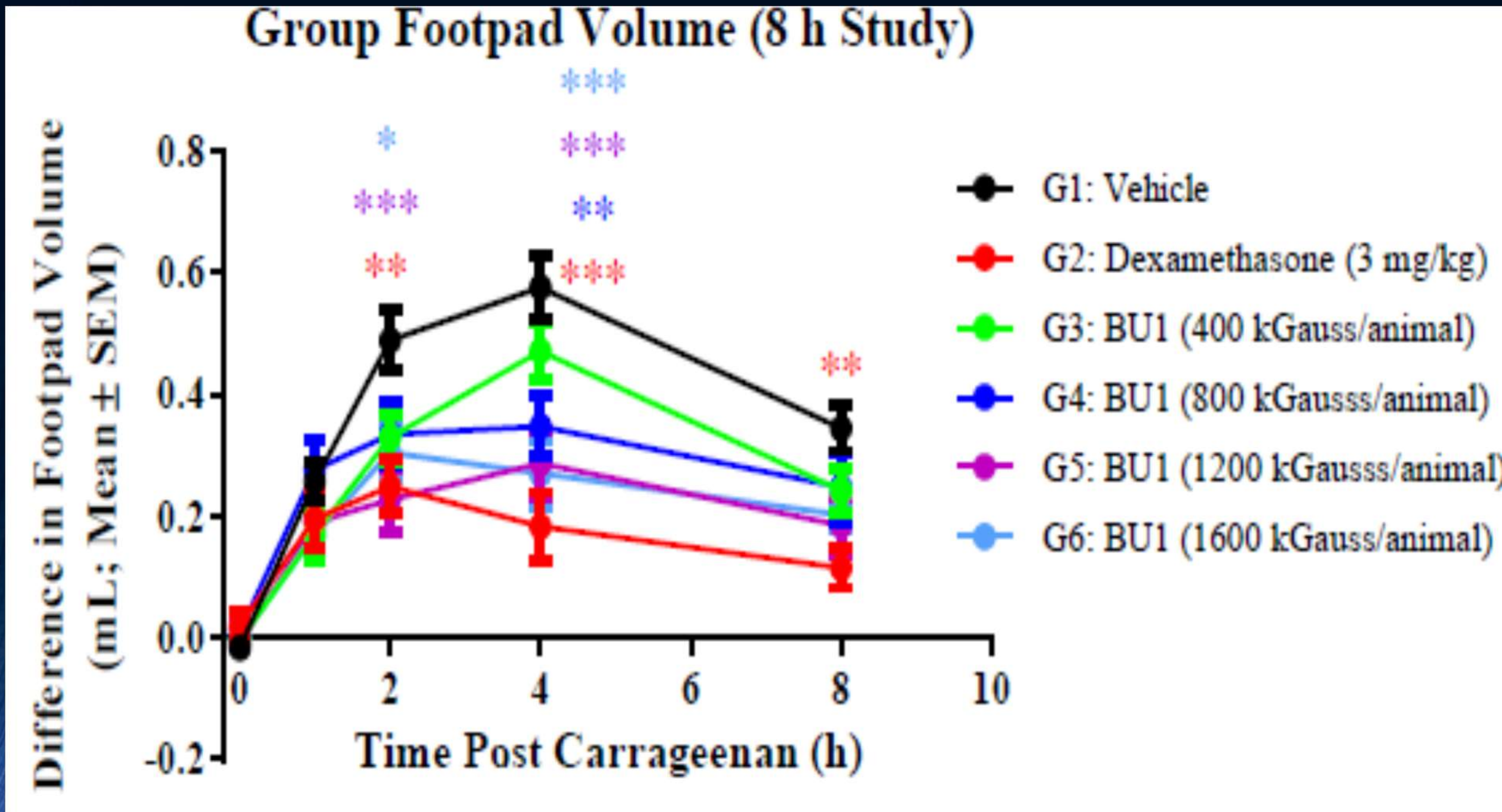

Figure 3 Group footpad volume difference between the carrageenan-injected and saline-injected paws was calculated by time and field intensity. Significance (one-way ANOVA and post-hoc Dunnett's test): * = P ≤ 0.05; ** = P < 0.01; *** = P < 0.001, compared to Group 1. Permission of Dr Dennis.

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10 Hz PEMF rat paw inflammation study

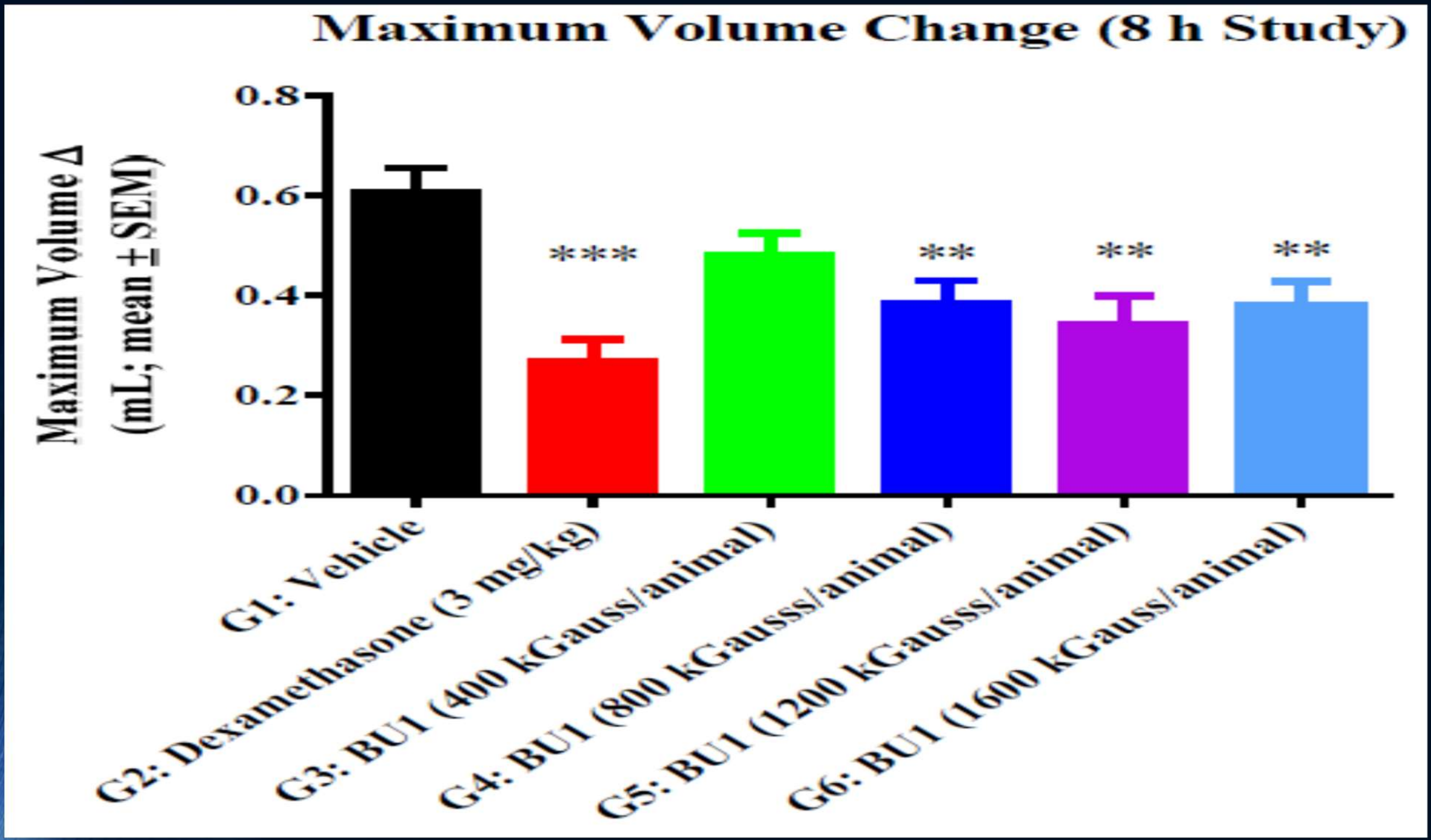

Figure 4 Footpad volume difference between maximum volume and baseline by time and field intensity. Significance (one-way ANOVA and post-hoc Dunnett's test): * = P ≤ 0.05; ** = P < 0.01; *** = P < 0.001, compared to Group 1.

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NASA 10 Hz (0.01-.3 G) PEMF study on stem cell growth

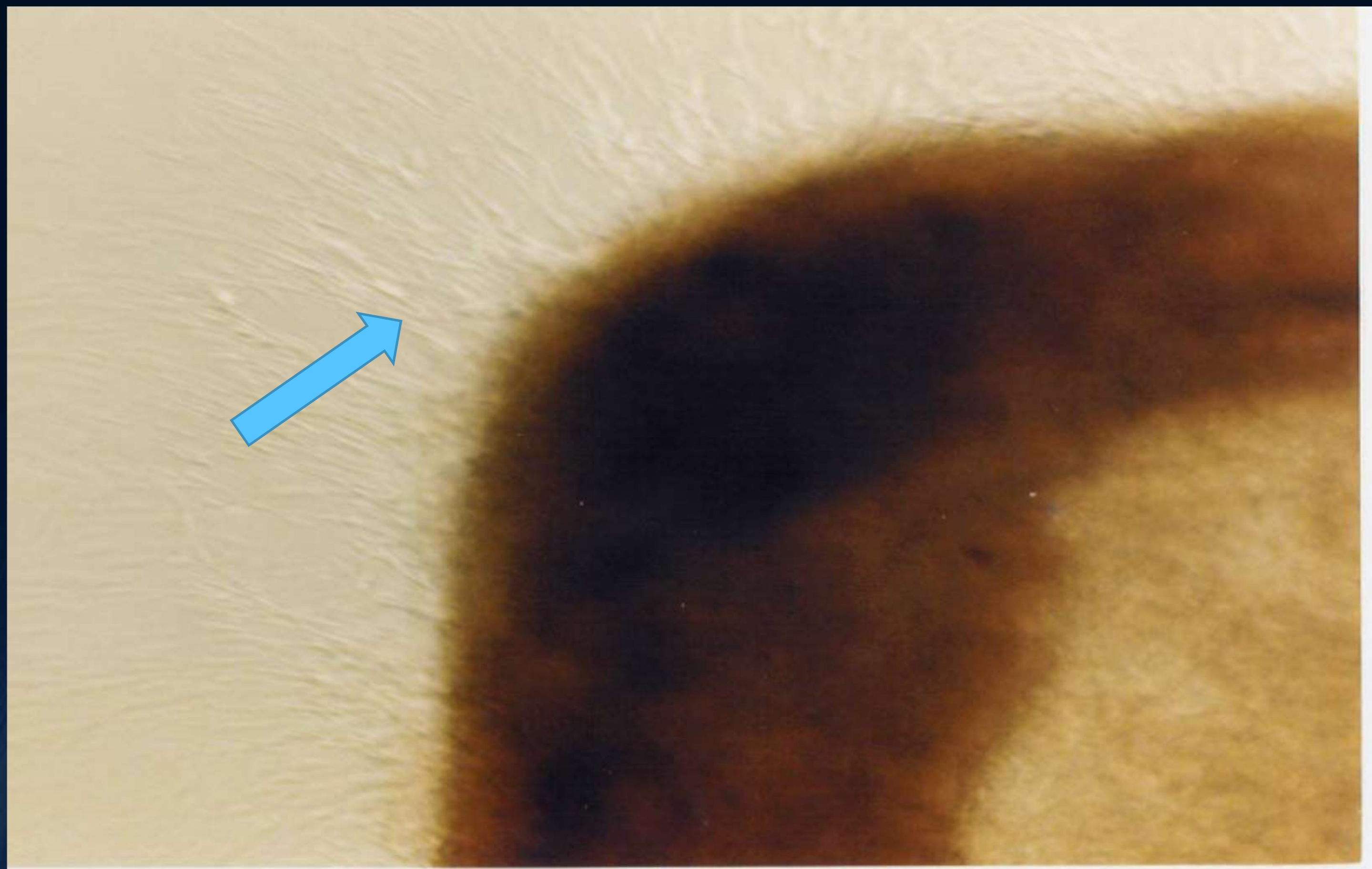

FIGURE 5. Close inspection of the edge of the corona reveals NHNP cells attempting to grow in an oriented fashion away from the transplanted tissue.

Physiological and molecular genetic effects of time-varying electromagnetic fields on human neuronal cells. Thomas J. Goodwin, PH.D. Lyndon B. Johnson Space Center, Houston, Texas. NASA/TP-2003-212054.

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NASA 10 Hz (0.01-.3 G) PEMF study on stem cell growth

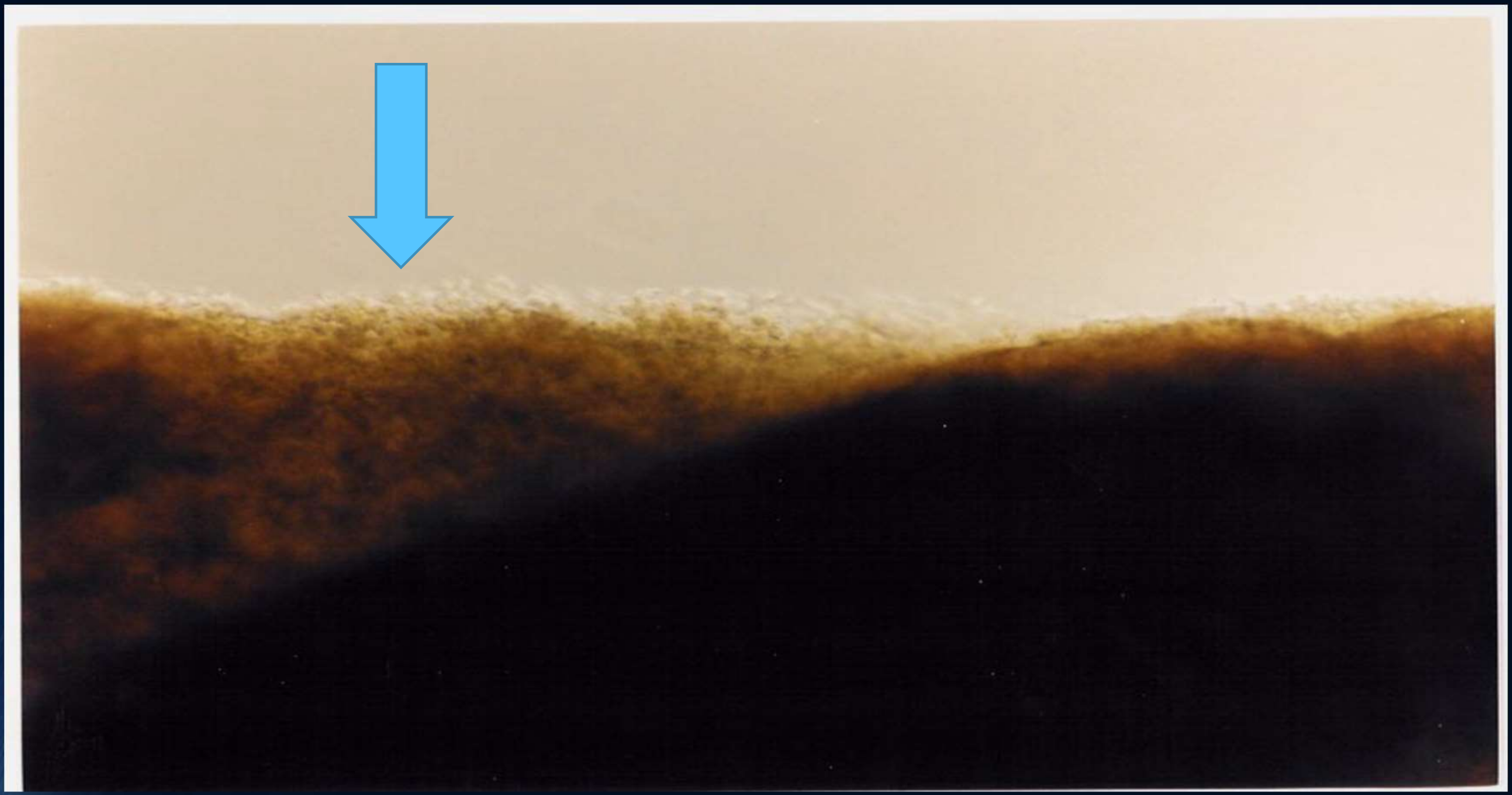

FIGURE 6. In direct contrast to the treated NHNP cells, non-waveform tissues attached but did not proliferate over the same 24-hour period

Physiological and molecular genetic effects of time-varying electromagnetic fields on human neuronal cells. Thomas J. Goodwin, PH.D. Lyndon B. Johnson Space Center, Houston, Texas. NASA/TP-2003-212054.

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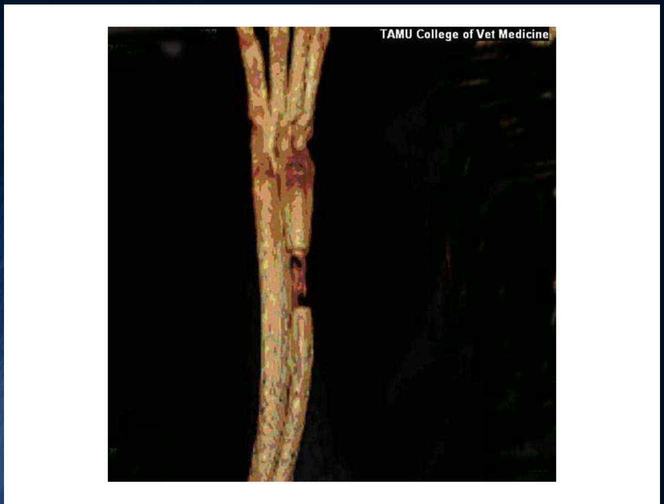
no PEMF



14 days

PEMF

28 days

MRI image of rabbit ulna after osteotomy

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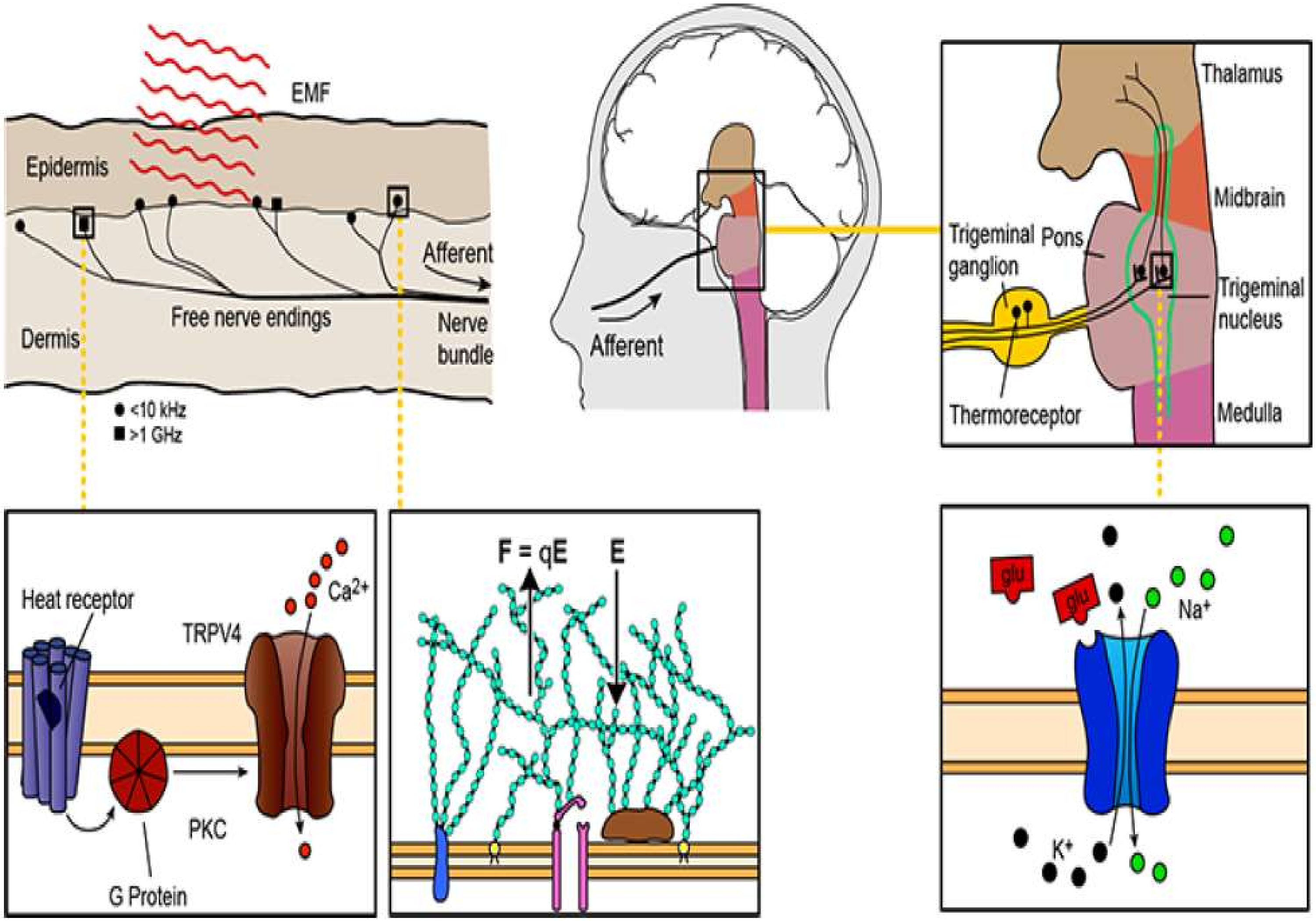
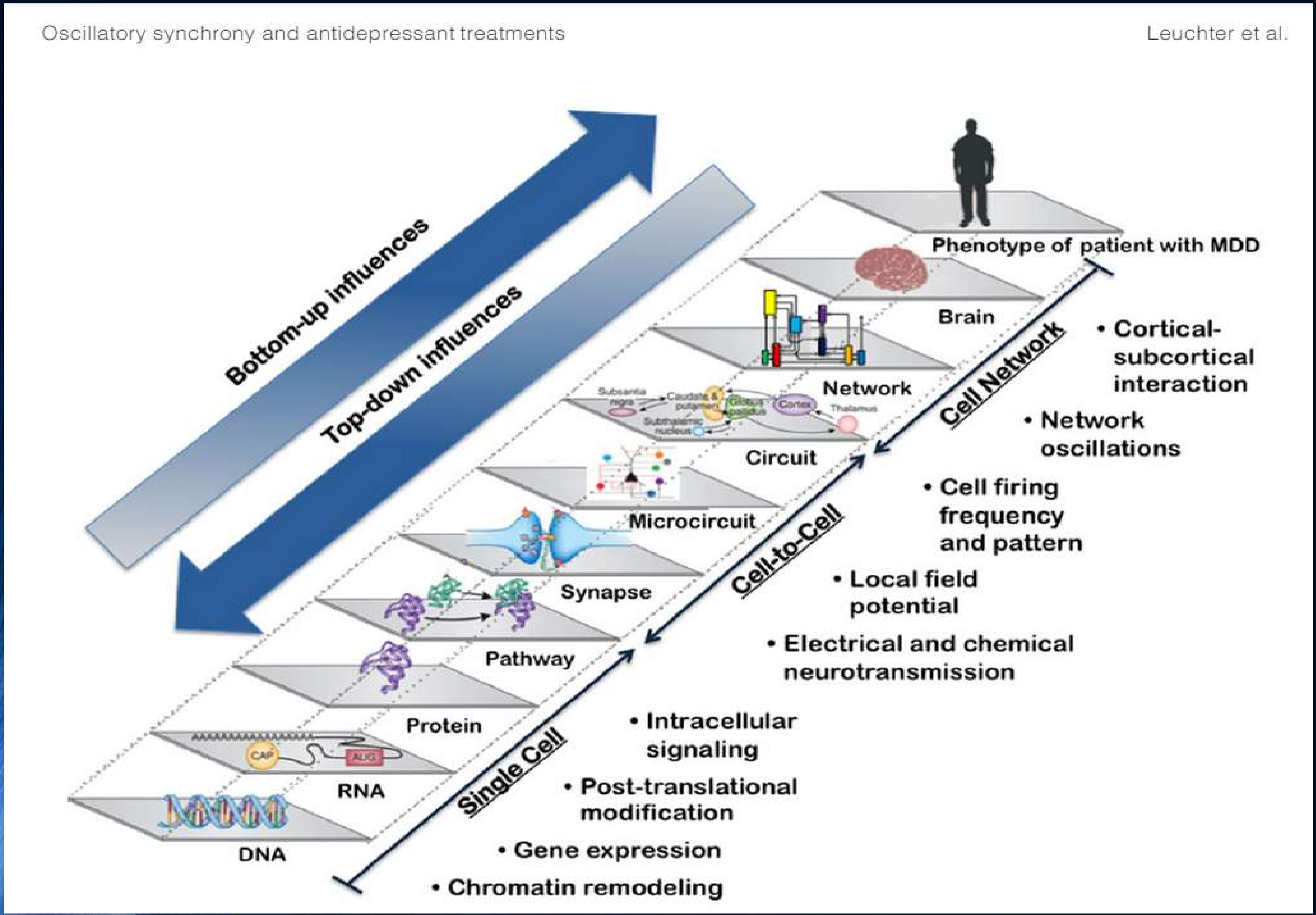


http://andrewamarino.com/laststudyfig02.html



Leuchter AF, Hunter AM, Krantz DE, Cook IA. Rhythms and blues: modulation of oscillatory synchrony and the mechanism of action of antidepressant treatments. Ann N Y Acad Sci. 2015 May;1344:78-91.

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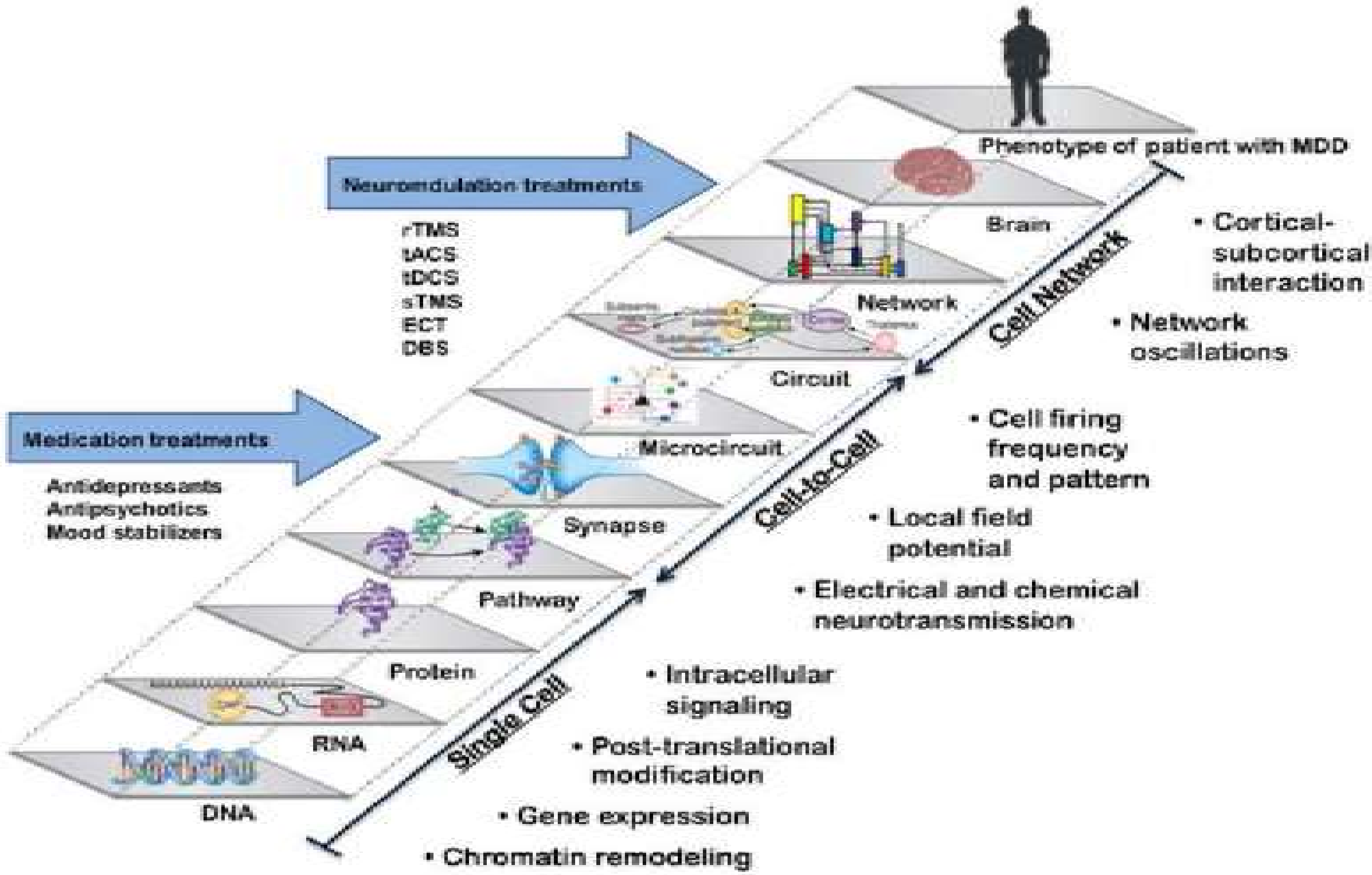


Figure 3. Hypothesized action of antidepressant treatments at different levels of biological complexity in the brain. Antidepressant

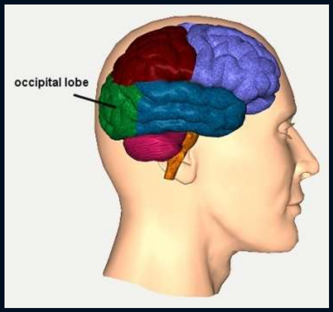
Leuchter AF, Hunter AM, Krantz DE, Cook IA. Rhythms and blues: modulation of oscillatory synchrony and the mechanism of action of antidepressant treatments. Ann N Y Acad Sci. 2015 May;1344:78-91.

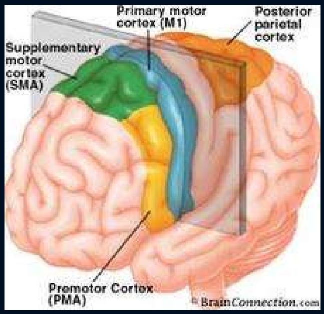
brain and neuro

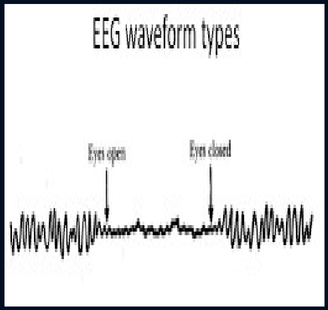
EEGs show different regions of the human brain engage in electrical oscillations at different frequencies.

- eyes closed in a state of relaxation,
  - occipital cortex oscillates at 10 Hz
  - sensory-motor cortex at 20 Hz.

- EEG rhythms change radically in the space of a second
  - open eyes or plan a simple movement
  - resonance frequencies
    - visual cortex 10 Hz
    - auditory cortex 40 Hz







Rosanova M, Casali A, Bellina V, et al. Natural frequencies of human corticothalamic circuits. J Neurosci. 2009 Jun 17;29(24):7679-85.

Niedermeyer, E. (1999) The Normal EEG of the Waking Adult. Electroencephalography. Lippincott Williams Wilkins, Baltimore.

any stable frequency presented to the body, especially the brain, evokes a cortical brain response

the brain synchronizes its own natural brainwave frequencies with that of the external stimulus

this is brainwave entrainment

entrainment

used in neurofeedback to induce many different brainwave states

- enhanced focus
- alertness
- relaxation
- meditation
- trance
- sleep-induction/maintenance

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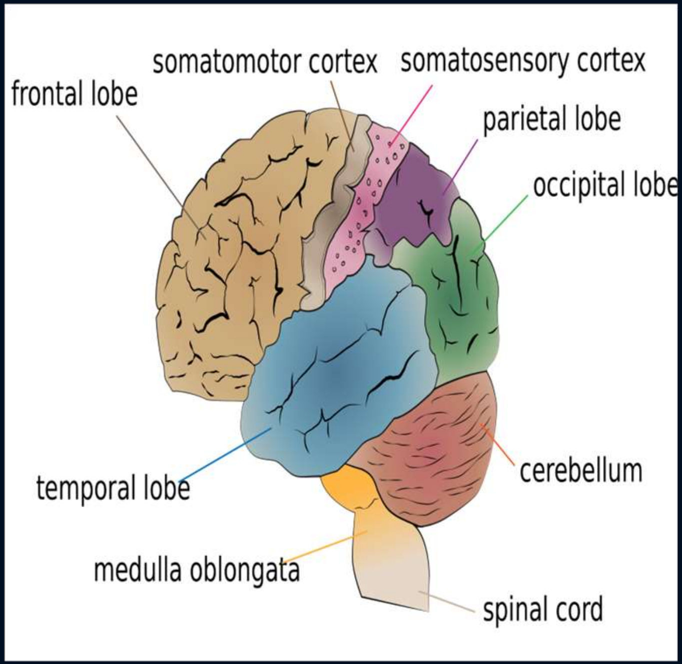
dominant oscillations in
various brain areas

- alpha-band (8-12 Hz) in
  the occipital brain cortex
- beta-band oscillations
  (13-20 Hz) in the parietal cortex
- fast beta/gamma-band oscillations
  (21-50 Hz) in the frontal cortex



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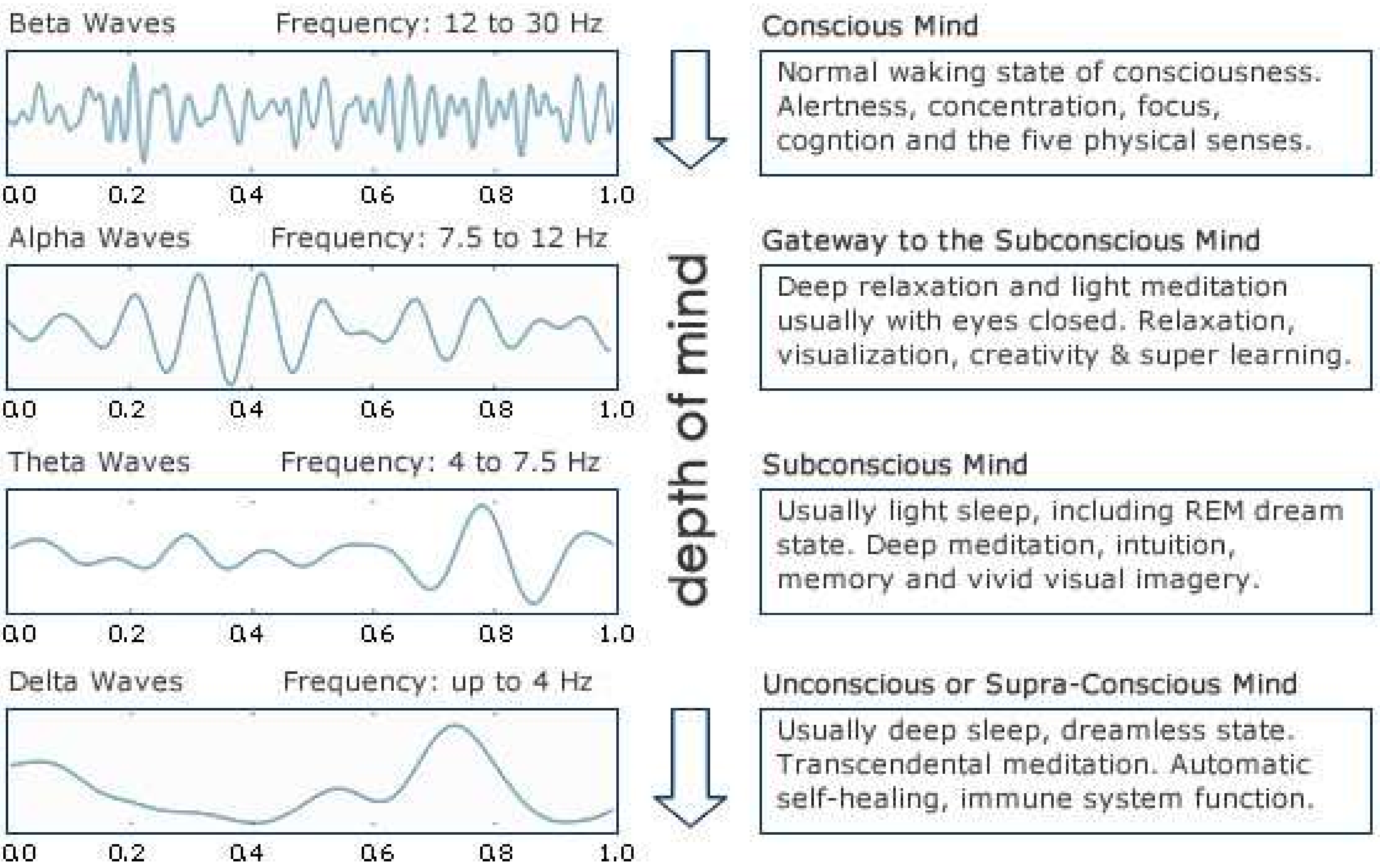
EEG Brain Frequency Chart



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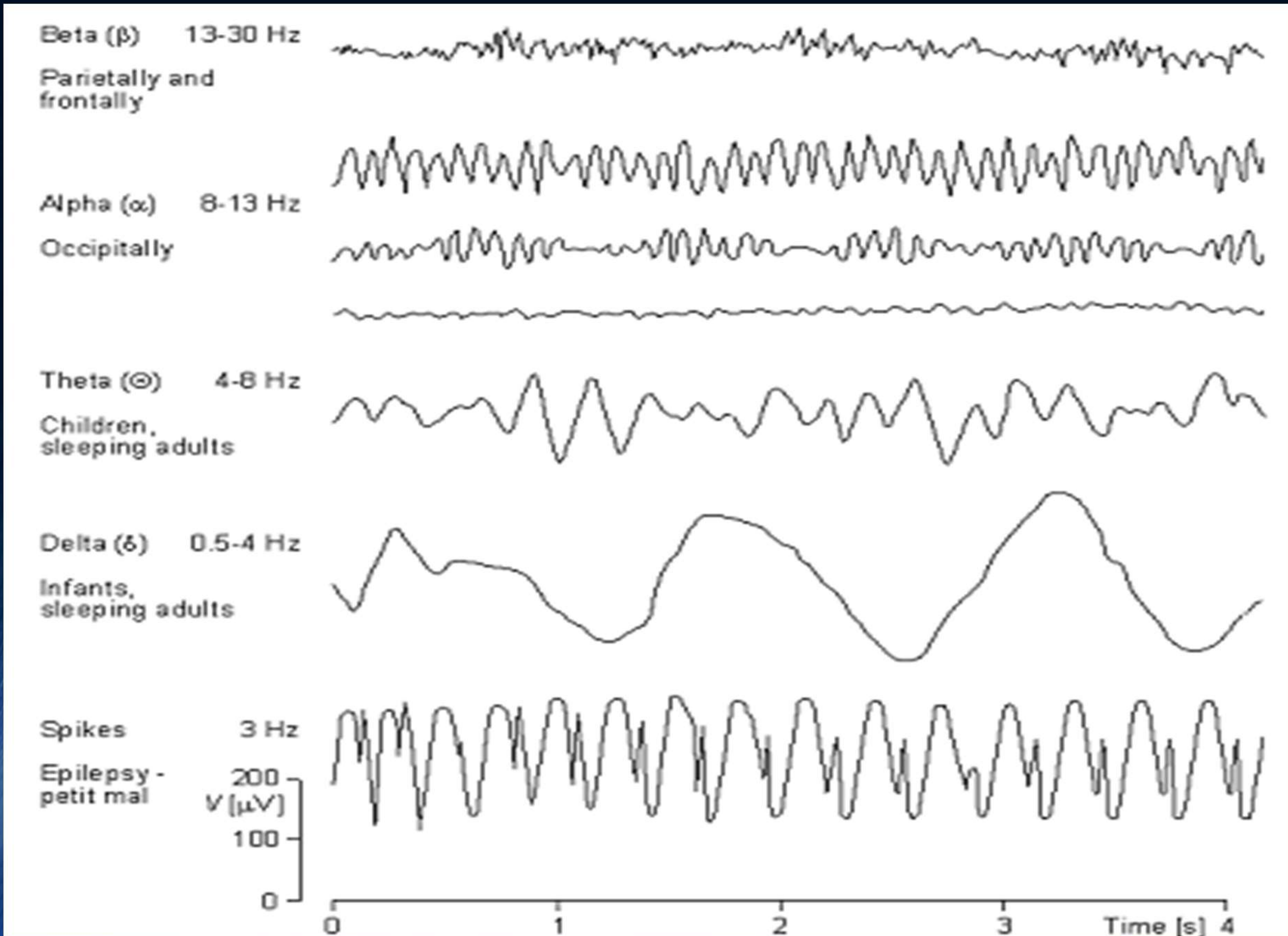

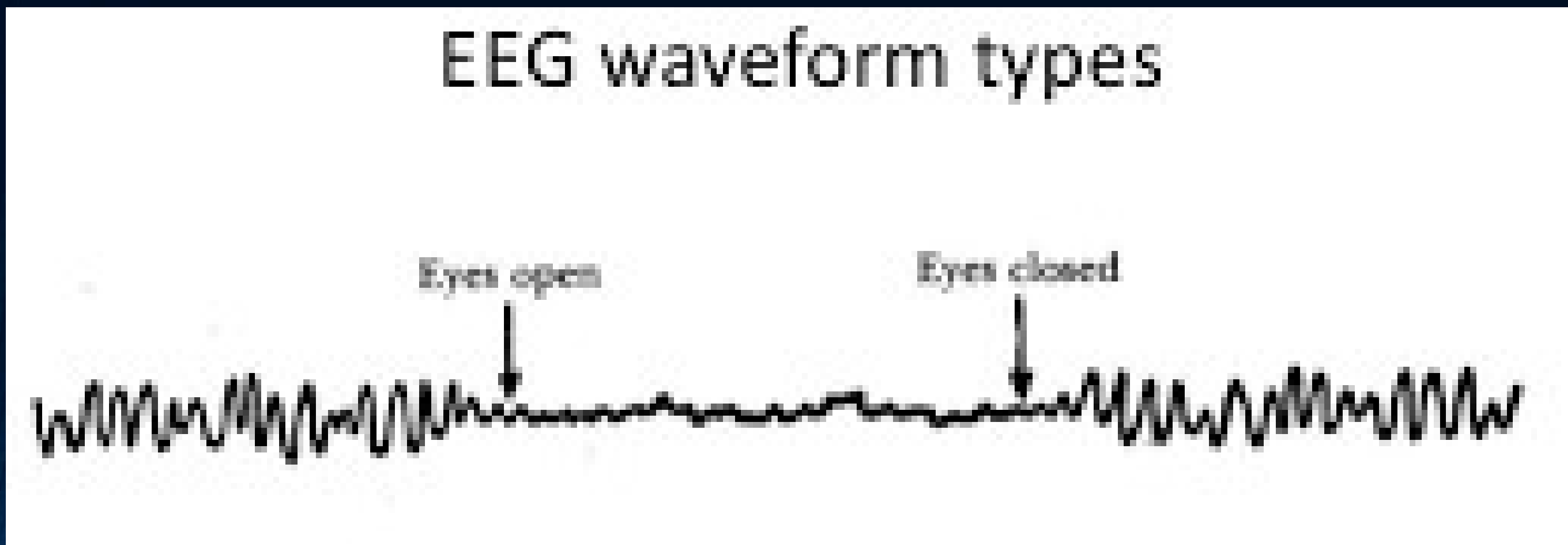
EEG waveform types
Eyes open
Eyes closed

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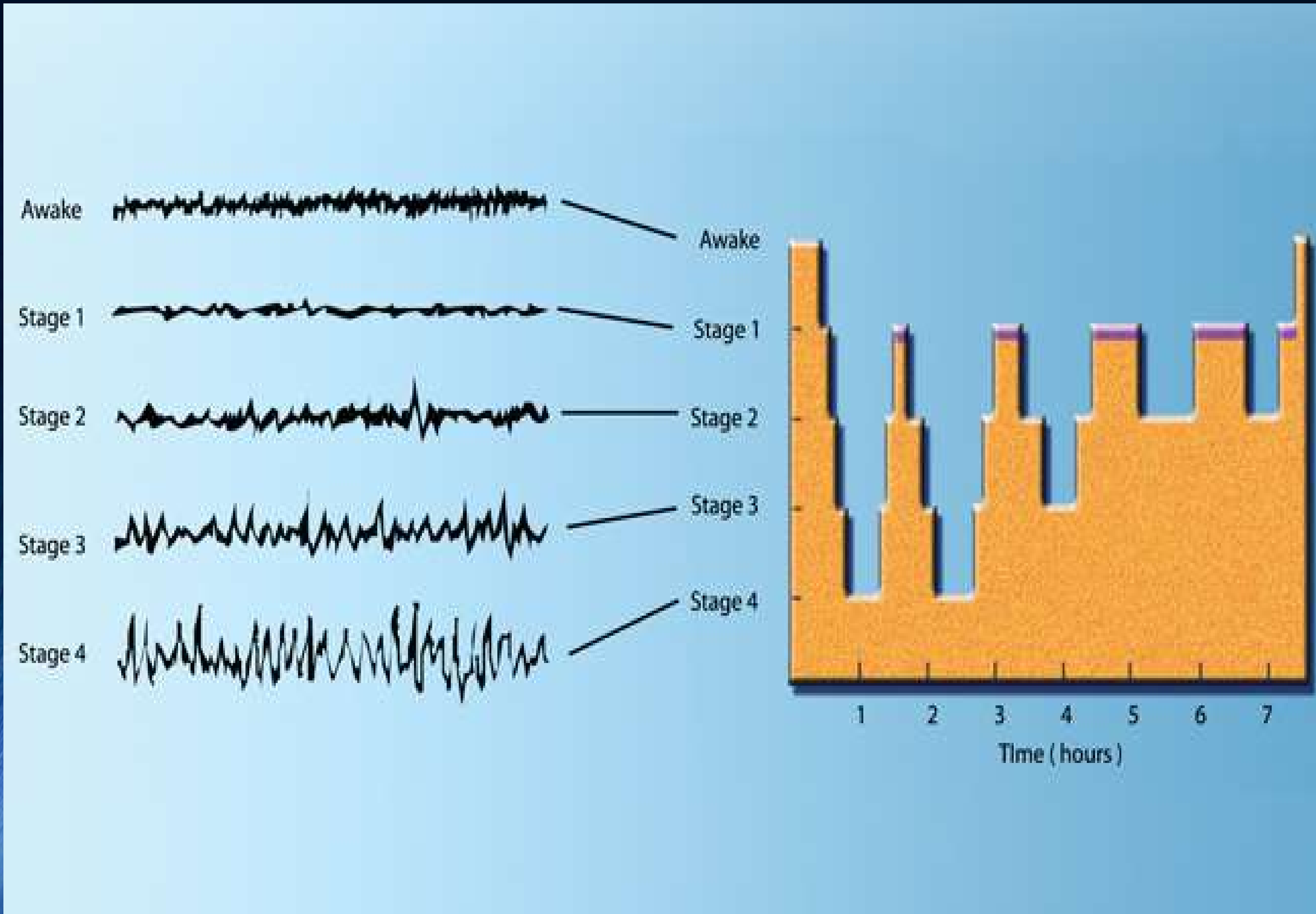

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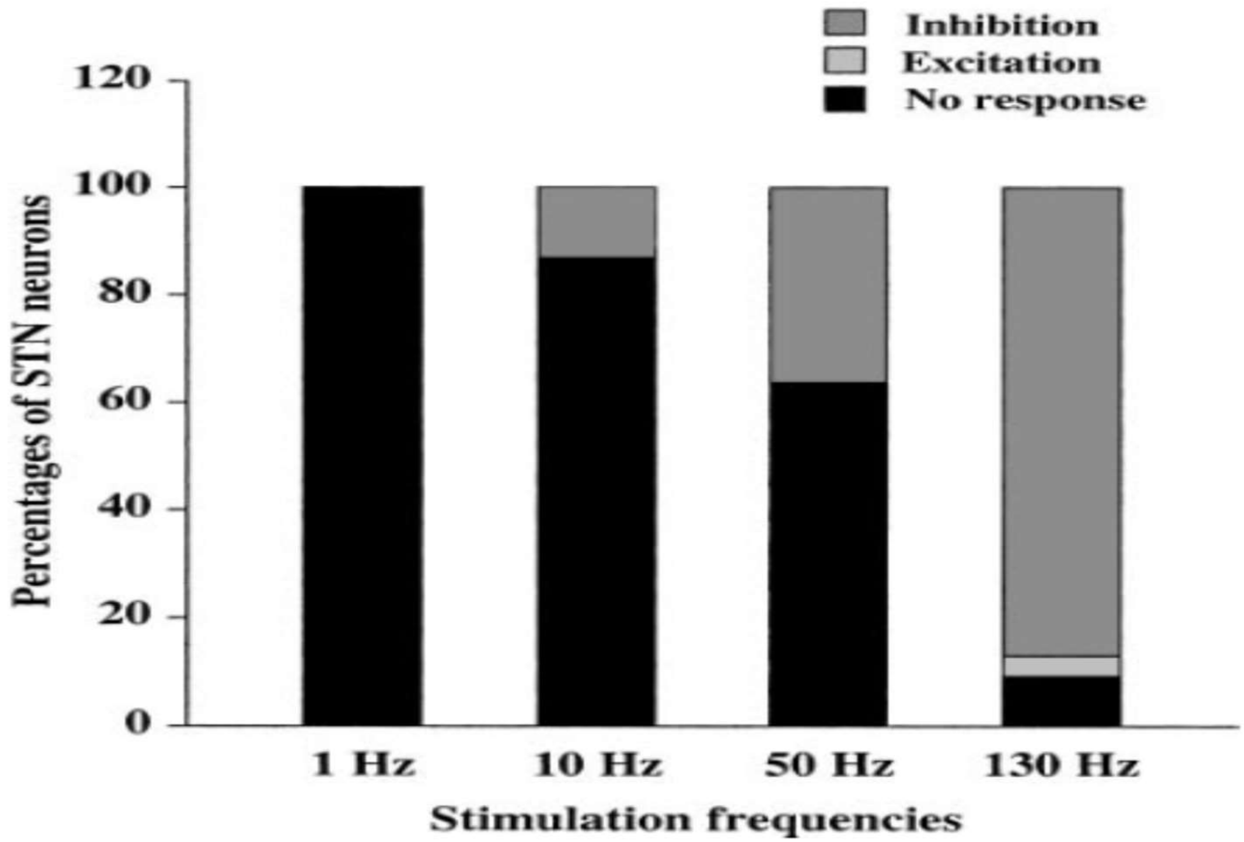

Figure 5. Histograms showing the percentage of STN neurons responding to each frequency of stimulation. Note the progressive augmentation of the percentage of neurons presenting an inhibitory response as the frequency of stimulation increases.

Tai CH, Boraud T, Bezard E, Bioulac B, Gross C, Benazzouz A. Electrophysiological and metabolic evidence that high-frequency stimulation of the subthalamic nucleus bridles neuronal activity in the subthalamic nucleus and the substantia nigra reticulata. FASEB J. 2003 Oct;17(13):1820-30.

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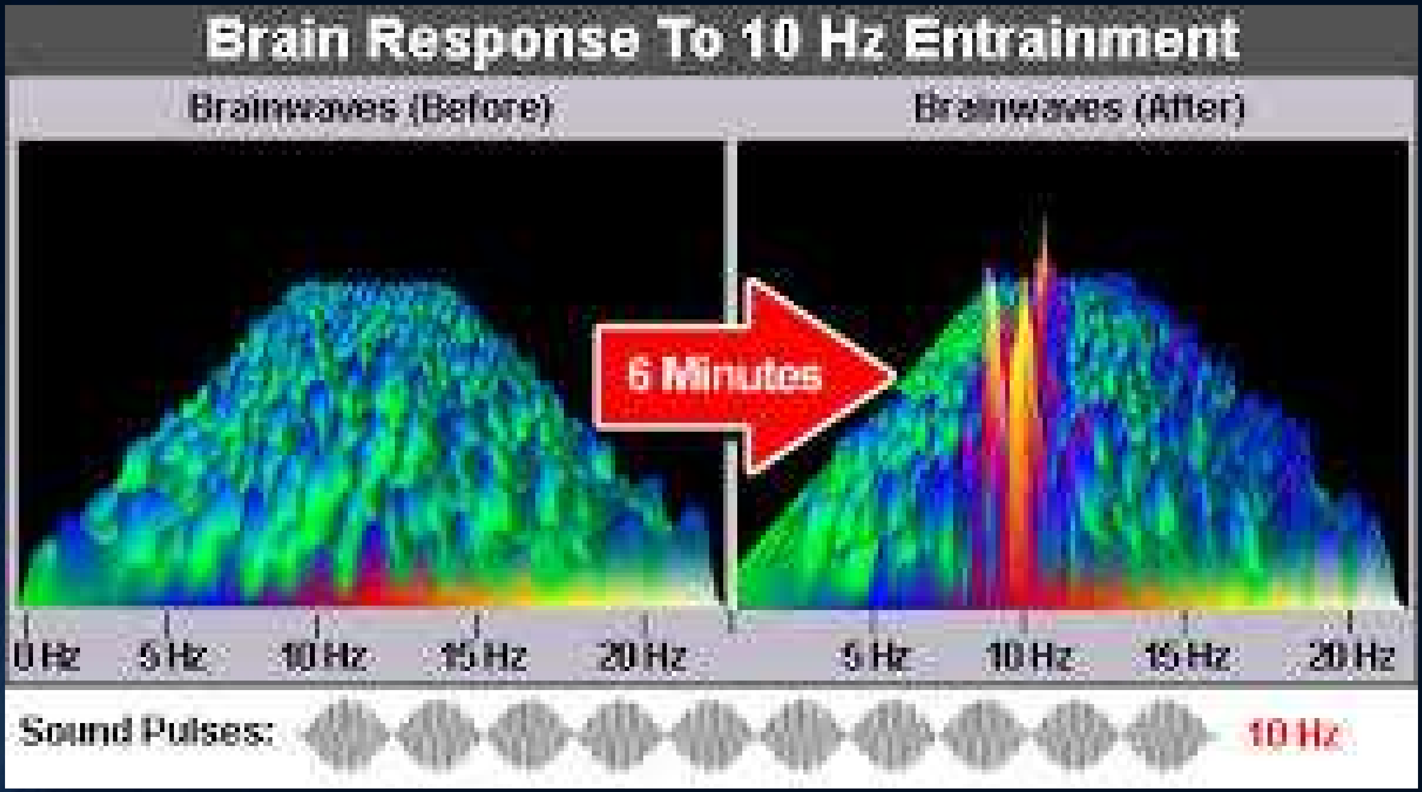

Frequencies (Hz)	Releases opioides						
	P substance	Encephaline	B Endorfine	Dinorfine	Endomorfine	CCK8	Orphaniine
100				X	X	X	X
15		X	X	X			
10	X						
4				X	X		
2		X	X		X		

Table 1. Release of opioid stimulatory function of frequency used.

Silvério-Lopes S.. Electroacupuncture and Stimulatory Frequencies in Analgesia, Acupuncture -Concepts and Physiology, Prof. Marcelo Saad (Ed.), (2011). ISBN: 978-953-307-410-8, InTech.

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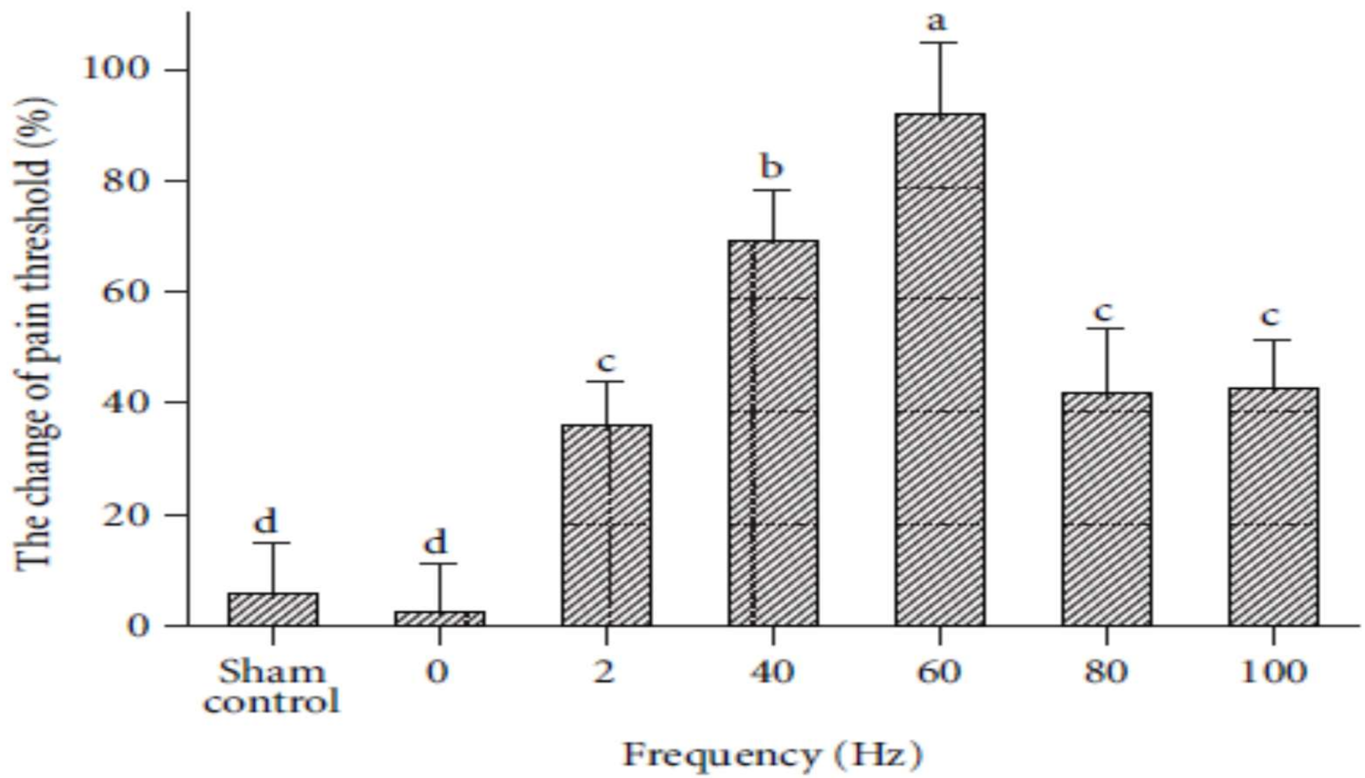

Figure 2: Pain threshold of goats stimulated by different frequencies (mean ± SD, %, $n = 7$). The same letter indicated that no significant difference in pain threshold between two frequencies ($P > 0.05$), and different letter indicated significant difference ($P < 0.05$).

Cheng LL, Ding MX, Xiong C, Zhou MY, Qiu ZY, Wang Q. Effects of EA of different frequencies on the release profile of endogenous opioid peptides in the central nerve system of goats. Evid Based Complement Alternat Med. 2012;2012:476457.

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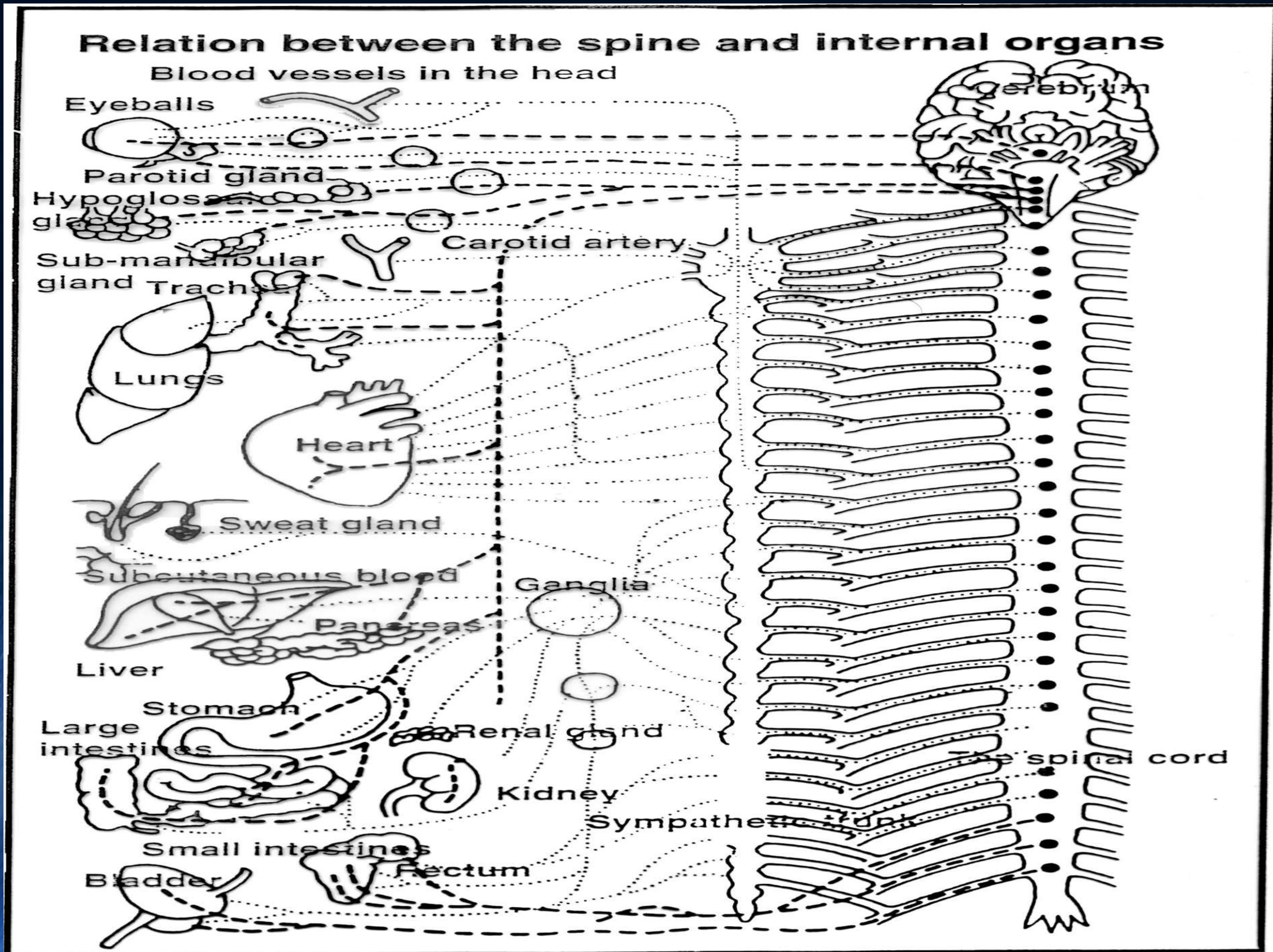

device mechanics?

field configuration needs to also be considered

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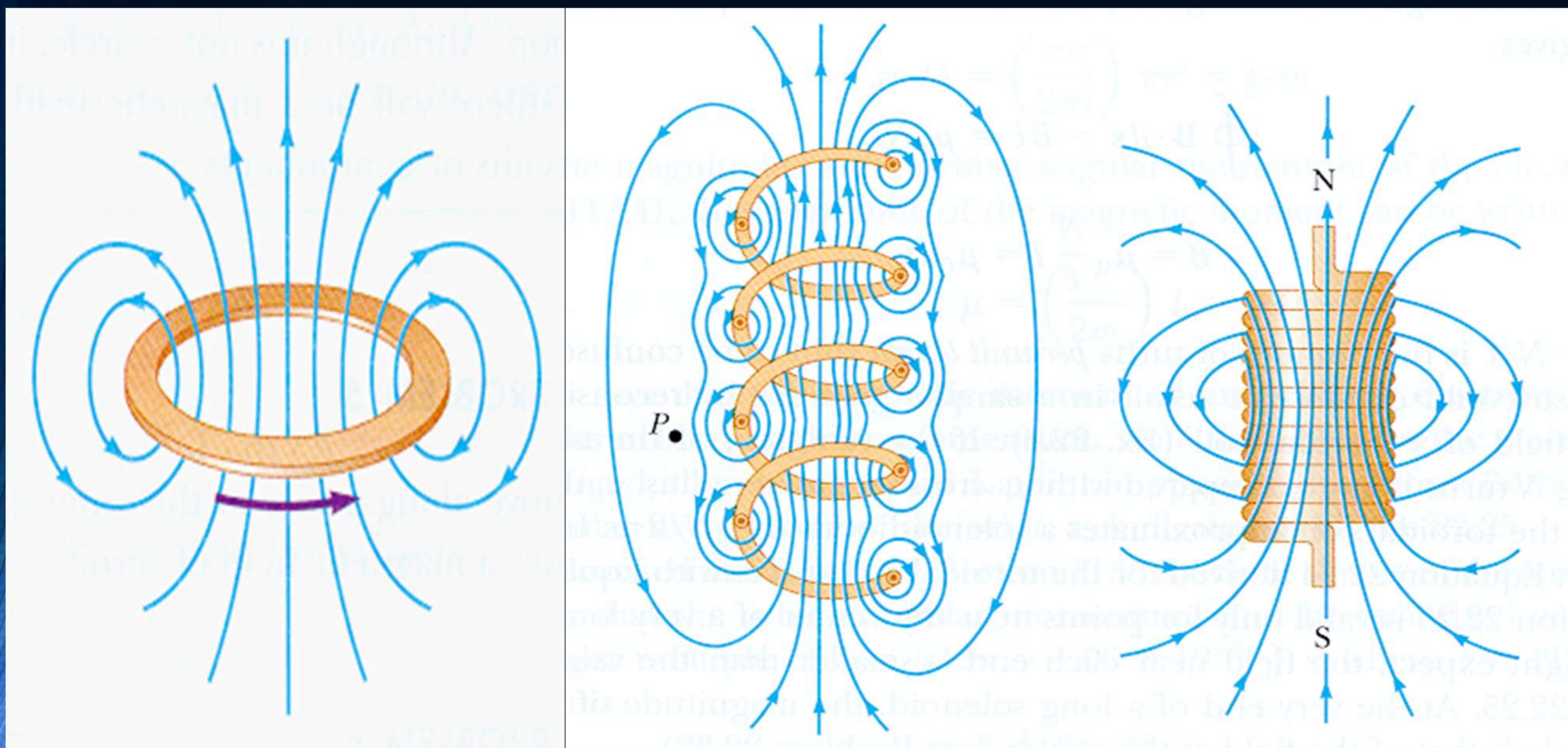
magnetic effect of currents



solenoid – uniform magnetic field

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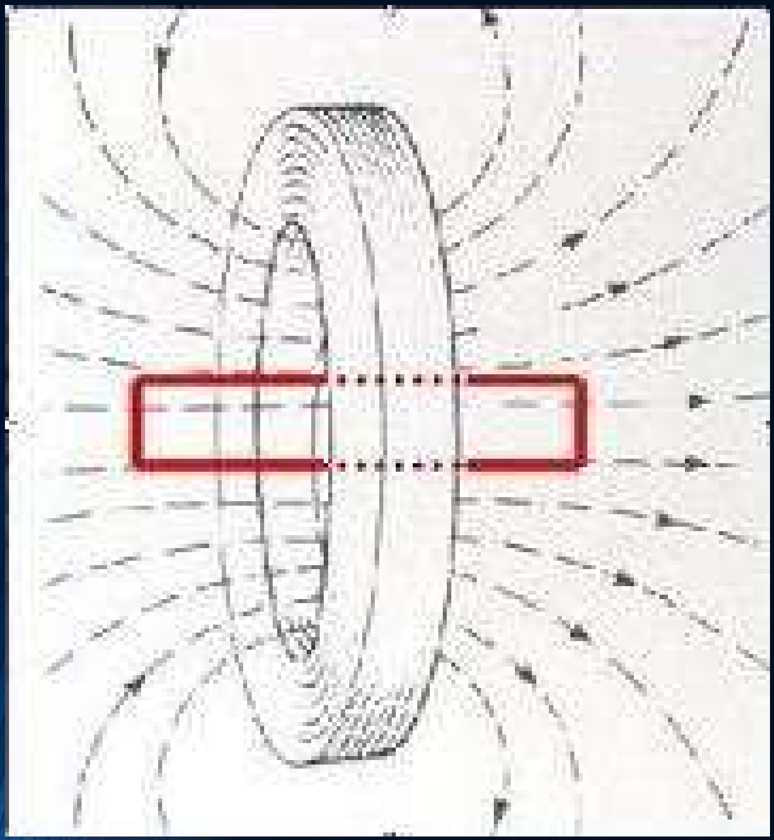

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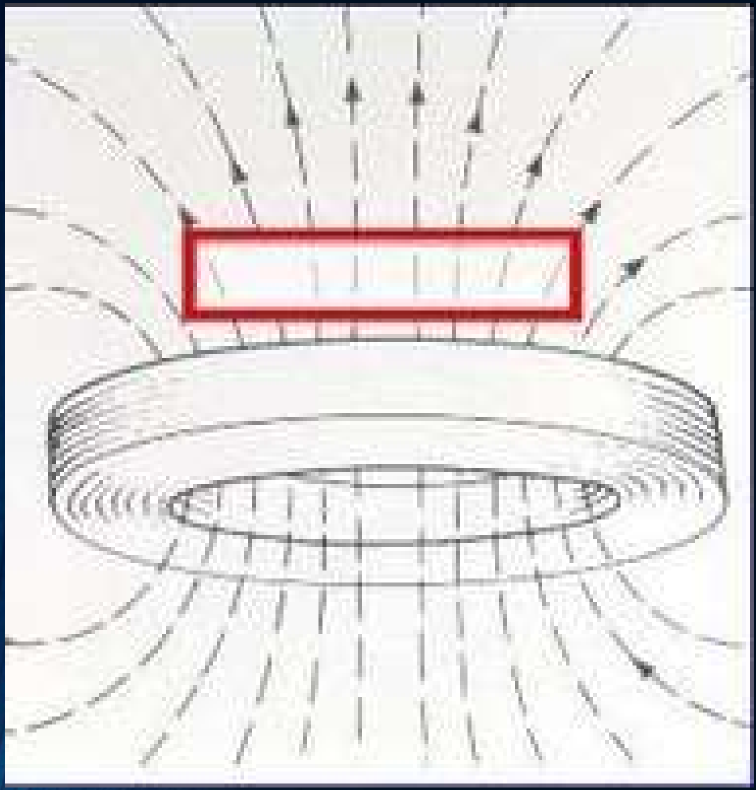

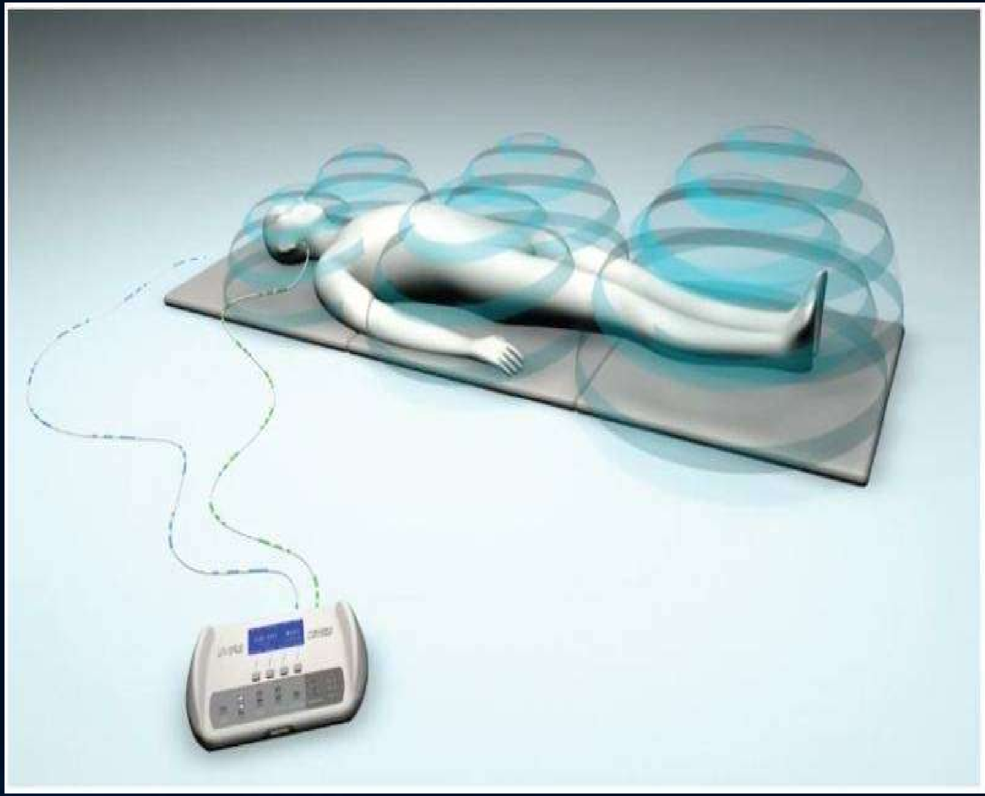

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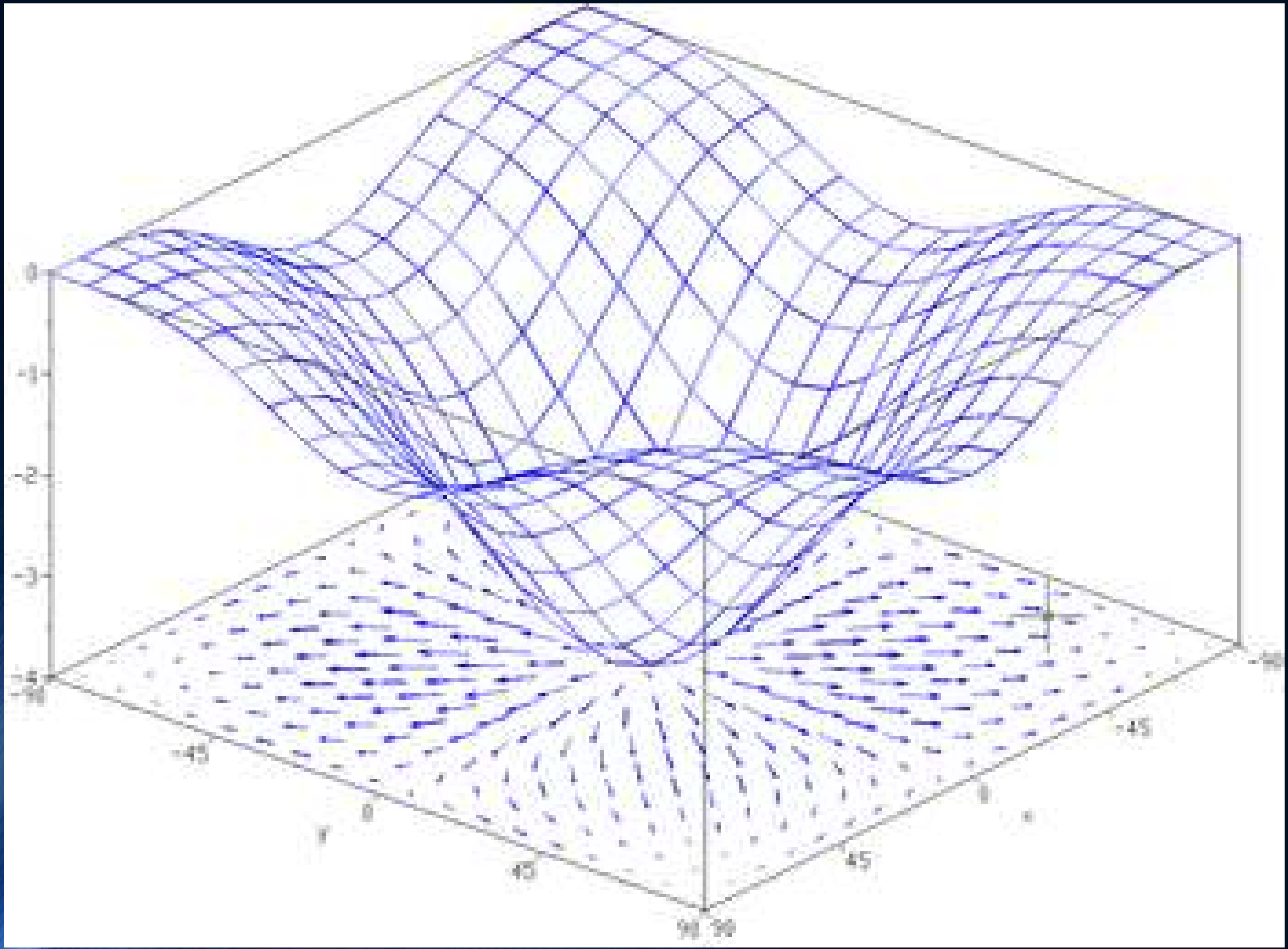

health applications

history of magnetics and health applications

- 2000 BC - Yellow Emperors Book of Internal Medicine
- application of magnetic stones at specific sites ? acupressure sites
- 4000 BC - Hindus refer to treatment of disease with stones (lodestones)
- Egyptian physicians and Cleopatra wore a small magnet to preserve youth
- Hippocrates used magnets/lodestones for pain

history of magnetics and health applications

- Paracelsus- wide use of magnets (seizures, psychiatric)
- Some magnets ground up and ingested
- Mesmer-mesmerized many with magnets and possibly hypnotism
- Hahnemann- founder of homeopathy, used magnets in tx programs

history of use in recent history

- Czech Republic:
  - 1970 checkerboard static fields
  - pulsed fields 1978
- Hungary: pulsed fields since 1982
- rest of Europe: around then

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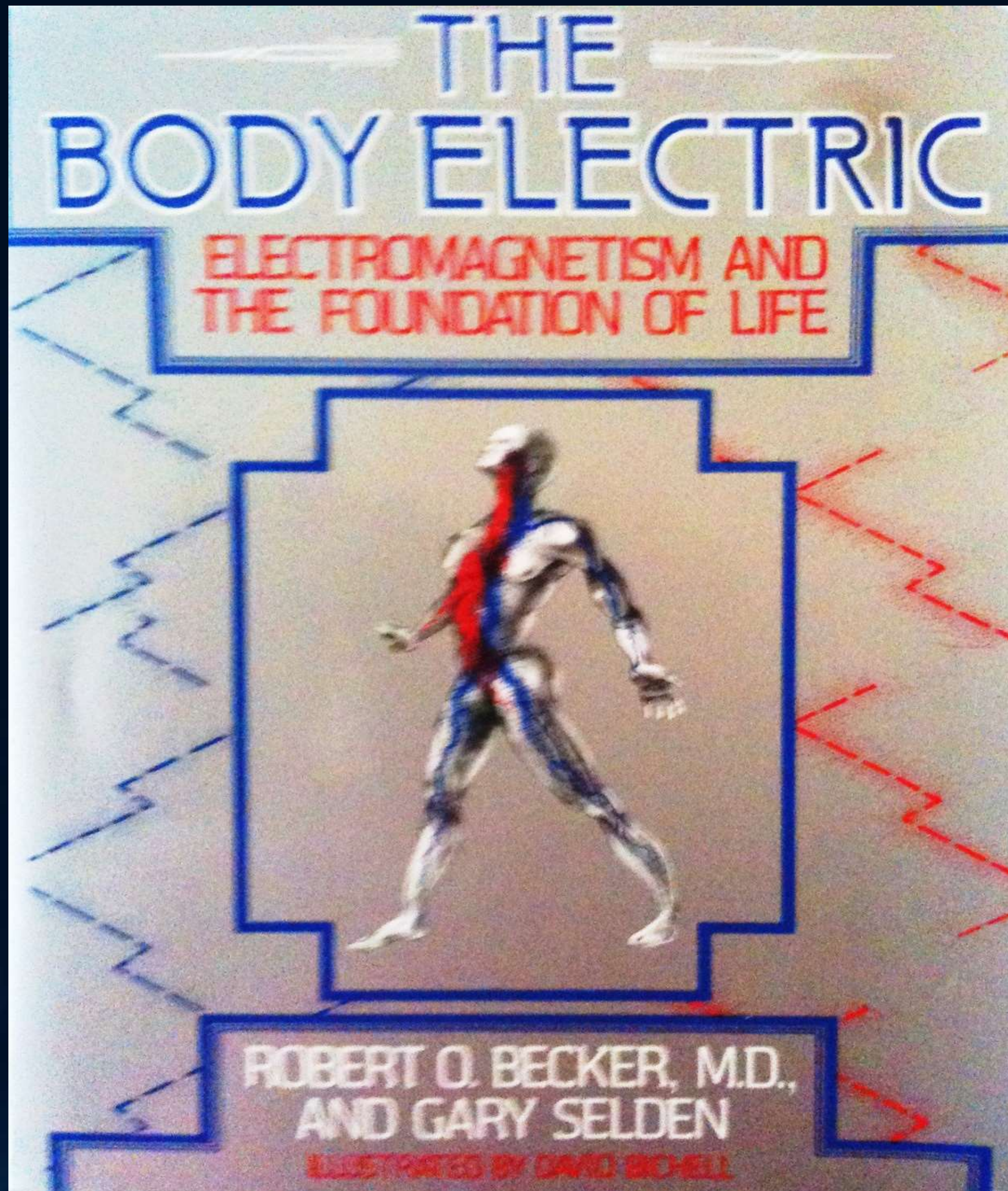

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clinical research

Alzheimer's [5 – 8 Hz],
arthritis [60 Hz],
back pain [64 Hz],
bacterial infection [50 Hz],
cancer [0.1 Hz – 114 KHz],
carpal tunnel syndrome [20 Hz],
cognitive function [900 MHz],
fibromyalgia [0.1 – 64 Hz],
foot ulcers [1 Hz]
gastroduodenitis [100 Hz],
mastitis [10 – 25 Hz],
multiple sclerosis [1 – 25 Hz],
migraine [27.12 MHz],
nerve regeneration [2 Hz],
neuropathy, diabetic [600 or 800 Hz]
neuropathy, diabetic [5-40 Hz]
oral surgery [30 Hz],
osteoarthritis [5 – 24 Hz],
osteoporosis [<50 Hz]
oxygen saturation [1-23 Hz]
post-operative knee [75Hz]
pelvic pain syndrome [50 Hz]
prostheses, loose [15 Hz]
PTSD [1 or 5 Hz],
septic shock [50 Hz],
tendinitis [17Hz]
ulcers, skin [75 Hz],
ulcers, pressure [1 Hz]
ulcers, venous [800 Hz]
whiplash [64 Hz],
wound healing [15 Hz].

Ross CL, Harrison BS. The use of magnetic field for the reduction of inflammation: a review of the history and therapeutic results. Altern Ther Health Med. 2013 Mar-Apr;19(2):47-54.

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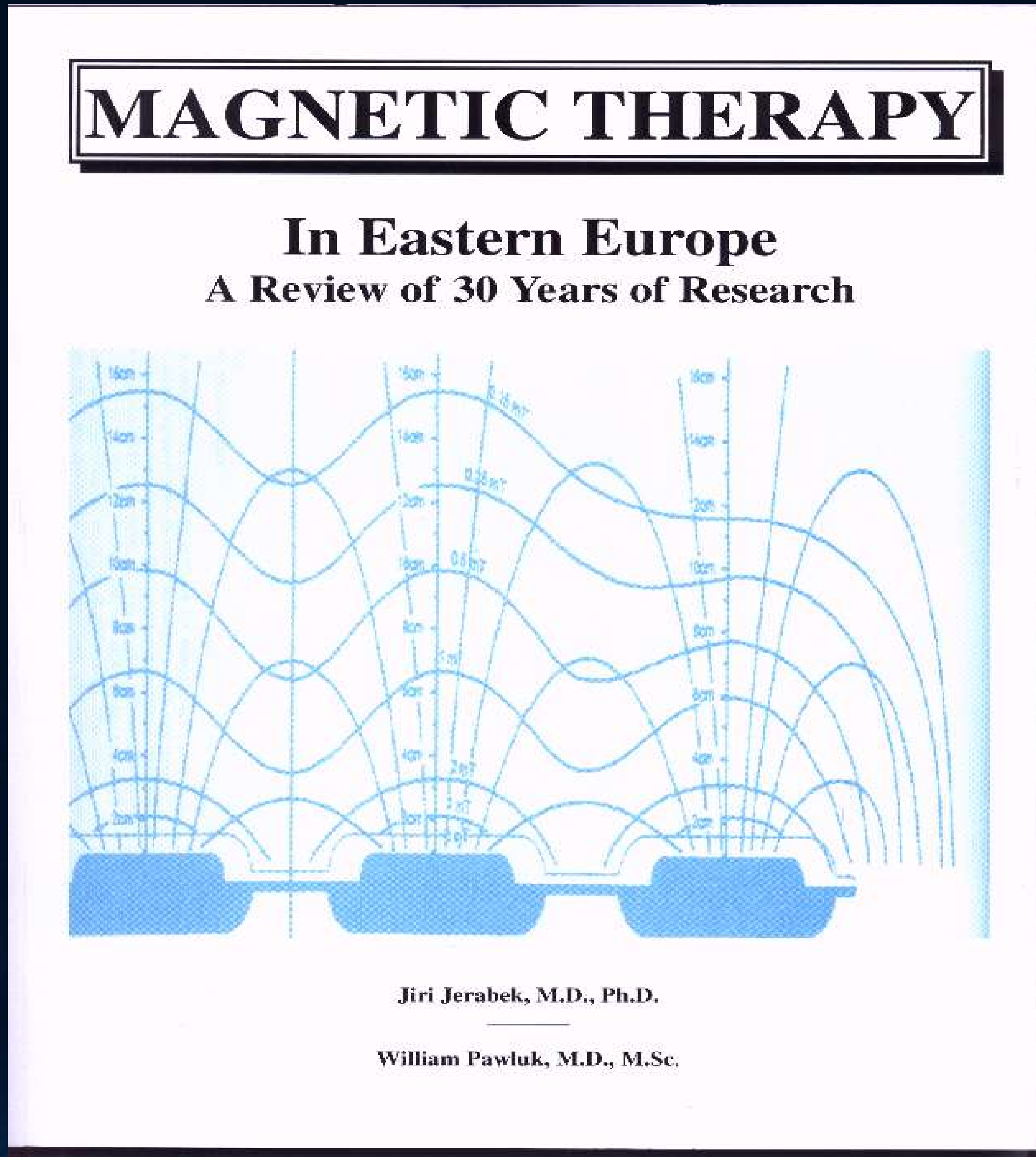
capillary reactions 20 Hz,
cervical arthritis 2 Hz/50 Hz/63 Hz/125 Hz,
chronic pancreatitis 5 Hz/50 Hz,
circulation 20 Hz,
circulatory brain disorders 30 – 50 Hz,
circulatory brain disorders 30-50 Hz,
degenerative/inflammatory disease 100 Hz,
diabetes 25 Hz,
driver fatigue 2 Hz,
enuresis 10/100 Hz,
enuresis 25 Hz/50 Hz,
immune system 12.5 Hz,
inguinal nerve injury 15 Hz/50 Hz.
leg ulcers 5 Hz/40 Hz,
macular degeneration 3.125 Hz,
microcirculation 80 Hz,
migraine 2 Hz/10 Hz,
multiple sclerosis 2.5 Hz/12.5 Hz/15 Hz/25 Hz,
osteoarthritis 10 Hz/15 Hz/30 Hz,
osteoarthritis 10/100 Hz,
peripheral vascular disease,
RSD 5-50 Hz,
sinusitis 10 Hz/25 Hz,
soft tissue disorders 100 Hz,
varicose vein surgery 20 – 40 Hz,
varicose vein surgery 20-40 Hz,

Jerabek, J and Pawluk, W. Magnetic therapy in Eastern Europe: a review of 30 years of research. Publ. Advanced Magnetic Research of the Delaware Valley, Chicago, 1996.

- osteoarthritis 3/7.8/20 modulation on 2 kHz coil
- ACL reconstruction 75 Hz
- epicondylitis 15 Hz
- neuropathy 40 Hz
- osteoarthritis 10 Hz/15 Hz/30 Hz/50 Hz
- pelvic pain syndrome 50 Hz
- post arthroscopy 75 Hz
- postoperative pain 0.5 Hz/320 Hz
- RSD 50 Hz/100 Hz
- shoulder pain 50 Hz.

Pawluk W. Magnetic Fields for Pain Control, Chapter 17. In Electromagnetic Fields in Biology and Medicine, Ed. Marko S. Markov, March 2015, CRC Press.


MAGNETIC THERAPY
In Eastern Europe
A Review of 30 Years of Research
Jiri Jerabek, M.D., Ph.D.
William Pawluk, M.D., M.Sc.

controlled studies humans

- atherosclerosis
- ischemic hrt disease
- chronic bronchitis
- polyneuritis
- fractures
- burns
- pre-op healing
- carpal tunnel
- endometritis
- cervicitis
- breast fissures
- post-partum
- breast engorgement & uterine involution
- endometriosis
- corneal trauma
- reduced clotting

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PEMF Studies Humans

- Alzheimer's
- ALS
- ankle sprain
- arthritis
- blepharitis
- bone fractures
- bronchitis
- cancer
- venous insufficiency
- dental problems
- depression
- dermatitis
- diabetes
- diseases of larynx
- Duchenne-Disease
- endometriosis
- epilepsy

PEMF Studies Humans

- gastroduodenitis
- general
- glaucoma
- hair loss
- headache
- heart disease
- hemophilia
- hepatitis
- herniated disk
- hip problems
- joint disease
- kidney problems
- lung disease
- lupus
- multiple sclerosis
- muscle injury
- neck pain
- nerve damage
- neurological Disorders

PEMF Studies Humans

- osteoarthritis
- osteochondrosis
- osteonecrosis
- osteoporosis
- otitis externa
- pancreatitis
- Parkinson's disease
- peripheral neuritis
- pneumonia
- herpetic neuralgia
- pseudoarthrosis
- psychiatric disorders
- respiratory problems
- sexual disorders
- sleep disorders
- spinal cord injury
- stroke

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PEMF Studies Humans

- synovitis
- tendonitis
- tourette's syndrome
- tuberculosis
- ulcers
- (gastric/duodenal)
- ulcers (trophic)
- urinary problems
- wound healing

- spinal stenosis
- tendonitis
- Crohn's Disease
- pulmonary Fibrosis
- COPD/ emphysema
- gangrene, vascular
- tinnitus
- sinusitis

high intensity PEMF research
transcranial magnetic stimulation
rTMS

patients treated with TeslaFit in my practice

- pudendal nerve pain
- sacroiliitis
- hip and knee tendinosis
- back pain
- pyriformis syndrome
- shoulder complex pain
- cancer
- etc.

MS over surface of the head

- depolarizes underlying superficial neurons which then induce electrical currents in the brain.
- previously had to be done with ECT
- electrical stim
  - skull acts as larger resistor
  - difficult to focus electricity to specific brain regions
  - requires powerful electrical fields
- magnetic stim
  - penetrates skull and whole brain freely
  - generates current in the brain w/o convulsions
  - creates magnetic field of about 2 T
  - induces about 30 V/M in the brain

MS over surface of the head

- depolarizes underlying superficial neurons which then induce electrical currents in the brain.
- previously had to be done with ECT
- electrical stim
  - skull acts as larger resistor
  - difficult to focus electricity to specific brain regions
  - requires powerful electrical fields
- magnetic stim
  - penetrates skull and whole brain freely
  - generates current in the brain w/o convulsions
  - creates magnetic field of about 2 T
  - induces about 30 V/M in the brain

- deeper brain still affected by cortical TMS
  - - affects interconnections of redundant cortical-subcortical neural loops

- PET, SPECT, fMRI – show effects in the brain
  - eg, activation of cortical-limbic loops

thalamic stroke

trigeminal neuropathy

- rTMS motor cortex area of related body pain region
- significant pain decrease
- benefit for up to 8 days after 'real' rTMS

Interventional neurophysiology for pain control: duration of pain relief following repetitive transcranial magnetic stimulation of the motor cortex. Lefaucheur JP, Drouot X, Nguyen JP. Neurophysiol Clin. 2001 Aug;31(4):247-52.

drug resistant neurogenic pain relieved by motor cortex rTMS

- intractable neurogenic pain:
  thalamic stroke, brainstem stroke; spinal cord, brachial plexus, or trigeminal nerve lesions.
- stim to hand area of ipsilateral motor cortex
- VAS after "real" or "sham" stim
- pain reduced 23% v 8%, p = 0.0002
- not as good for pain in brainstem stroke
- best for facial pain
- target for TMS not to brain pain zone area but adjacent area.
- transient relief

Neurogenic pain relief by repetitive transcranial magnetic cortical stimulation depends on the origin and the site of pain. J Lefaucheur, X Drouot, et al. J Neurol Neurosurg Psychiatry 2004;75:612–616.

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brain stimulation analgesic effect

Grp 1 - 20% intensity, 7 min

Grp 2 - 30% intensity, 3 min

Grp 1 - **23% better** ($P < 0.01$)

Grp 2 - **26% better** ($P < 0.01$)

Wang Y, Niu J, Shen Q, Jiang D. Sheng Wu Yi Xue Gong Cheng Xue Za Zhi. Analgesic effect induced by stimulation of rats brain with strong pulsed magnetic field: a preliminary study. 2001 Dec;18(4):552-3, 572.

rTMS

- TMS directly stimulates superficial cortex, can’t do w deep electro stimulation
- deeper brain structures influenced by cortical TMS, due to cortex’s massive interconnections and redundant cortical- sub cortical loops.
- functional imaging [PET, SPECT, FMR I], shows TMS can activate cortical-limbic loops.
- TMS is used to assess brain functions
- studies on movement, visual perception, memory, attention, speech, and mood.

rTMS

- TMS originally used over prefrontal cortex to treat depression because of the potential for activating cortical – limbic loops.
- primary indication for the Neurostar is to treat resistant depression
- about 10 sessions of 10-15 mins each
- antidepressant effects occur over days to weeks.

high intensity PEMF research

not just r/TMS

TMS/PEMFs impact tissues beyond reach of electrical, ultrasound, laser, radiofrequency, etc.

therapeutic uses :

- depression, mania, movement disorders, schizophrenia, anxiety disorders, tinnitus, Parkinson's, MS, Tourette's, long-term anticonvulsant effects.
- deep chronic pain
- autism spectrum disorders
- pyriformis syndrome
- spinal pain syndromes
- vertebral and pelvic fractures
- deep solid organ cancers

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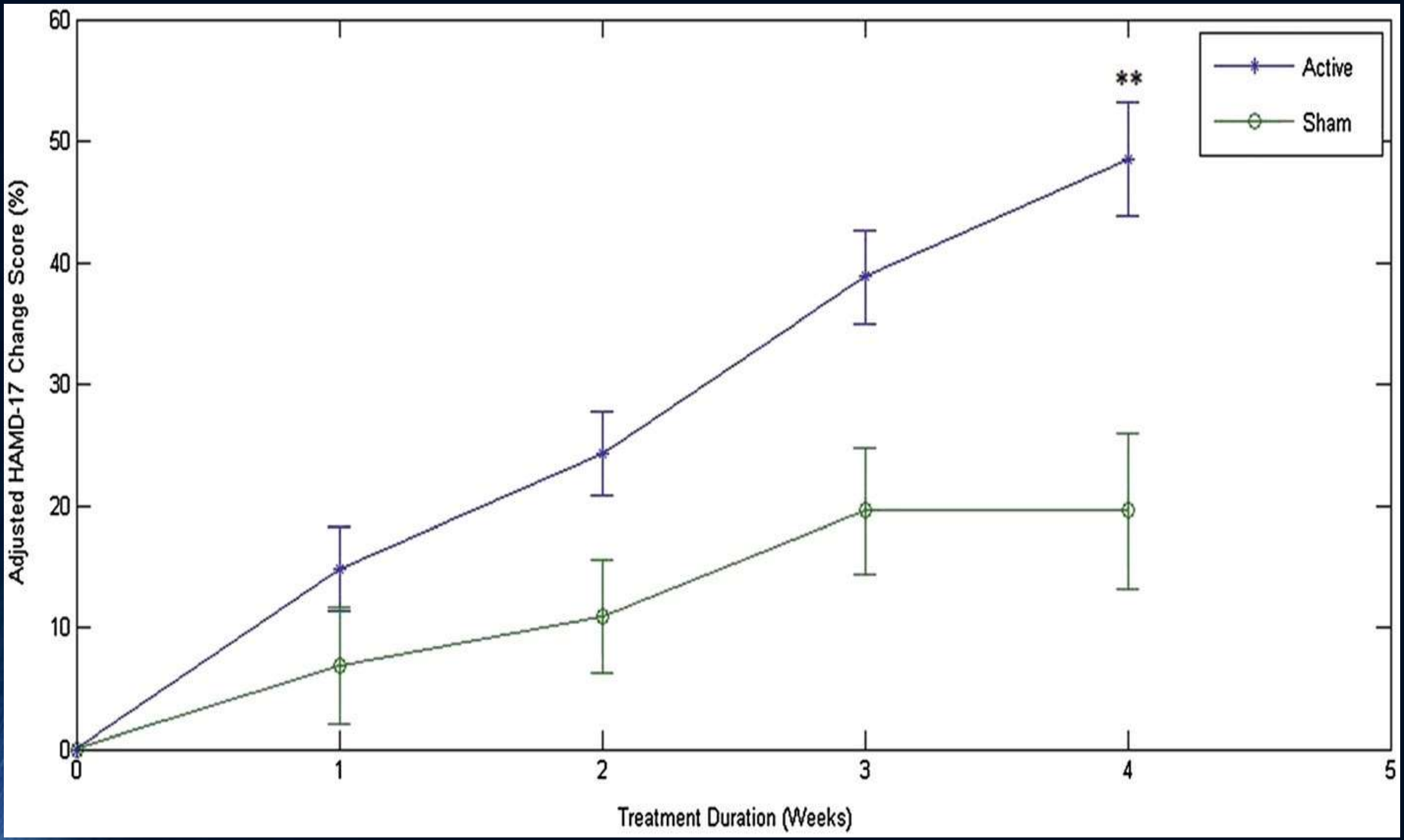

Average improvement in HAMD-17 score for the active group compared to sham (** shows $p < 0.01$).

Jin Y, Phillips B. A pilot study of the use of EEG-based synchronized Transcranial Magnetic Stimulation (sTMS) for treatment of Major Depression. BMC Psychiatry. 2014 Jan 18;14:13.

neuromodulation of bladder hyper-reflexia by magnetic stimulation of sacral roots

- spinal cord injury with bladder hyper-reflexia
- S2-S4 sacral anterior roots
- profound reduction in detrusor contraction

Br J Urol. 1996 Jul;78(1):39-46. Neuromodulation of detrusor hyper-reflexia by functional magnetic stimulation of the sacral roots. Sheriff MK, Shah PJ, Fowler C, Mundy AR, Craggs MD.

multiple sclerosis
lower limb spasticity

- TMS at the spinal level
- decreased muscle spasticity by 65% ($P < 0.01$).
- decreased soleus reflex
- no significant change in healthy individuals
- long-term depression of synaptic transmission.

Long-lasting depression of soleus motoneurons excitability following repetitive magnetic stimuli of the spinal cord in multiple sclerosis patients. Nielsen JF, Sinkjaer T. Mult scler. 1997 Feb;3(1):18-3.

quadriceps stimulation
magnetic (MFS) vs transcutaneous electrical (NMES)

- VAS compared at same peak torque
  median difference VAS -3.7 lower w MFS
- mean max peak torque higher w
  MFS 9.5 vs. NMES 4.4 Nm.
- MFS had less pain at same isometric peak torque.

Magnetic stimulation of the quadriceps femoris muscle: comparison of pain with electrical stimulation. Han TR, Shin HI, Kim IS. Am J Phys Med Rehabil. 2006 Jul;85(7):593-9.

high intensity PEMF and pain

- chronic pain is often from aberrant small neural networks w self-perpetuated neurogenic inflammation
- post-traumatic/postop low-back pain, RSD, neuropathy, thoracic outlet, endometriosis.
- <= ten,10-min exposures to areas of maximal pain.

- VAS measure
- all w some relief
- 1 pain free after 4 txs.
- avge VAS relief 1.86 active vs 0.19 sham
- max relief 3 hr after tx
- ½ with long lasting relief
- 2 w complete relief and
- 3 partial relief lasting 4 mos.
- others relief lasting 8 - 72 hr.

Pain control using high-intensity pulsed magnetic stimulation. Ellis, WV. Bioelectromagnetics 14(6):553-556, 1993 .

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prostate hypertrophy

- study groups =10 each, 74 y.o
- controls - α-blocker 4 weeks
- HIEMF group - 2 wks, 30 min/d, 5 days/wk
- HIEMF group results
  - Prostate Symptom Score (IPSS) $P < 0.02$
  - U/S volume, residual urine, mean urine flow $P < 0.05$
- significant objective and symptom improvement
- control group - only IPSS better ($P < 0.05$)
- follow-up for 1 yr - EMF tx still positive

Giannakopoulos XK, Giotis C, Karkabounas SCh, Verginadis II, Simos YV, Peschos D, Evangelou AM. Effects of pulsed electromagnetic fields on benign prostate hyperplasia. Int Urol Nephrol. 2011 Dec;43(4):955-60.

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Medium Intensity PEMFs

10 mT (100 gauss) to 100 mT (1000 gauss)

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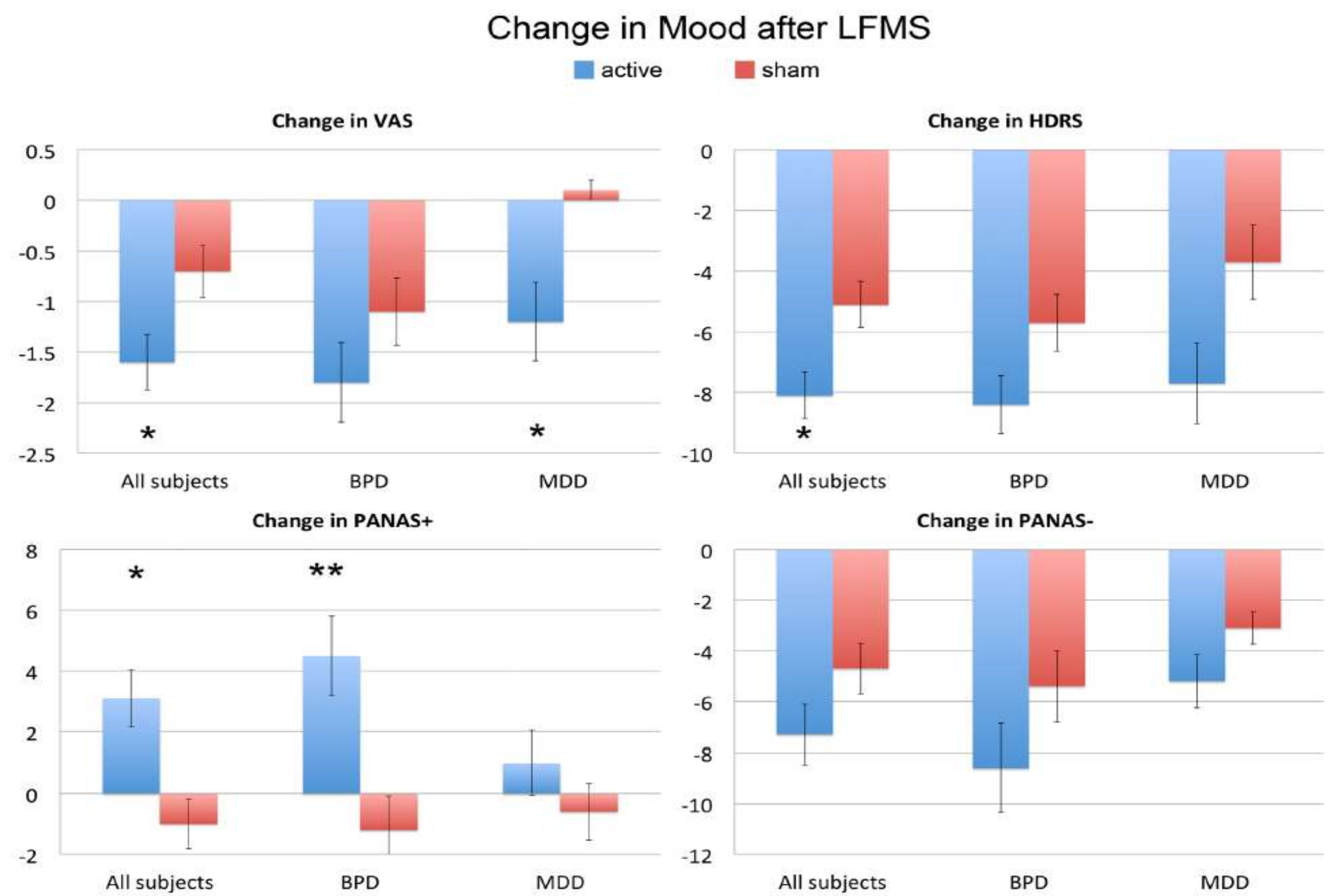

Figure 2. Change in mood after a single 20-minute application of low field magnetic stimulation (LFMS). Subjects had either bipolar disorder (BPD) or major depressive disorder (MDD) by DSM-IV criteria and were currently depressed (17-item Hamilton Depression Rating Scale [HDRS-17] ≥17). All subjects were administered active or sham LFMS treatment for 20 minutes in a randomized double blind protocol. Results are shown for the primary outcome measures (visual analog scale [VAS] and HDRS-17) and the secondary outcome measures (Positive and Negative Affect Schedule [PANAS]), and for the diagnostic subgroups of BPD ($n = 41$) and MDD ($n = 22$) patients as well as for the combined group ($n = 63$). A negative change indicates improvement in mood in the VAS, HDRS-17, and negative affect scale; a positive change indicates improvement in mood in the positive affect scale. Statistical analyses were carried out as described in the text and are presented in Table 2. Statistical significance after Bonferroni correction: $^{*}p < .05$; $^{**}p < .01$.

Rohan ML, Yamamoto RT, Ravichandran CT, et al. Rapid mood-elevating effects of low field magnetic stimulation in depression. Biol Psychiatry. 2014 Aug 1;76(3):186-93.

hip arthritis

- 50 Hz pulsed sinusoidal MF,
- 35 mT field PEMF for 15 min, 15 treatments
- improves pain in 86%
- average mobility without pain improved markedly

Rehacek J, Straub J, Benova H. (1982) The effect of magnetic fields on coxarthroses. Fysiatr Revmatol Vestn 60(2): 66–68.

lumbar OA

- 35–40 mT, 20 min/day for 20-25 days
- relieve or eliminate pain 90%–95% of the time for.

Mitbreit IM, Savchenko AG, Volkova LP et al. (1986) Low-frequency magnetic field in the complex treatment of patients with lumbar osteochondrosis. Ortop Travmatol Protez (10):24-27.

pain and related trigger points

- 0.5–1.5 mT at the site
- help with some still pain free 6 mons after

Rauscher E, Van Bise WL. Pulsed magnetic field treatment of chronic back pain. 23rd Annual Meeting of Bioelectromagnetics Society, St. Paul, MN, June 2001. Abstract 6-3:38 chronic musculoskeletal pain

- treated for only 3 days, once per day
- can eliminate and/or maintain pain

Stewart DJ, Stewart JE. (1989) The destabilization of an abnormal physiological balanced situation, chronic musculoskeletal pain, utilizing magnetic biological device. Acta Med Hung 46(4): 323–337.

diabetic neuropathy

- 20 exposures
- sinusoidal, 40 Hz, 15 mT, daily, 12 min
- reduction of pain and paresthesias
- vibration sensation and muscle strength improved in 85% of patients
- all better than sham controls.

Cieslar G, Sieron A, Radelli J. (1995) The estimation of therapeutic effect of variable magnetic fields in patients with diabetic neuropathy including vibratory sensibility. Balneol Pol 37(1): 23–27.

muscle mitochondria

- rats for 4 h/day, 5 days/wk for 20 sessions
- 10 in the control group
- succinic dehydrogenase (SDH) and NAD
- reduced in animals with femur operations
- PEMFs increased SDH and NAD
- PEMF's improve energy cycling in muscle
- improve efficiency of intact muscles or enhance compensatory mechanisms in damaged muscles

From Detlavs , I, Chapter 28, Application Of Electromagnetic Fields And Traumatology And Orthopedics, in Bioelectromagnetic Medicine, 2004, Marcel Dekker. Rosch, PJ and Markov, MS., editors.

osteosynthesis
metal implants

- faster osteointegration
- arthroplasty or dental implants
- loosening of implants reduced

treatment of fresh bone fractures

- if used in early stages of fresh fracture significantly reduce healing time
- early vascular improvement
- stimulate chondrocyte and bone formation.
- prolonged treatments may be deleterious,

  enhancing chondrogenesis beyond what seen in normal repair

DJD/DDD spine

- 5- 10 mT for 3-4 wks, N=> 5000, 20-80 yrs.
- some effect in 7- 10 days
- some improved after 1-2 txs.
- half had aggravation of pain first 2-3 txs
- gradual improvement after
- few patients no benefit at initial follow-up
- of those many began to see benefit 3-6 mos
- positive effects in 80%
- best results w reflex pain syndromes
- acute and also severe chronic conditions helped
- best results in acute

osteoarthritis treatments 3-4 wks

- reduce pain, increased movement, reduce edema, improve circulation,
- improve metabolism and immunological measures.
- some better w only 3-5 txs
- some had pain aggravation first wk
- after this, all began to improve
- at end 20-30% had 75-80% improvement
- stimulates proteoglycan synthesis
- increased GAG and cartilage
- matrix restoration in cartilage w milder involvement.
- seriously damaged **cartilage, response less**

femoral head osteonecrosis

N=95

- many decreased pain and better motion
- Steinberg stage 0-II, no progression w grade improvement in 9/15
- stage IV-V pts progressed; none improved

N=23

- txs mean 36 mos
- all w FICAT 2 improved; 46% w FICAT 3
- even 2 w FICAT 4 better after 32 months

another study

- 52% w FICAT 2-3 clinical improvement and x-ray stabilization
- prevented femoral head collapse

PMFs and nerve regeneration

- injured sciatic nerves of rats
- compound action potential (CAP)
- 1.5 mT 1 h/day PEMF for 38 days after injury > significant differences in conduction CAPs.
- PEMF improved abnormal electro- physiological activities of injured nerves
- observed abnormalities in signaling or aberrant ion channel functions following injury may be restored by PEMF
- PEMF treatment may reduce the time required for healing and rehabilitation in peripheral nerve injury

Gunay, I. and Mert, T., Pulsed magnetic fields enhance the rate of recovery of damaged nerve excitability. Bioelectromagnetics 17 NOV 2010

circulation

- 35 mT/20Hz/20’ healthy subjects
- abdomen/extremities: no EKG effect
- chest/neck: QRS volt ⇩, T wave amplitude ⇩
- any location: vessel filling always ⇧ arms/legs
- skin temperature ⇧ by 1.3$\pm$0.2 deg. C.
- in 90% blood pressure and pulse ⇩

oxygen saturation
injured muscles

- injured muscles have low pO_2 - 7.48 mmHg
- normal extremities - 29.6 mmHg
- PEMF's 14 days post-op > pO_2 22.97 mmHg
- tx at 21 days post-op had similar results
- tx at 30 days difference disappeared
- PEMF's normalize O_2 faster in damaged muscle
- also see improved circulation as tissue heals

fresh bone fractures

- early stage fractures
- reduce healing time
- early vascular improvement
- stimulate chondrocyte and bone formation
- prolonged treatments may enhance chondrogenesis beyond normal repair

rheumatoid arthritis,
systemic sclerosis,
rheumatic polyarthritis

- everyday 10-15 min., 18-25 mT
- majority had improved symptoms
- positive neuro/hormonal changes
- decreased aggregation RBCs

osteoarthritis treatments

- reduce pain and edema
- improve movement and circulation
- some better w only 3-5 txs
- some w aggravation first wk
- at 3-4 wks 20-30% were 75-80% better
- proteoglycan synthesis improved
- GAGs and cartilage improved
- matrix restoration in cartilage when mild involvement.
- seriously damaged cartilage, less benefit

nerve regeneration

- injured sciatic nerves of rats
- compound action potential (CAP)
- PEMF 1.5 mT 1 h/day, 38 days > significant differences in conduction CAPs
- improved abnormal electrophysiology of injured nerves
- abnormalities in signaling or ion channel functions post injury restored
- reduce time for healing/rehabilitation

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osteoradionecrosis

- N=17 1992 to 1998
- post interstitial/ext RT, failed hyperbaric O2
- at home rx w various PEMF devices
  - hoop solenoids (35-45 cm ID) or
  - disk solenoids (8 cm ID)
- 1-5 mT/24-50 Hz/BID/30’/8-10 hrs apart
- 7 days/wk first 2 weeks-5 d/wk after
- rx time 3-12 mos as needed
- pain, inflammation, fistulas, soft tissue/bone health by Panorex
- assessed before/after rx and follow up
- follow up 6-84 mos

osteoradionecrosis

- complete remission of inflammatory disease
- bone recovery achieved in 12 patients
- 2 got surgery to correct oral function
- 1 pathological fracture had xray with consolidation evident
- complete pain relief in most
- adverse effects infrequent and mild
- no differences w type of PEMF equipment
- compliance best w 35 cm diameter solenoid

Laffranchi A et al, Istituto Nazionale Tumori, Milan, Italy

experimental infectious arthritis

- EBI; 72 Hz pulse
- New Zealand white rabbits
- 3 groups, 6 unstimulated each, 6 stimulated
- intraarticular S. aureus in R. knee; L. knee saline
- knees cultured at 24 hr.
- Ceforamide at 36 hr Q12 hr/d for 2 wk
- all got PEMF >36 hrs. for 21 days

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experimental infectious arthritis

	stim	non-stim
wet wt tibia infected	34mg	28.5mgwet
wet wt tibia uninfected	37.7mg	34.5mg
p<	NS	0.01
dry wt tibia infected	9.3mg	7.9mg
dry wt tibia uninfected	10.4mg	10.0mg
p<	NS	0.002
GAG tibia infected	719ugm	488ugm
GAG tibia uninfected	1070ugm	1030ugm
p<	0.002	0.001

femoral cartilage: weights and GAG NS; positive trends for tibial plateau collagen loss, reduced with PEMF

Smith, RL. Bioelectrical Repair and Growth Society (BRAGS), 4th Annual Meeting, November 1984, Kyoto, Japan

chronic pancreatitis

- sinusoidal, sinusoidal interrupted, pulsed, pulsed interrupted
- 50Hz/20'x15
- 17.5 and 24mT sinusoidal fields
- improvement clinical & laboratory
- trypsin ⇩, trypsin inhibitors ⇧, kallikrein ⇩
- optimum strength - 17.5 mT
- 35mT - all worse after magnetic therapy

coagulation

- 5mT/50Hz/30’
- circulating aggregates ⇩
- ADP induced thrombocyte aggregation ⇩
- collagen induced coagulation ⇩
- blood viscosity ⇩
- erythrocyte deformability ⇧
- non significant circulatory changes
- no effects on EEG

post-myocardial infarction rehabilitation: group 1 with and without acetylsalicylic acid (ASA) aggregation of platelets (%)

	Before	After
ADP induced		
without ASA	59.94±4.19	45.22±4.36
with ASA	45.39±3.65	30.62±2.69
epinephrine induced		
without ASA	79.50±7.43	58.50±6.28
with ASA	52.50±2.31	42.10±2.40

sham control group did not show before and after changes

inguinal nerve injuries

- 2.8 -5.6 mT/sinus/50Hz/10'-15'x12-15
- mainly trauma, peri-operative injuries
- pain, dysuria, motor disturbances at outset
- improvement after 5-6th exposure.
- n = 30 : 73% relief, 20% no effect, 7% continued to worsen
- improvement likely caused by edema reduction and microcirculation ⇧

clinical papers - orthopedics

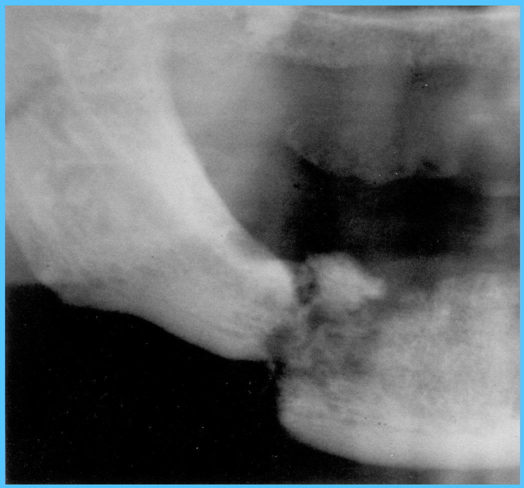
- Garland et al: Contemporary Orthopaedics 22 (3): March 1991
  - 80% heal rate of nonunion fractures
- Mooney: Spine 15 (7): 708-712, 1990
  - active vs placebo ($p \leq .01$) 92.2% vs 67.9%
- Mooney: Surgical Technologies International II, pg 405 - 410, 1993
  - PEMFs overcome risk factors !!!
- Simmons et al, NASS Quebec, Canada 1989
  - 68% successful spinal fusions in failed fusion
    9 months out without additional surgery
- Bose: Joint Section on Disorders of the Spinal & Peripheral Nerves, 12th Annual meeting, Orlando, FL, March 96.
  - 95% success rate in instrumented posterior lumbar fusions

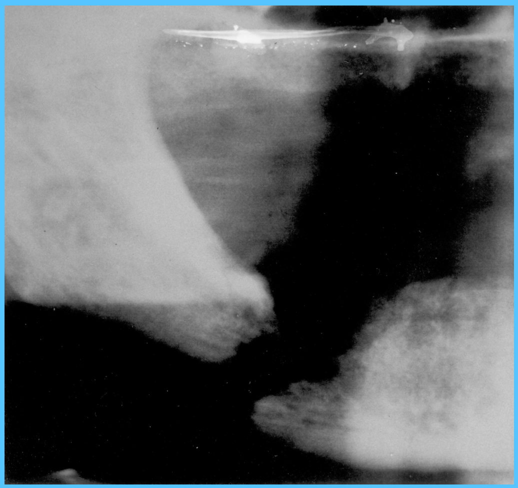
Orthofix Inc.

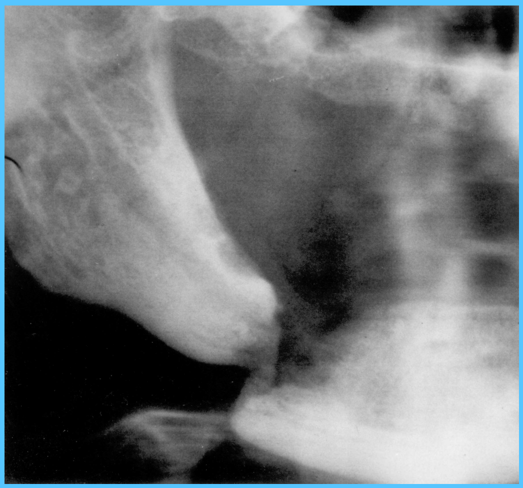
conditions reviewed on drpawluk.com

- Alzheimer’s
- atrial fibrillation
- back pain
- lumbar disc disease
- blood viscosity
- breast cancer
- cancer
- cataracts
- concussion/TBI
- degenerative disc disease
- dental issues
- diabetes
- depression/anxiety
- Lyme disease
- multiple sclerosis
- neuro- myelitis
- enuresis
- osteoarthritis
- pain management
- paraplegia/spinal cord injury
- prostate hyperplasia
- restoring alkaline balance
- scleroderma
- seizures and epilepsy
- shingles
- sleep disorders
- smoking cessation
- sports injury recovery
- sports rehabilitation
- urinary incontinence
- vocal cords

case studies

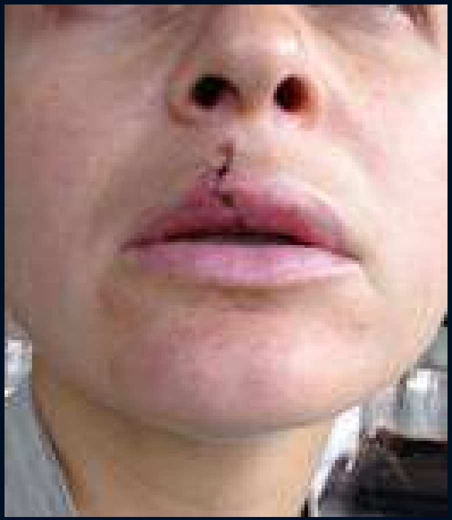


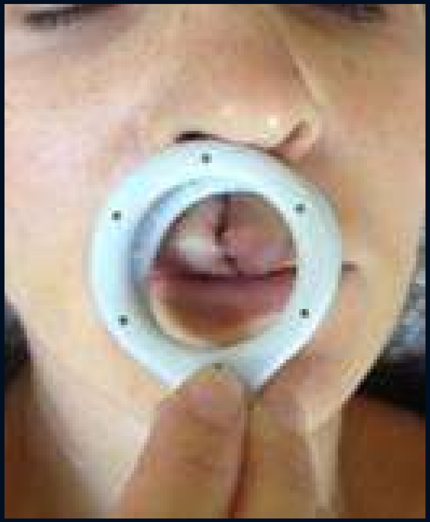


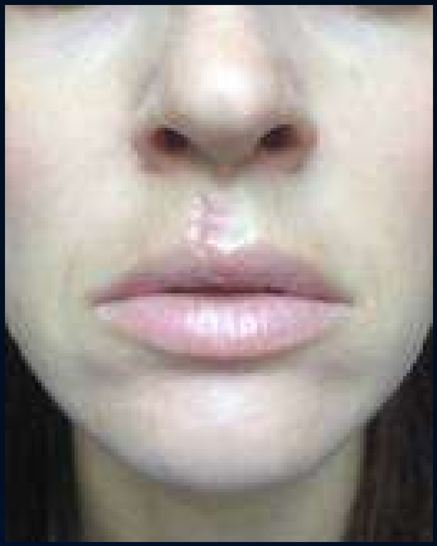


Male, born in 1927. In 1989 (age 62) diagnosed with infiltrating squamous cell carcinoma of oral cavity mucosa (lingual, right mandibular) with extension to root of tongue (T2N1aM0). In 1991, 26 months after RT (6500cGy: 700 with iridium needles and 5800 TCT) and removal of teeth, developed ORN of right mandible, with sequestrum, pathological fracture and osteo-cutaneous fistula. After 5 months we proposed magneto-therapy (the first case we treated). Fig.1 shows the situation at initiation in Aug. 1992. Fig. 2 is 2 months later: the sequestrum was eliminated spontaneously, the fistula closed and the mucosa regenerated. Fig. 3, taken at 4 months from initiation shows formation of bone bridge. At the latest check-up in Oct. 1999 the patient was well with no signs of disease recurrence.

through & through lip laceration







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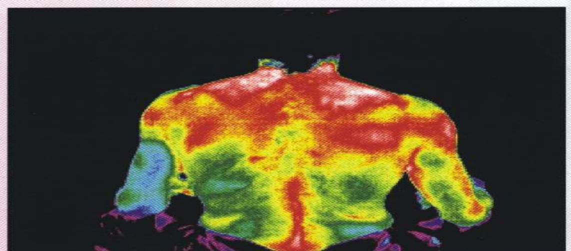
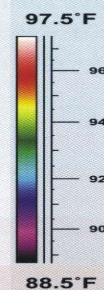
THERMAL ILLUSTRATIONS:

The temperature span and settings in both images are the same so you can make reference to color differences to distinguish any changes caused from the special magnet impregnated roller designed for traditional rollouts, stress relief and improved energy flow responses. Observe the differences in his arms in the before images and the remarkable relief of stress, irritation, and "overheating" that appeared when the man first placed himself in position for the demonstration. (*Note: White and orange areas usually denote extreme irritation.*)

BEFORE ROLLOUT





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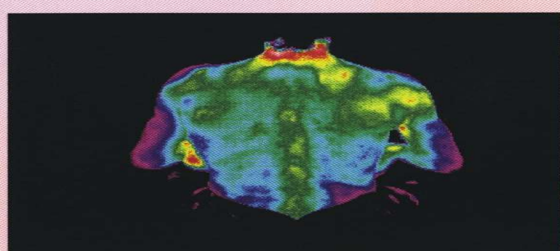
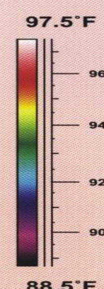
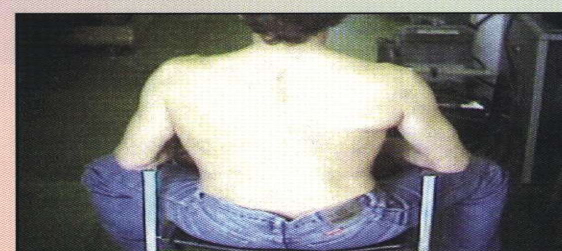
AFTER ROLLOUT







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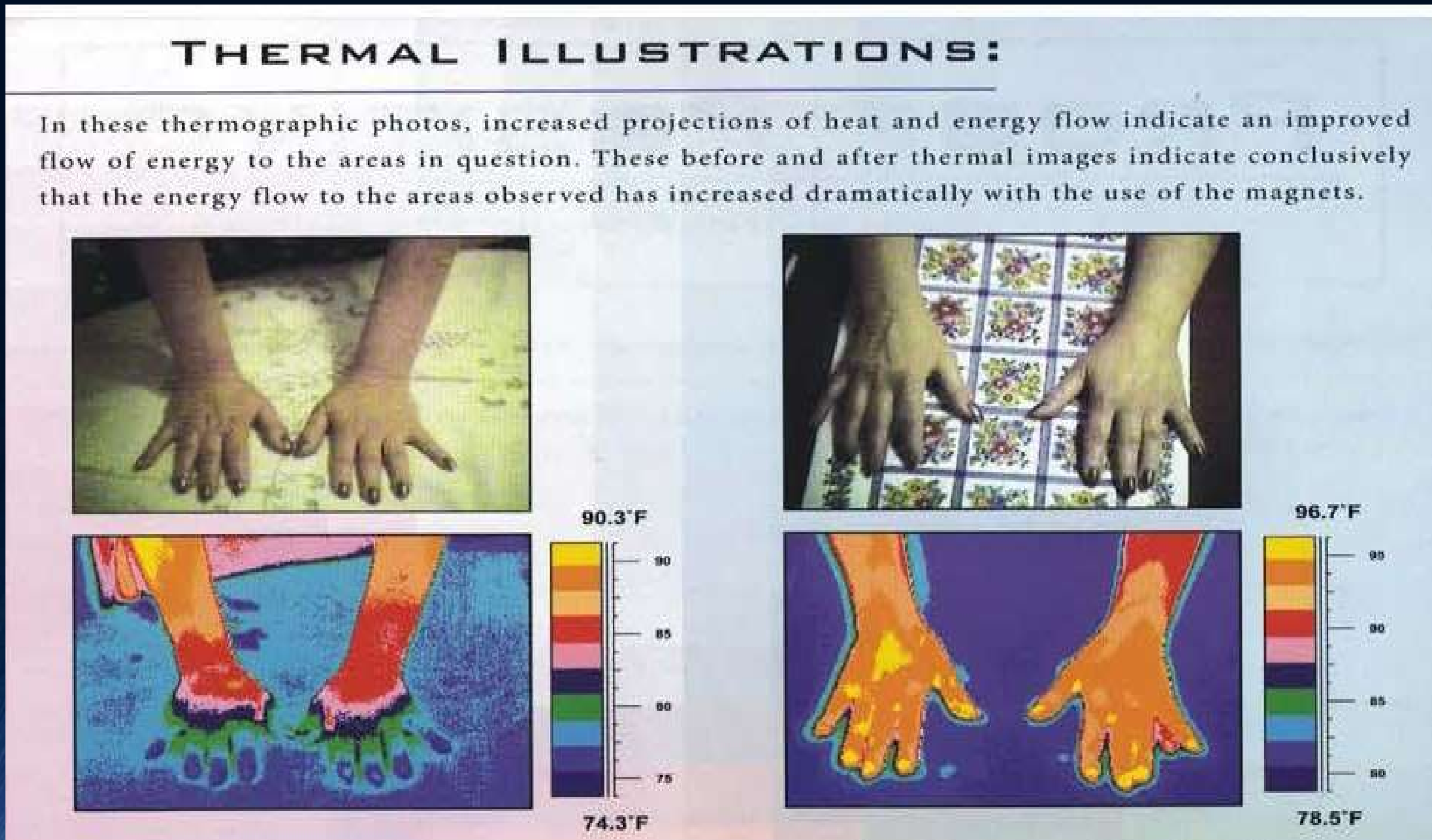

Images before/after treatment. Dramatically reduced pain medication and quality-of-life improvement in 11 days. Blood vessels dilated.

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before

after

diabetic neuropathic Charcot foot

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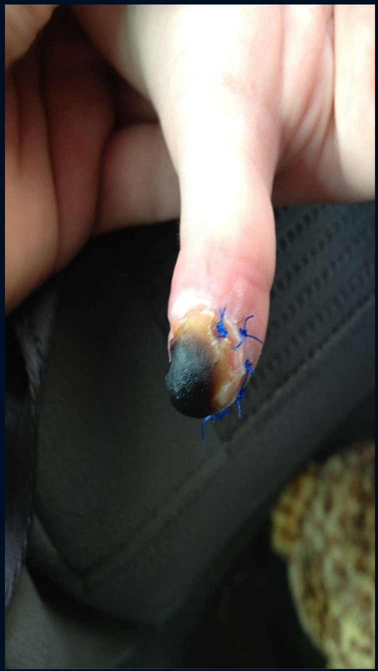
3 yr old w complete avulsion of distal thumb

07.12.12

pre-PEMF



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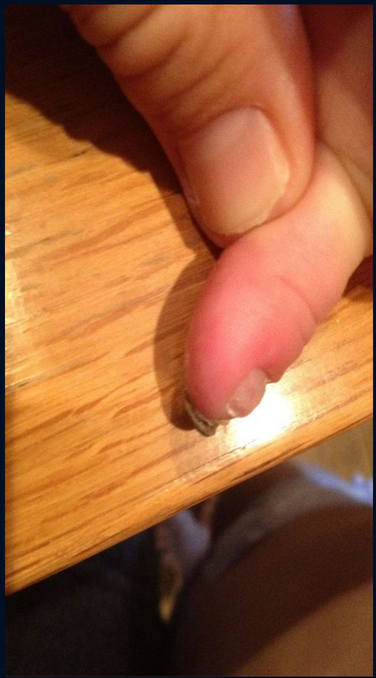
post-PEMF



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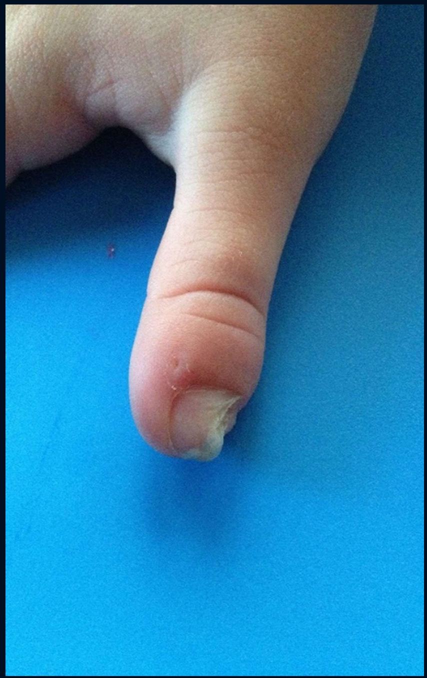
post-PEMF



10.02.12

post-PEMF

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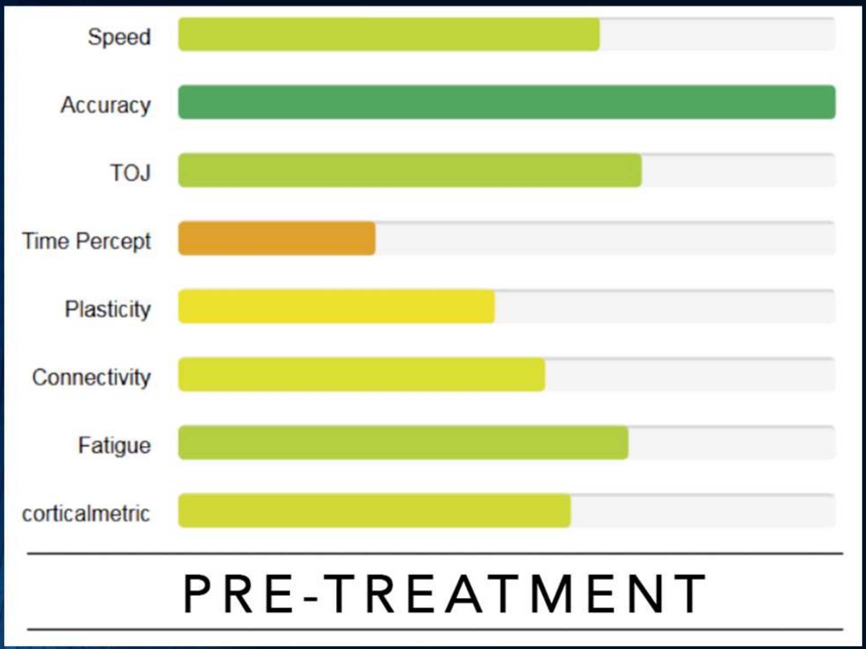
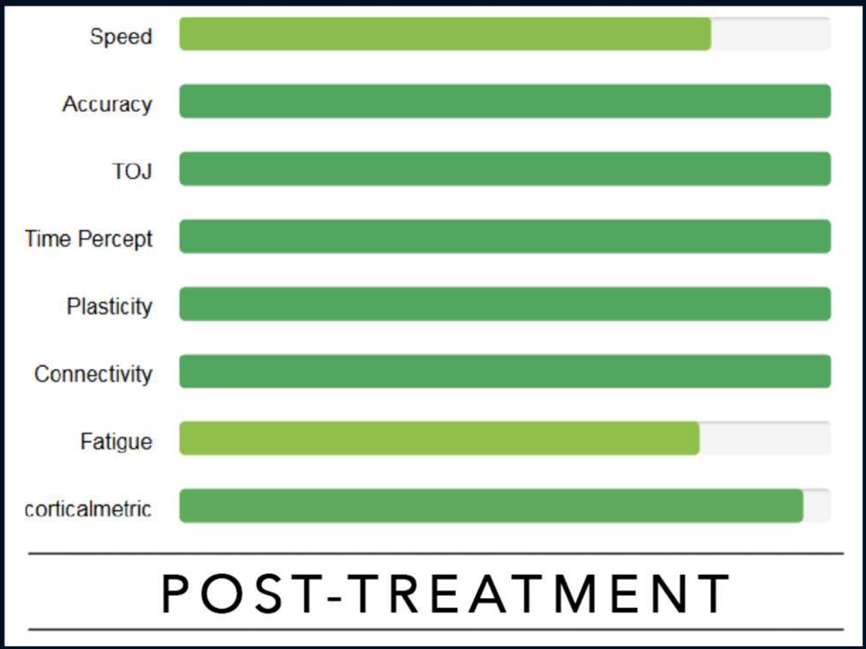
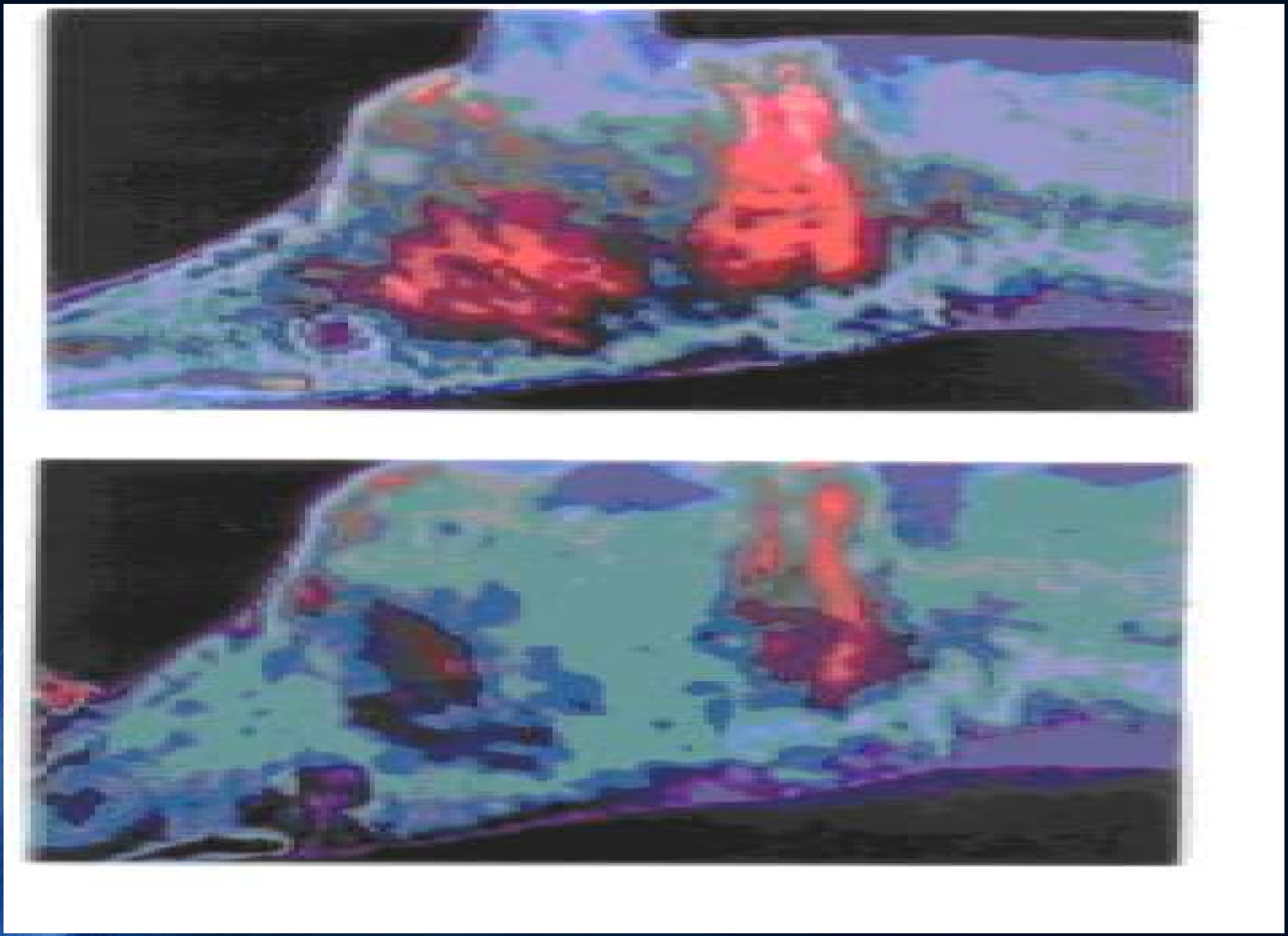
improvements in Brain Gauge performance parallel mTBI recovery





40 yo direct L parietal head trauma from an MVA. 8 mos later continued cognitive, visual, vestibular dysfunction. Sensitive to light/noise, neck pain, unable to continue post-graduate studies. One previous concussion 2005.

Cortical Metrics (CM) tests showed diminished function in multiple metrics. After a single treatment focusing on C1-C3 and occipital, temporal, parietal, and sphenoid regions, reported improved cognitive function and reduced sensitivity to light/noise. CM one day post-treatment show greatly improved function in all areas. Objective findings post treatment showed improvements in visual tracking and pupillary response and Babinski response. Returned to graduate program.



low intensity PEMFs

< 10 mT (100 gauss)

pain perception and pain-related EEG changes in humans

- 2 hr with 0.02-0.07 mT/20-70 µT ELF MFs
- caused positive change in pain-related EEG patterns

Sartucci F, Bonfiglio L, Del Seppia C et al. (1997) Changes in pain perception and pain-related somatosensory evoked potentials in humans produced by exposure to oscillating magnetic fields. Brain Res 769(2): 362–366.

back pain or whiplash syndrome

- up to 30 μT PEMF twice a day for 2 weeks
- along with usual pain medications
- relieves pain in 8 days in the PEMF group vs 12 days in controls
- headache halved in PEMF group
- neck and shoulder/ arm pain improved by one-third versus medications alone

Thuile C, Walzl M. (2002) Evaluation of electromagnetic fields in the treatment of pain in patients with lumbar radiculopathy or the VAS-pain and anxiety ratings pain and anxiety ratings whiplash syndrome. Neuro Rehabil 17: 63–67.

arthroscopic treatment of knee cartilage

- 75 Hz, rectangular wave after 2 groups: lower-intensity control (0.05 mT/50 μT) and active (1.5 mT),
- for 90 days, 6 h per day.
- knee score values at 90 days higher in actives
- NSAID use 26% active, 75% control
- 3-year follow-up, % completely recovered was higher in actives

Zorzi C, Dall'Oca C, Cadossi R et al. (July 2007) Effects of pulsed electromagnetic fields on patients' recovery after arthroscopic surgery: Prospective, randomized and double-blind study.
Knee Surg Sports Traumatol Arthrosc 15(7): 830–834.

knee osteoarthritis [OA]

- grade 3
- 50 Hz, 105 µT PEMF, 30 min, for 3 weeks
- pain improved significantly in both sham and active treatment groups relatively equally ($p < 0.000$).
- actives significant improvement in am stiffness and activities of daily living (ADL) vs controls.

Ay S, Evcik D. (April 2009) The effects of pulsed electromagnetic fields in the treatment of knee osteoarthritis: A randomized, placebo-controlled trial. Rheumatol Int 29(6): 663–666.

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fibromyalgia

- acute 30 min MF exposure
- <= 400 μT; < 3 kHz
- significant pre–post effect in
- VAS-pain and anxiety ratings

Shupak NM, McKay JC, Nielson WR et al. (2006) Exposure to a specific pulsed low-frequency magnetic field: A double-blind placebo-controlled study of effects on pain ratings in rheumatoid arthritis and fibromyalgia patients. Pain Res Manage 11(2): 85–90.

- small, battery-operated very weak field strengths benefit musculoskeletal disorders (Fischer, 2002).
- because of the very low strength used, treatment at the site of pain may need to last between 11 and 132 days, two times per week, 4 h each, and, if needed, continuous use.

Fischer G. (2002) Relieving pain in diseases of the musculoskeletal system with small apparatuses that produce magnetic fields, Personal communication.

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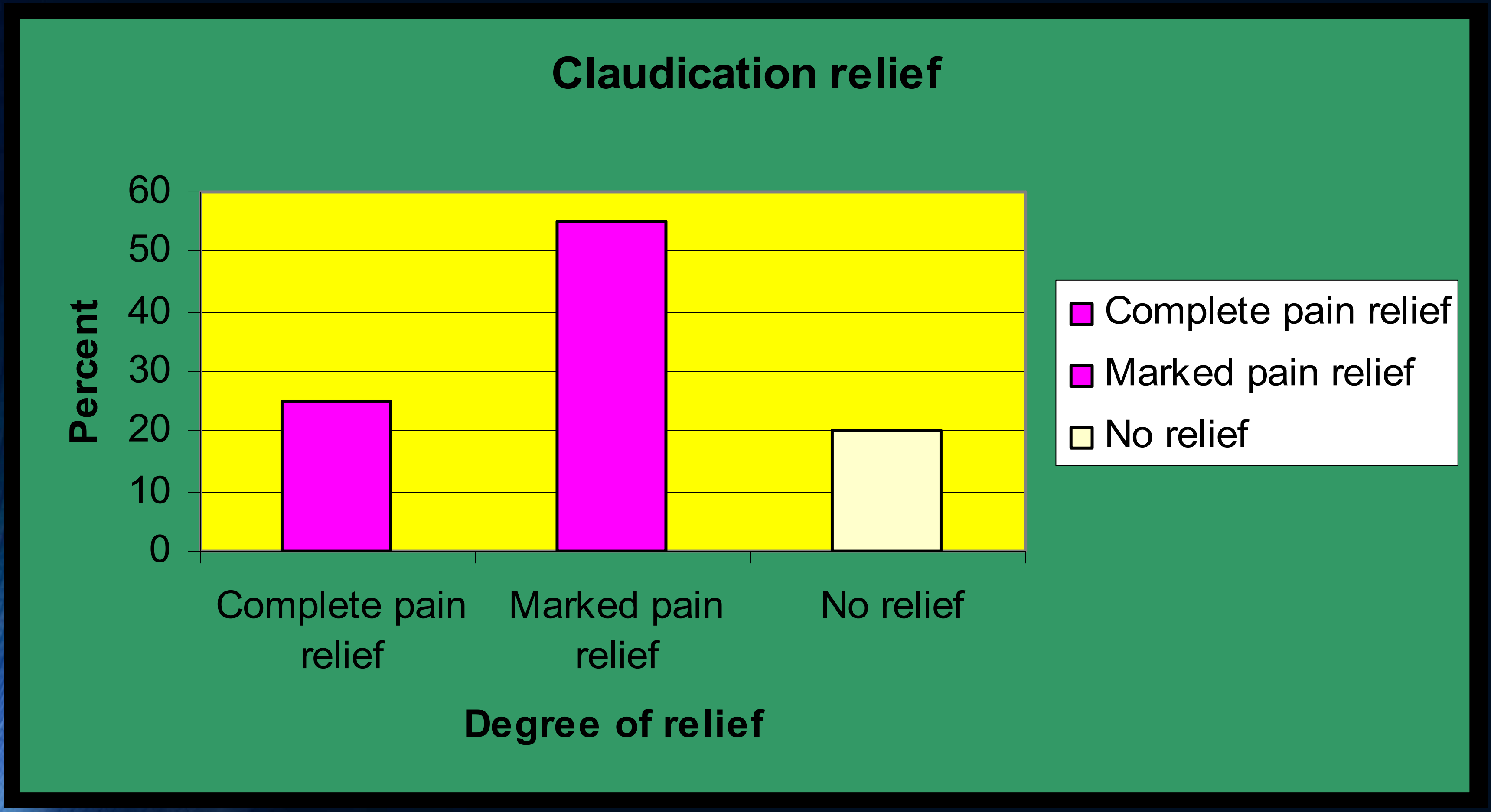
atherosclerosis



strength (B) in mT 2.5, pulsed, half sinusoidal, 100 Hz, 20‘, 15 treatments

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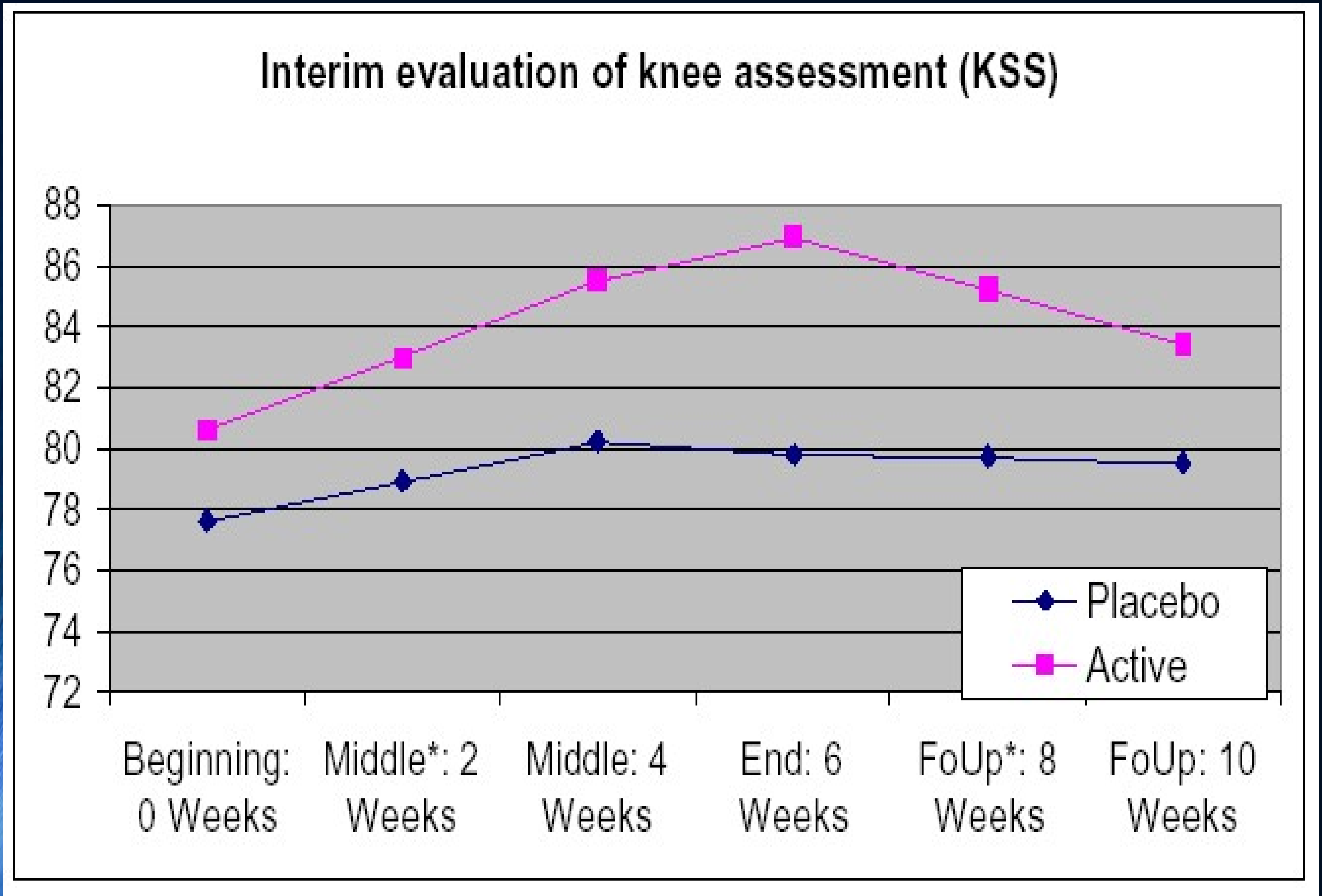

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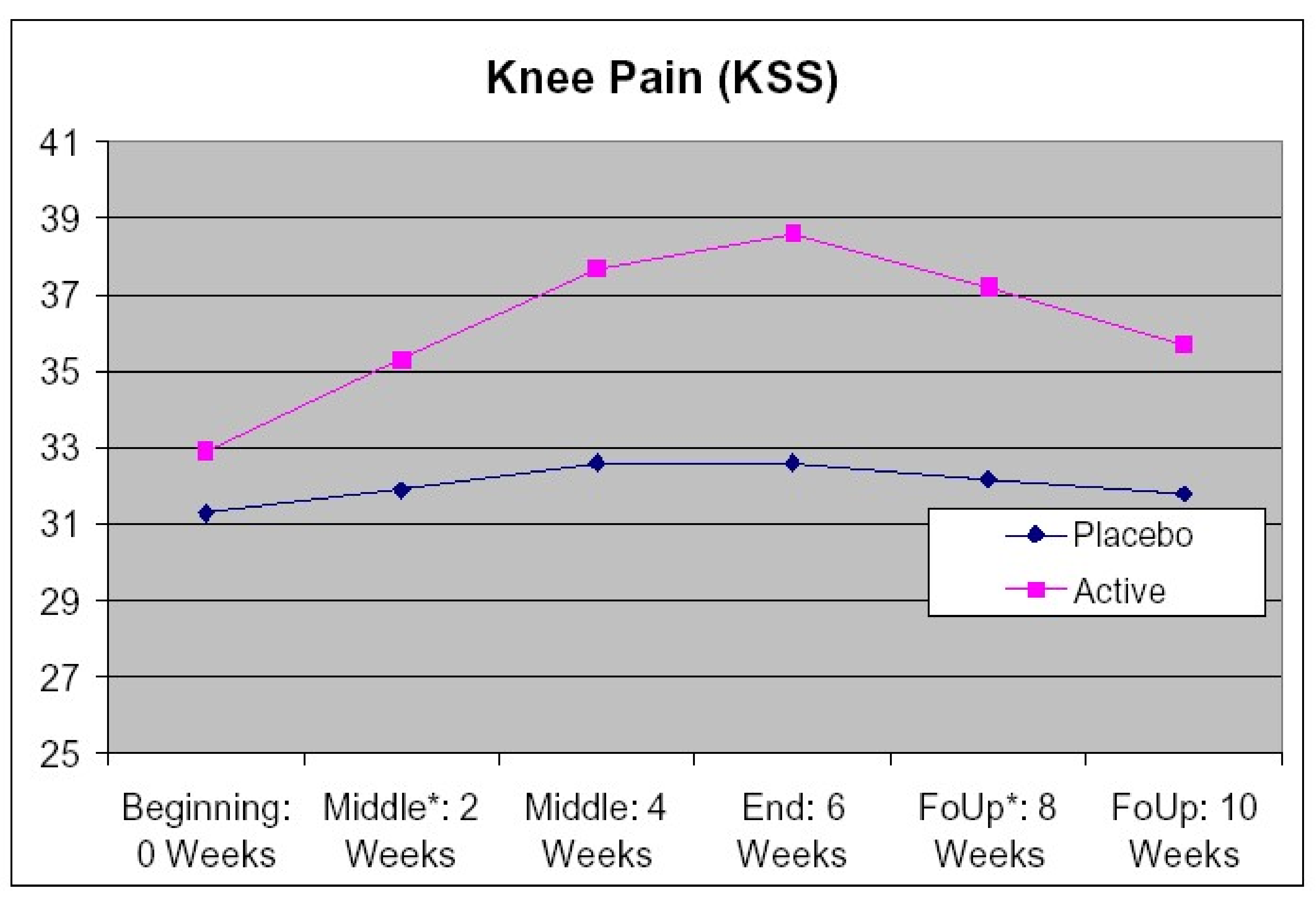

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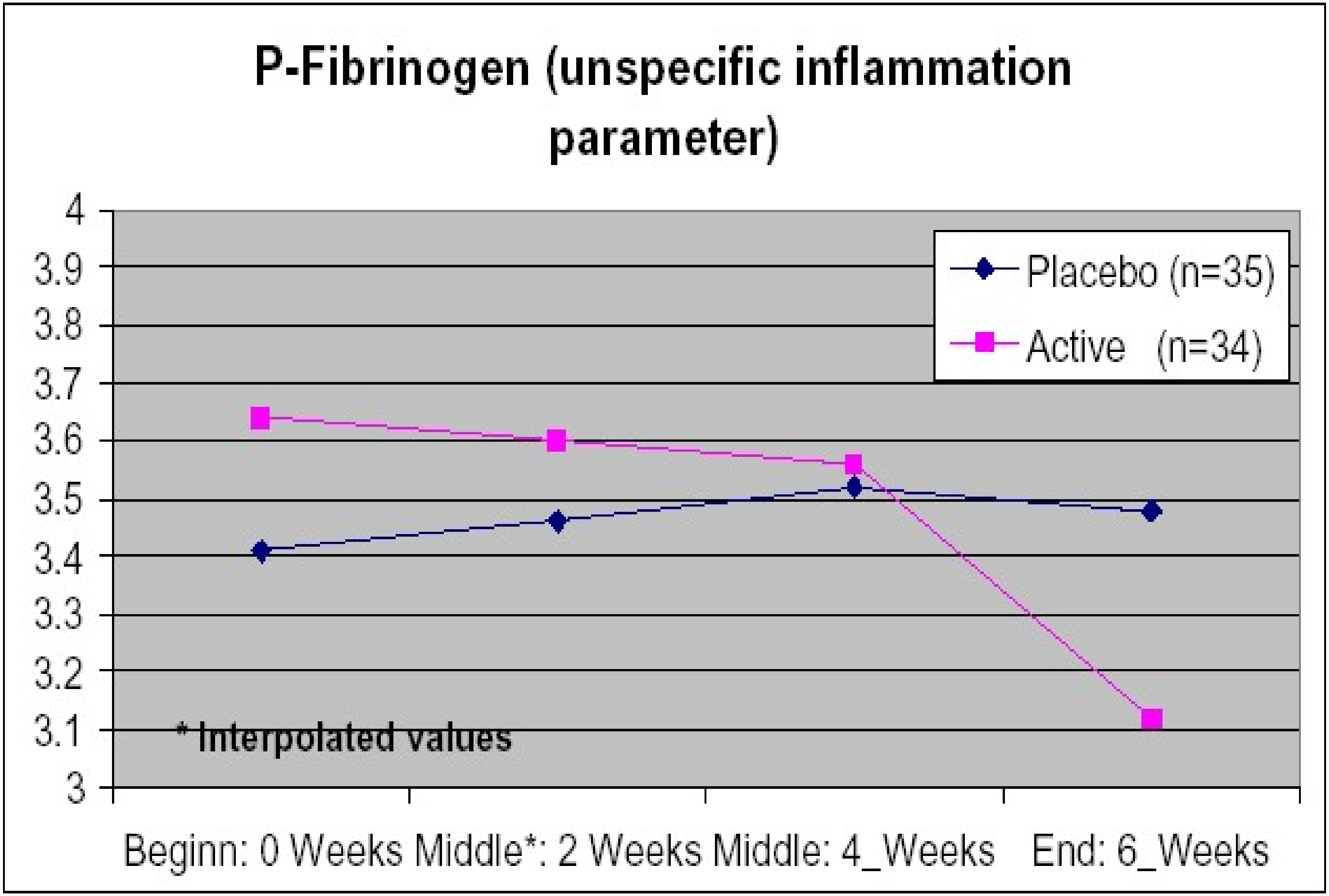

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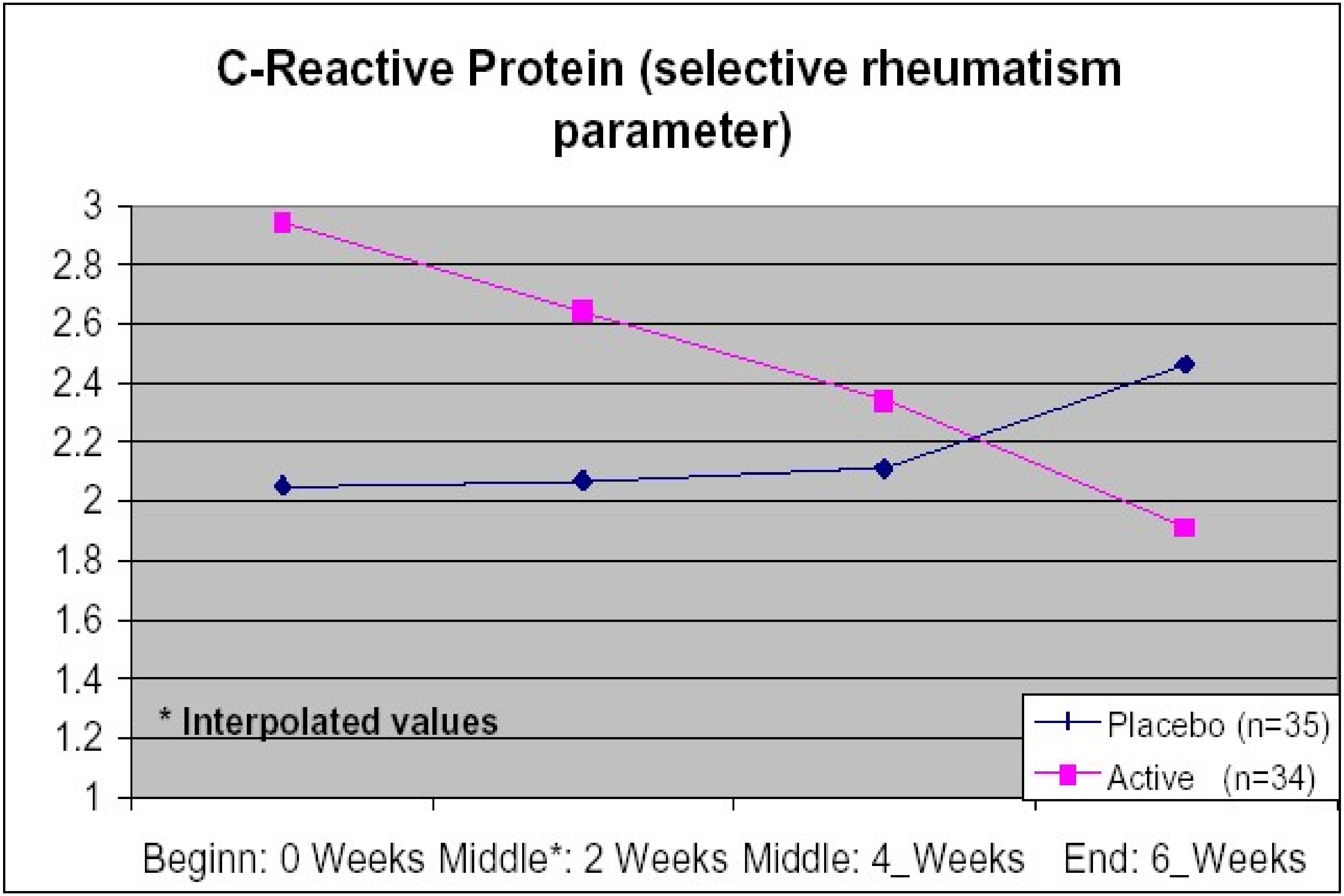

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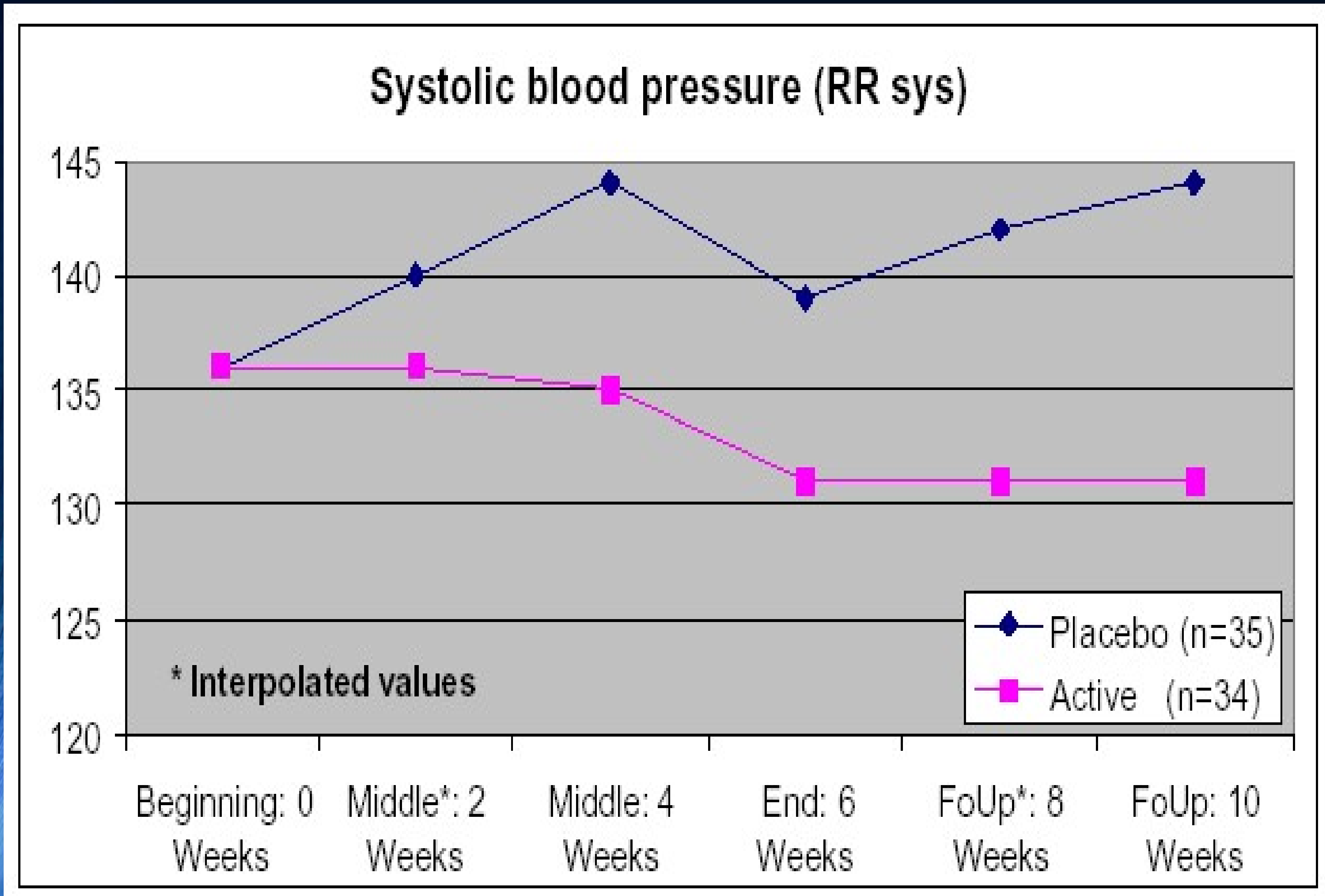

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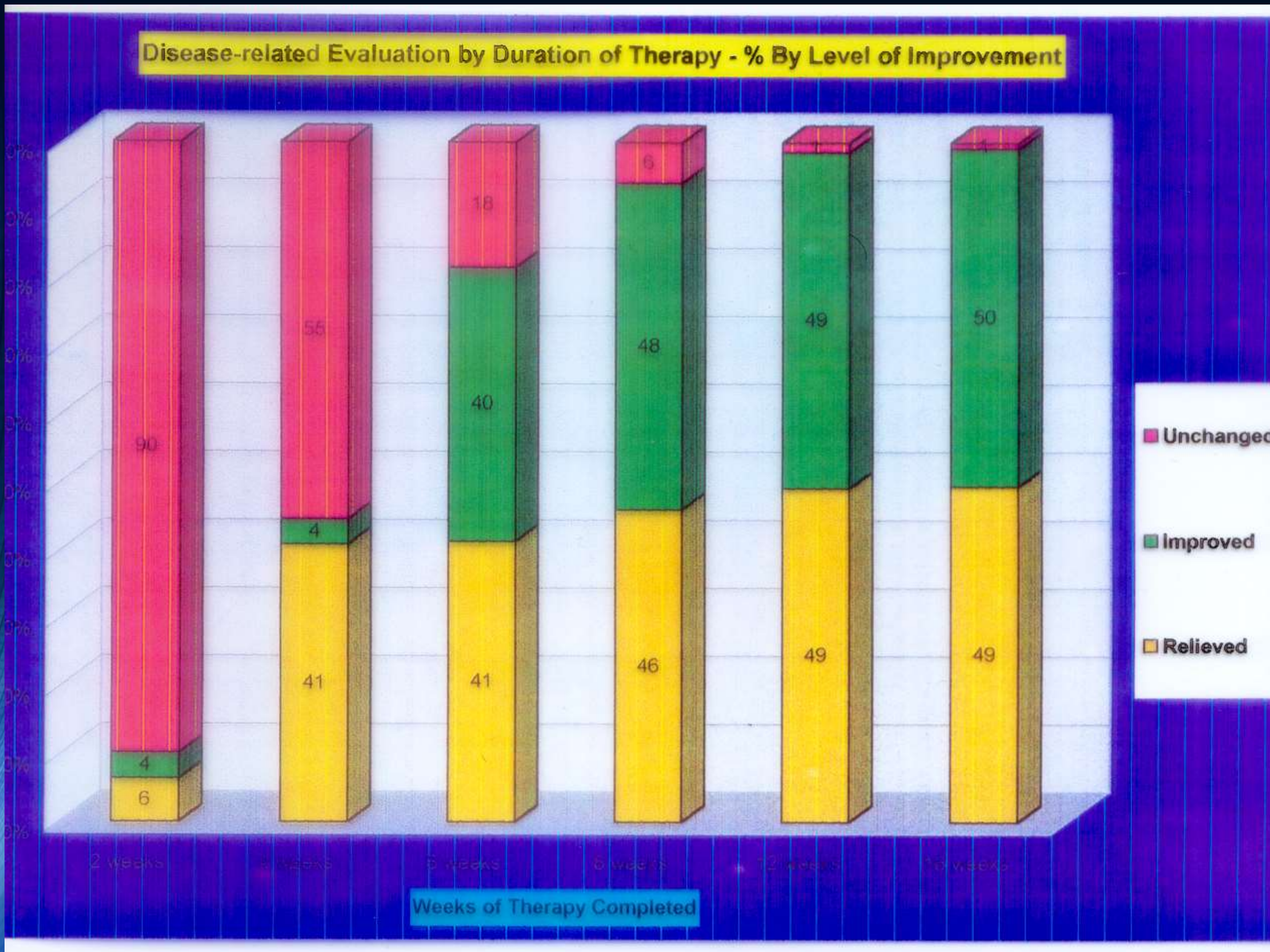


magnet fields heal wounds

- ‘88 accident to shin; several operations;
- diabetes; wound did’t heal; discharge; pain
- 1992 surgery to cover the wound
- 100 μT pad twice a day 8 mins
- wounds started to heal
- stopped treating; 14 d wound burst open again
- after 2 wks used again; wounds healed
- slept better; digestion better; lost weight;
- less tired; not only healed wounds, also general health improved

Offene Wunden am Knöchel.

Nach der Magnetfeldtherapie.

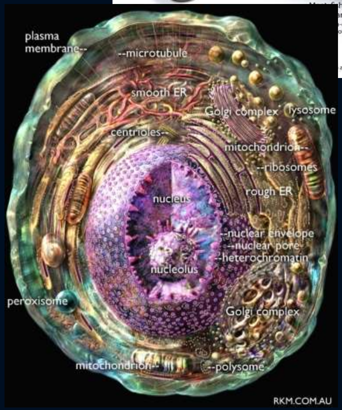
practical considerations

to build a house you need:

- bricks and mortar
- workers
- plans
- tools
  - hand tools vs
  - power tools
- power

to repair the body you need:

- nutrients
- functional cells
- functional genetics
- fuel/energy
- natural vs
  stimulated energy



safety of high intensity PEMFs

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risk

- Macaque monkeys exposed 18 hr/day for 21 day periods.
  - no striking or consistent changes in appearance, demeanor, or behavior
  - brains of 5 autopsied animals normal
  - no significant metabolic alterations
- rats electrically stimulated to produce seizures, PEMFs inhibited generation of seizures.
- rTMS studies found reductions in suicidality in PCS; minimal side effects; no one died of suicide within 6 month follow-up.

George MS, Raman R, Benedek DM, et al. A two-site pilot randomized 3 day trial of high dose left prefrontal repetitive transcranial magnetic stimulation (rTMS) for suicidal inpatients. Brain Stimul. 2014 May-Jun;7(3):421-31.
Ossenkopp KP, Cain DP. Inhibitory effects of acute exposure to low-intensity 60-hz magnetic fields on electrically kindled seizures in rats. Brain Res 442(2):255-260, 1988.
Wolpaw JR, Seegal RF, Dowman R. Chronic exposure of primates to 60-Hz electric and magnetic fields: I. Exposure system and measurements of general health and performance. Bioelectromagnetics. 1989;10(3):277-88..

risk

- TMS or rTMS does not carry risk since total time too short.
- 1 patient w 70 treatment sessions over 12 months, 420,000 pulses, with no side effects
- 75-yo had 130 sessions over 26 mons, 156,000 stimuli
- 7 patients had 60 sessions over 12 months, 72,000 stimuli
- healthy men had 12,960 rTMS magnetic pulses a day for up to 3 days in 1 week, 38,880 pulses over 1 week
  - one of the largest known rTMS exposures
  - no significant side effects
- doses to 12,960 pulses/day appear safe and tolerable

Anderson B, Mishory A, Nahas Z, Borckardt JJ, Yamanaka K, Rastogi K, George MS. Tolerability and safety of high daily doses of repetitive transcranial magnetic stimulation in healthy young men. J ECT. 2006 Mar;22(1):49-53.
Rossia S, Hallett M, Rossini, PM, Pascual-Leone A. The Safety of TMS Consensus Group1. Safety, ethical considerations, and application guidelines for the use of transcranial magnetic stimulation

risk

- relapsing remitting MS with TBI
- no patient had relapse during follow-up for over 8 mons
- magnetic brain stimulation easy to perform, painless, and safe

Ingram DA, Thompson AJ, Swash M. Central motor conduction in multiple sclerosis: evaluation of abnormalities revealed by transcutaneous magnetic stimulation of the brain. J Neurol Neurosurg Psychiatry 51(4):487-494, 1988.

risk

- question of whether PEMFs act as cancer promoter
- rats w experimental brain glioma
- no promotion tumor growth

Eberhardt JL, Persson BRR. Development of rat brain tumours during exposure to continuous and pulsed 915 MHz electromagnetic radiation (meeting abstract). First World Congress for Electricity and Magnetism in Biology and Medicine, 14-19 June, Lake Buena Vista, FL, Abstract No. I-1, p. 27-28, 1992.

levels of illness

- the body may progress through 1 or more stages of reaction to physical insults.
- using common cold, as an example, the stages are:
  - energetic stage (i.e. tired/achy)
  - physiological stage (i.e. runny nose, sneezing)
  - patho-physiological stage (i.e. coughing, phlegm)
  - pathologic stage (i.e. pneumonia, abscess)

levels of illness

treatment response

- energetic stage - very rapid – mins to hrs
- physiological stage - quick – hrs to 1-2 days
- patho-physiological stage – days to weeks
- pathologic stage – weeks to yrs

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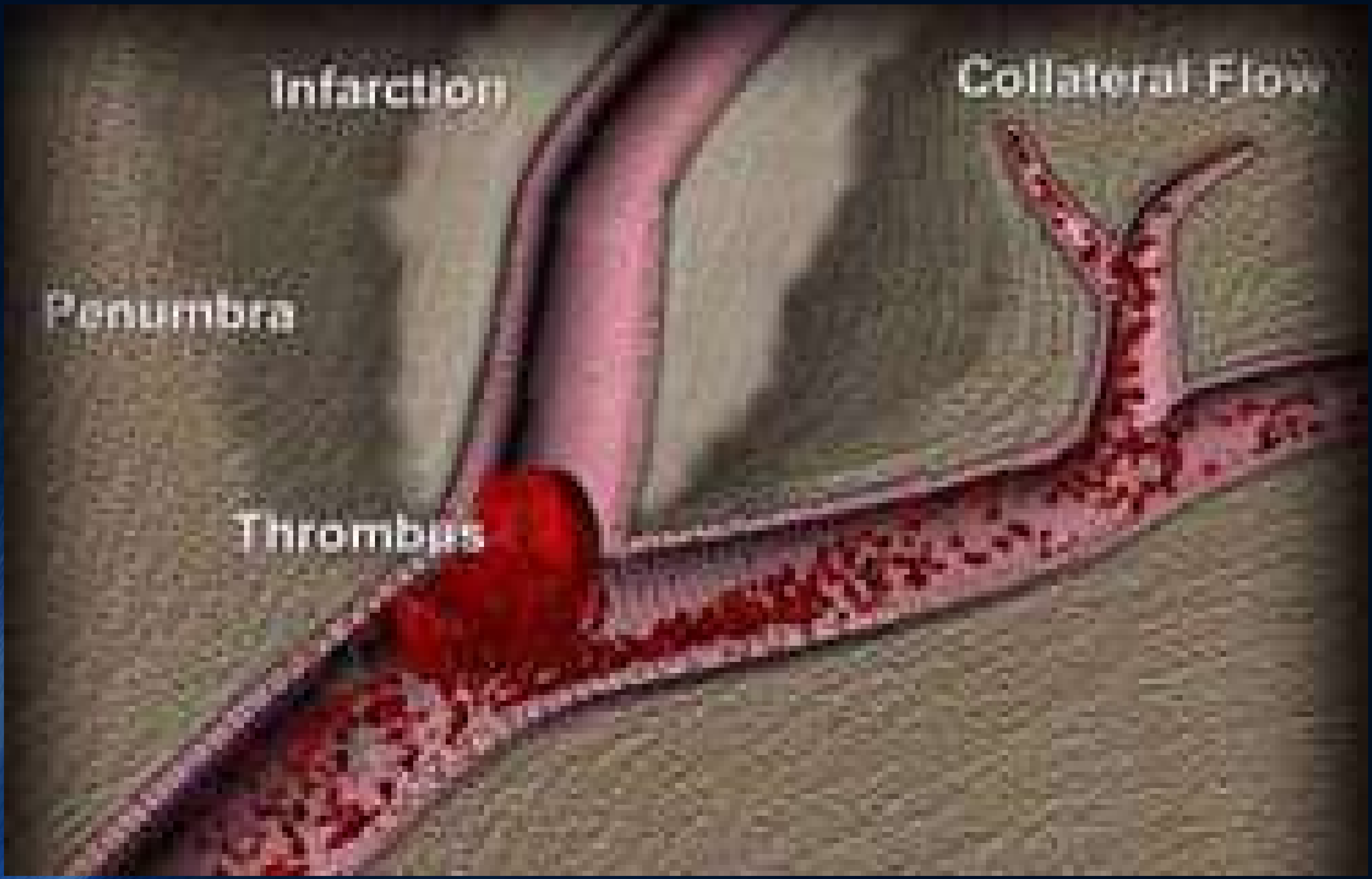
penumbral effect



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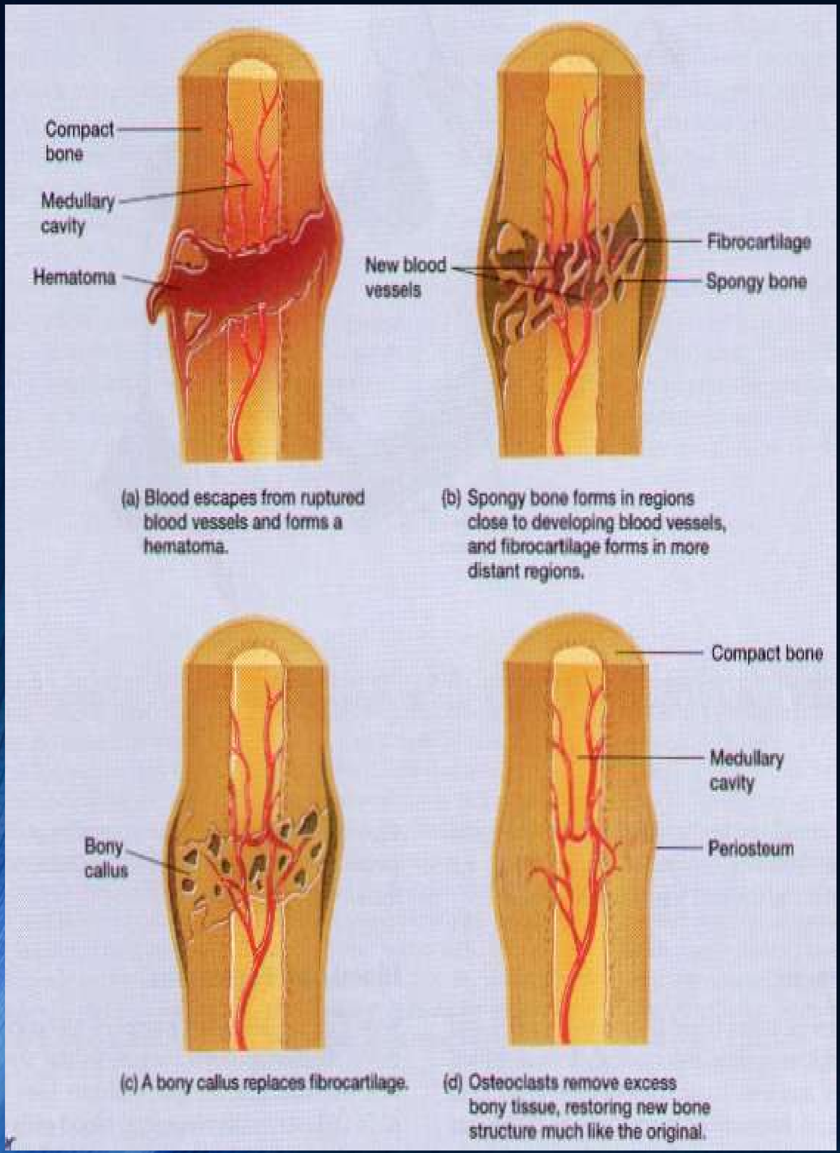
patho-physiologic lesion – nonunion fracture

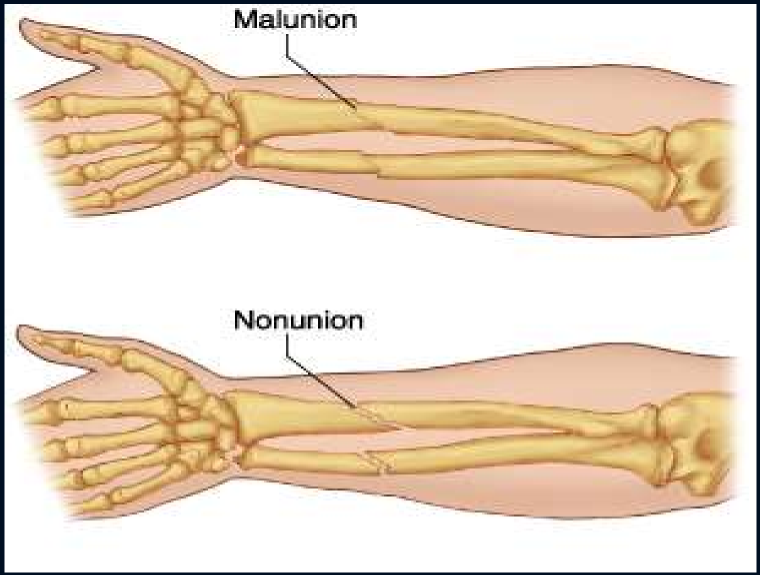


(a) Blood escapes from ruptured blood vessels and forms a hematoma.

(b) Spongy bone forms in regions close to developing blood vessels, and fibrocartilage forms in more distant regions.

(c) A bony callus replaces fibrocartilage.

(d) Osteoclasts remove excess bony tissue, restoring new bone structure much like the original.



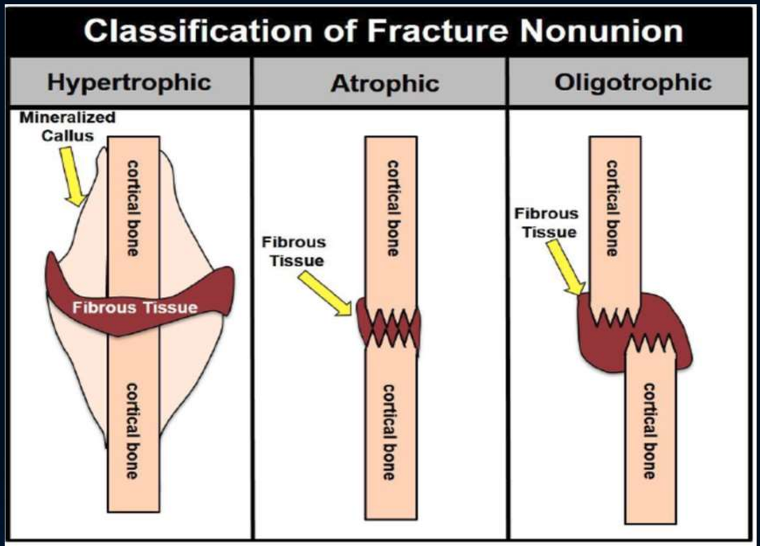


Figure 2: Classification of fracture nonunion

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magnetic field therapies do not raise the dead !

PEMF healing response

time taken to get response by the body is determined by the body's self -healing processes, which vary from person to another.

with this understanding, consider the following:

a) refreshing sleep first needs to be recovered; deep sleep regenerates

b) a.m. rx re-energizes awake functioning

c) p.m. rx relieves pains or tensions

d) when pain is relieved, real healing treatment starts, using key 3 & up gradually.

e) duration/depth chronic pathology, body's "pollution“ plus use of food, air, liquids, medicines, stress reduction, lifestyle, environment, pollution, epidemics, electrosmog, etc.

magnetic field sensitivity

who will be “over” sensitive?

- very anxious
- very sensitive to medications
- extreme weather sensitivity
- sensitive to computer terminals
- hands on healers
- dowsers
- neg. reactions to other magnets
- hyper inflamed
- neuro-toxicity
- borderline personalities

side effects

- no serious, permanent side effects reported in Japan in 20 yrs use
- studies of MRI workers indicated no adverse, long term effects to higher magnetic fields
- initial exacerbation of discomfort, burning, warmth in some according to anecdotal use

harmful effects are not normally observed during exposure to even strong MFs.

strong fields should be used with caution if at all in those with magnetically sensitive foreign bodies, electrical devices, pregnancy and possibly those known to be especially vulnerable to cardiac dysrhythmias.

CONTRAINDICATIONS

- pregnancy, pacemakers
- pain modulators
- insulin pumps, defibrillators
- hyperthyroidism, myasthenia gravis
- active bleeding [especially gi]
- adrenal/hypothalamic/pituitary dysfunction
- active Tb, acute serious viral infections
- cancer, active current
- psychoses

other stimulation technologies

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Table 3. Comparison of Electromagnetic Field Parameters Among Various Electromagnetic Treatment Modalities Currently Used for Depression and LFMS

	Method	Field	Pulse	Frequency
ECT	Electrode	>200 V/m	1 msec	60 Hz
DBS	Implant	100 V/m	60 μsec	120 Hz
rTMS	Coil	100 V/m	500 μsec	10 Hz
LFMS	Coil	1 V/m	256 μsec	1 kHz

The delivery method, electric field strength, and pulse characteristics for these electromagnetic therapies are shown. Most treatment modalities feature electric fields well over the 50 V/m threshold required for axonal stimulation. Note that the small voltage used in DBS results in a large electric field when applied over the small distance between electrodes positioned in the brain.

DBS, deep brain stimulation; ECT, electroconvulsive therapy; LFMS, low field magnetic stimulation; rTMS, repetitive transcranial magnetic stimulation.

Rohan ML, Yamamoto RT, Ravichandran CT, et al. Rapid mood-elevating effects of low field magnetic stimulation in depression. Biol Psychiatry. 2014 Aug 1;76(3):186-93.

- maximum injected current density by CES

  1-mA stimulus, is 5 pA/cm2 at radius of 13 mm
- current density needed to elicit a functional response is larger than 300 pA/cm2
- physiological effect of CES is not specific
- current which reaches the brain may cause release of neurotransmitters which may cause some effects such as relaxation

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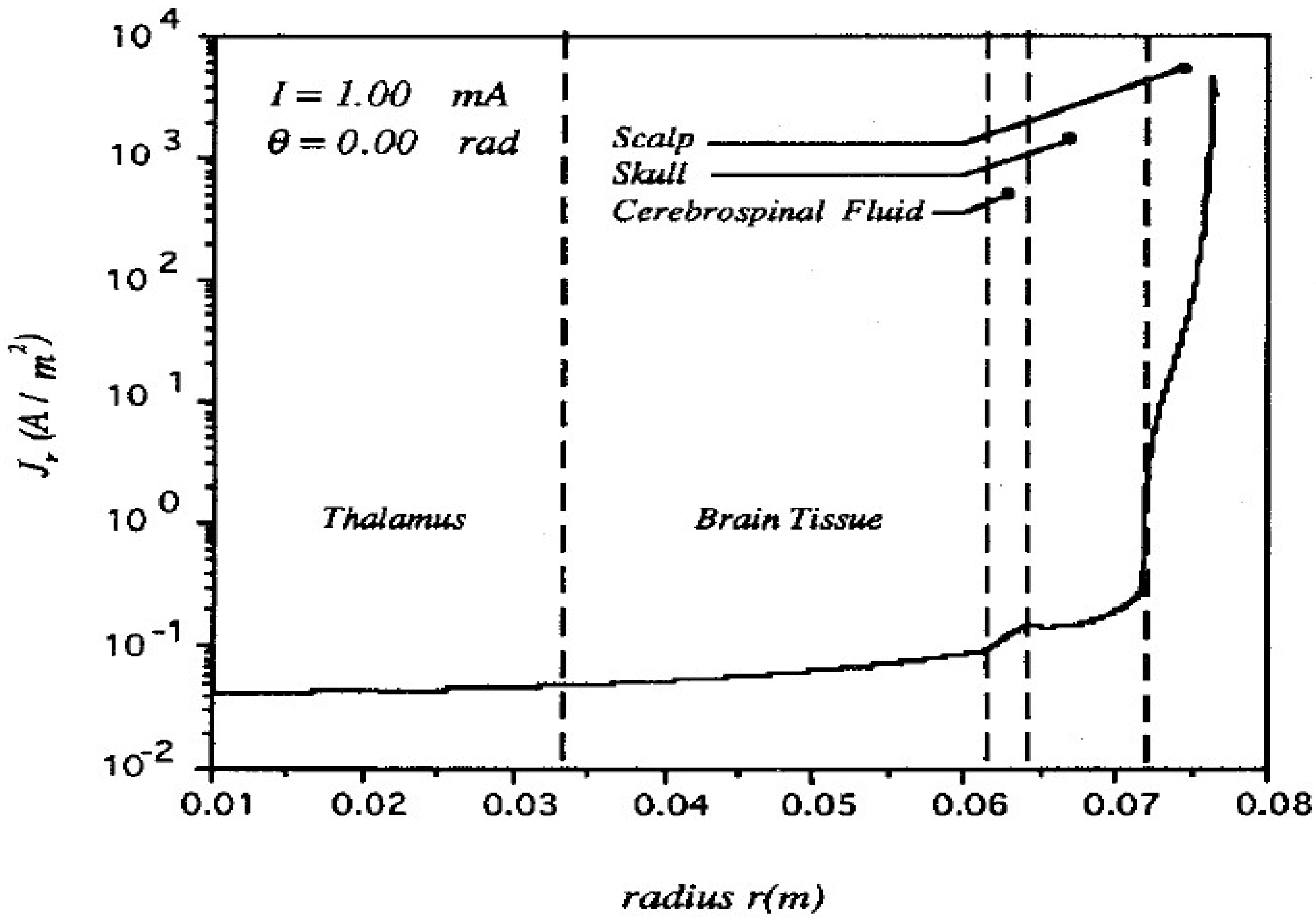

Fig. 4. The radial current density distribution $J_r(r, \theta)$ at $\theta = 0$, as a function of the radius.

Ferdjallah M, Bostick FX Jr, Barr RE. Potential and current density distributions of cranial electrotherapy stimulation (CES) i in a four-concentric-spheres model. IEEE Trans Biomed Eng. 1996 Sep;43(9):939-43.

devices

beyond theory

what PEMF systems are available?

FDA-approved	OTC
Neocontrol/Neotone	low intensity
?Regenerix; IVIVI	- FlexPulse
EBI/Osteologic/others	- many others
Magnatherm/Diapulse	high intensity
transcranial stimulation	- PEMF-120
others	- TeslaFit

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Neurostar

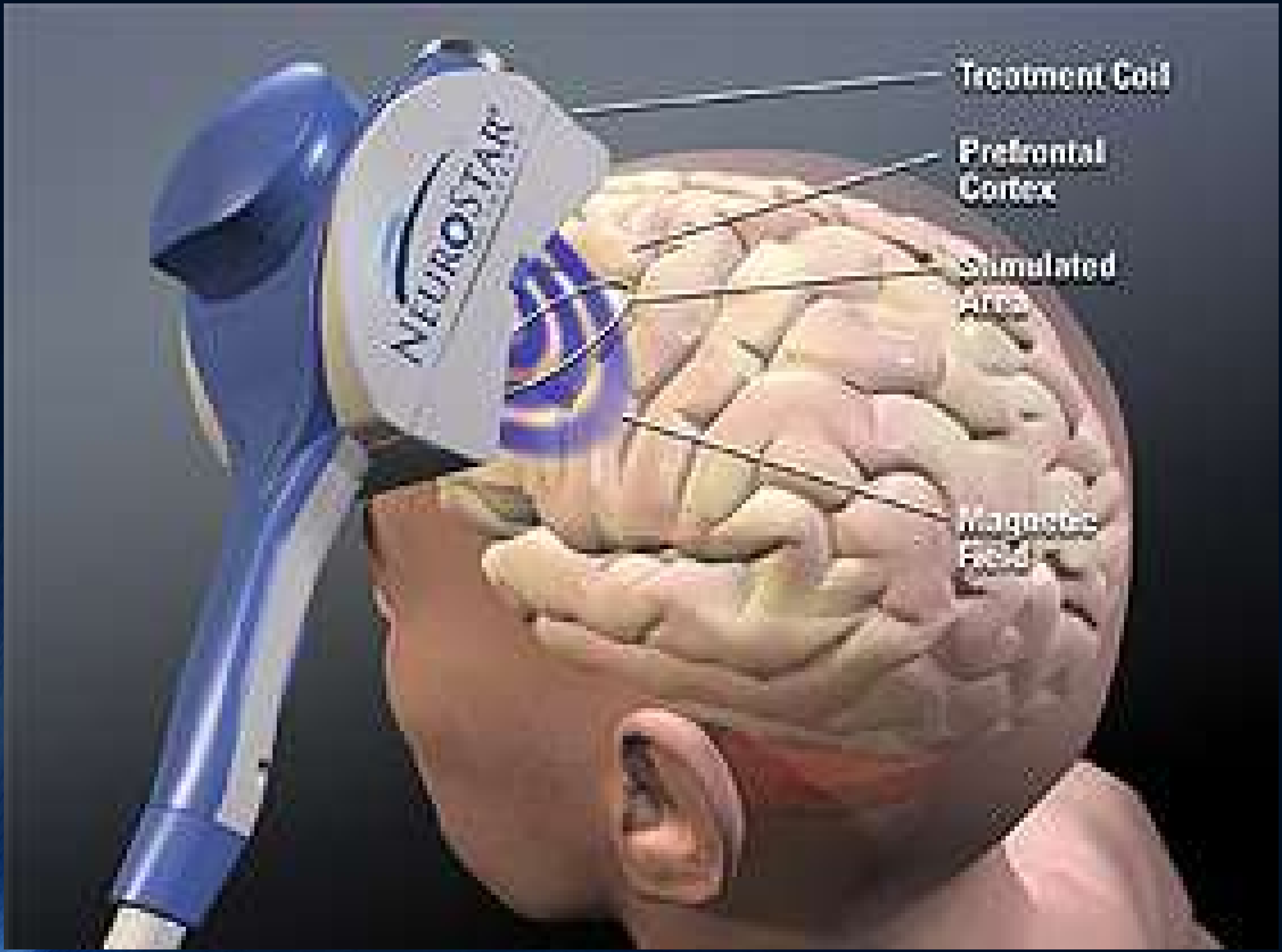

Figure 9–1. Coil positioning for active TMS (center) as well as several commonly used sham techniques (inserts). Active TMS is performed with the figure-eight coil tangential to the scalp, with the intersection of the figure-eight in direct contact with the scalp. All of the sham manipulations consist of angling the coil slightly off the head

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NEOCONTROL™

choosing a PEMF system

considerations:

- cost
- field intensity
- convenience
- applicators
- programs
- reliability
- health condition/s
- value
- whole body or local
- research

CENTURION

wave form: square
max intensity: 50 gauss (5,000 µt)
frequencies: 2 – 30 hz
programs: 4
duration: 20 – 60 minutes

iMRS Professional

waveforms: sawtooth large pad;
square small pad
max intensity:
pads 0.64 gauss (64 µt);
probe 3 g (300 µt);
sensitive setting ~1-10 µt
frequencies: 0.1-32 hz
programs: 4
duration: 2-60 minutes
small pad - 4 brain wave levels
add-ons: audio jack/light goggles; HRV

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OMNIUM 1 (basic combo set)

wave form: sawtooth on large pad, square on small pad
max intensity: full-body applicator 0.45 gauss (45 µt), small applicator 0.7 gauss (70 µt)
frequency range: 0.1 – 32 hertz
programs: 5
duration: 1 – 60 minutes
add-ons: sound and light therapy goggles

LENYO FRACTAL

wave form: square
max intensity: 0.1 gauss (10 μt)
frequency range: 1 hz - 200 khz
programs: 32;

20 subprograms each
duration: 10 – 20 minutes

PARMEDS home

wave form: square
max intensity: full-body mattress 70 gauss and small mattress 200 gauss
frequency range: 1 – 50 hz
programs: 10
duration: 15 – 30 minutes

PARMEDS ultra 3D

wave form: square
max intensity: full-body mattress 500 gauss
frequency range: 1 – 50 hz
programs: 10 , with computer 72+
duration: 20 – 30 min., 1-99 min. programmable

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MAS Special Multi +

wave form: selectable
max intensity: full-body mattress 25 Gauss (25000 uT), small applicator 100 Gauss (10000 μT)
frequency range: 0.2 – 9999 Hz
programs: 90+
duration: 1 min – 12 hours

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PEMF 120

wave form: impulse
max intensity: 20,000 gauss (2T)
pulse rate: 1 – 50 pulses/sec
duration: 1 – 10 minutes

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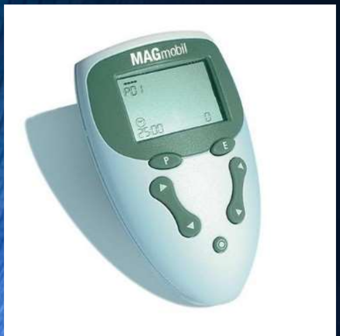
MAG MOBIL

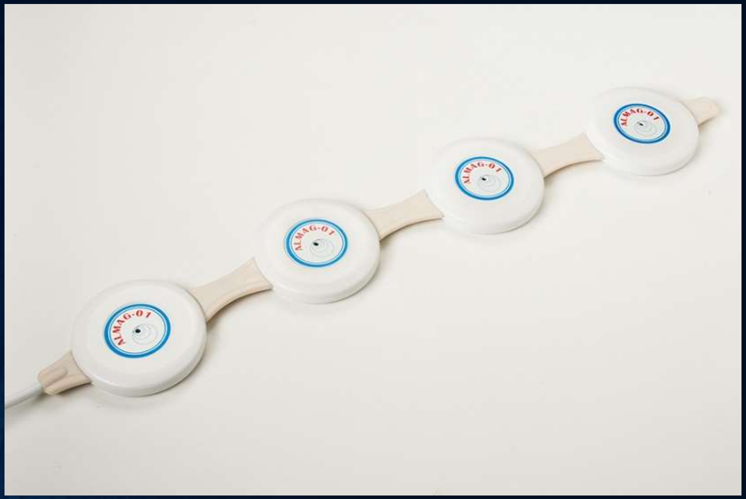
wave form: sinus
max intensity: 0.5 gauss (50 µt)
frequency range: 2 – 15 hz
programs: 6
duration: 5 – 30 min. or continuous



MEDITHERA

wave form: sawtooth
max intensity: 0.75 gauss (75 µt)
frequency range: 0.3 – 250 hz
programs: 3
duration: 1 – 59 min.

ALMAG



wave form: sinus
max intensity: 200 gauss (20000 µT)
frequency: 7.8 hz
program duration: 20 min

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Earthpulse

wave form: square
max intensity: 1100 gauss (110000 μT)
frequency range: 1 – 14.1 hz
programs: 10
duration: up to 12 hours

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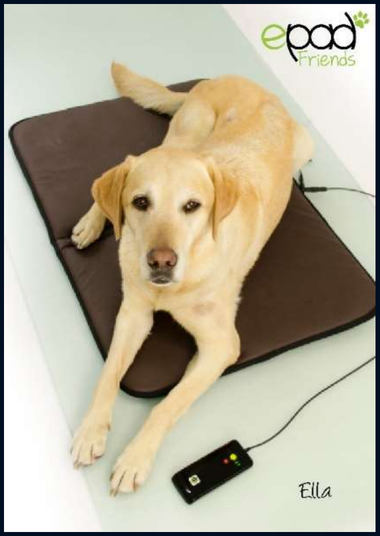

ePAD Relax
ePAD Sport
ePAD Friends

wave form: rectangle
max intensity: 0.4 gauss (40 µt)
frequency range:

3/5/8 hz for epad relax;
3/8/1500 hz for epad sport;
3/8/25 hz for epad friends
programs: 3
duration: 25 minutes

FLEXPULSE

wave form: trapezoidal
max intensity: 200 gauss (20000 µt)
frequency range: 3 – 1000 hz
programs: 6
duration: 10 – 60 min. or continuous
battery-operated

FlexPulse

Program	Function
1: 10Hz	Cellular Stimulation
2: 10Hz/100Hz	Cellular Repair
3: 3Hz	Deep Relaxation
4: 7.83Hz	Balance/restoration
5: 23Hz	Alertness/e-smog
6: 1,000Hz	Mood Balancing

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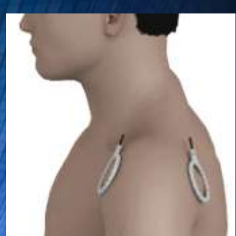
MICRO PULSE

wave form: trapezoidal
max intensity: 200 gauss (20000 µt)
2 frequencies: 10 hz, 100 hz
program: 1
duration: continuous

battery-operated

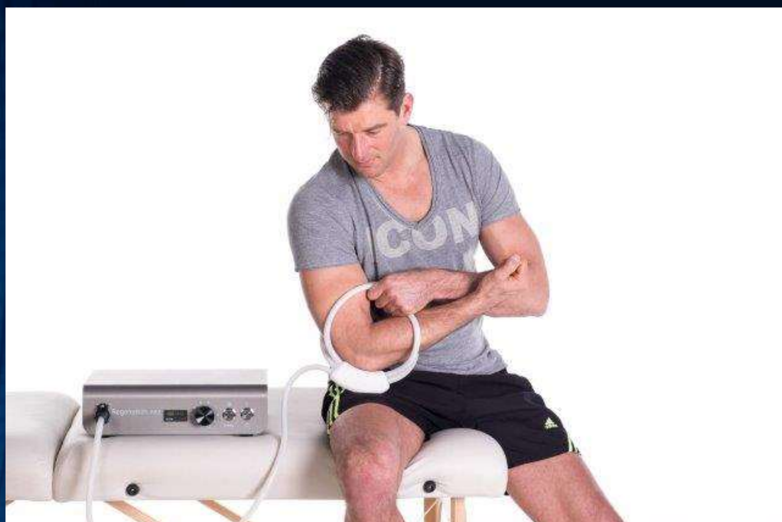




SOTA Magnetic Pulser

wave form: impulse
max intensity: slow mode 6000 gauss (600000 µt), fast mode 2500 gauss (250000 µt)
pulse rate:

slow mode 1 pulse per 5 seconds,
fast mode 1 pulse per second
programs: 2
duration: 20 min.



TeslaFit Pro

waveform: impulse
max intensity: 4940 gauss (494000 µt)
pulse rate: 1-50 pulses per second
duration: 5 min.

TeslaFit Plus

waveform: impulse
max intensity: 2300 gauss (230000 µt)
pulse rate: 1-50 pulses per second
duration: 5, 15, 30 min.

TeslaFit systems

- high intensity systems
- with muscle contracting capability
- produce better effects, faster

———-

solid state switch
vs
capacitor discharge

BIOTORUS

wave form: sawtooth
max intensity: 35 gauss (3500 μT)
frequency range: 1.3 72.7 hz
programs: 3
duration: 5-60 min.

RESOURCES

http://www.drpawluk.com
http://www.bioelectromagnetics.org
http://www.emf-portal.de

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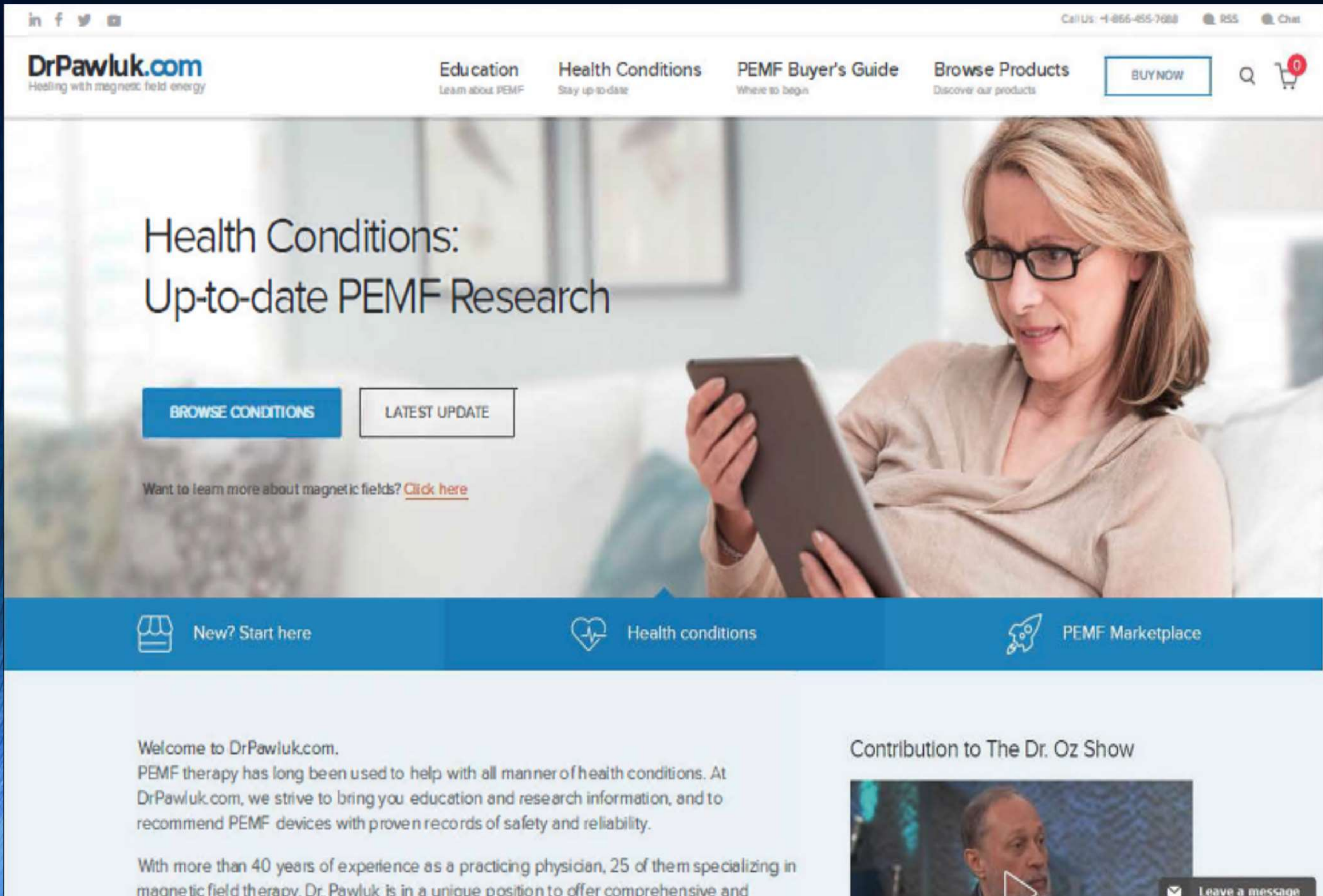

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