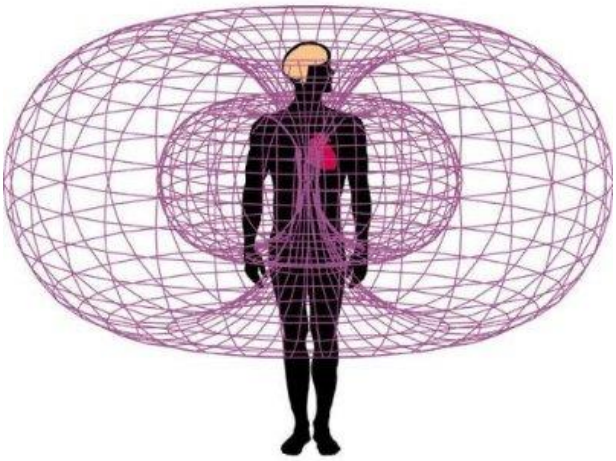
Biomagnetic Fields

The body produces its own very complex electrical activity. Wherever there is electrical activity, there is also a magnetic field. This is basic physics and applies to all life. The body's own magnetic fields (MFs) are extremely tiny—so tiny that they are easily obscured by the surrounding planetary and environmental fields. These external fields have to be blocked to allow study of the body's own magnetic fields. The natural internal electrical and magnetic fields of the body regulate all the body's processes and interact with one another. Unlocking these biomagnetic fields secrets opens new alternatives in diagnosis and treatment.



Biomagnetometers

There are many devices for taking measurement of electrical fields, including electroencephalograms (EEGs) and electrocardiograms (EKGs). There are significant limits to the information able to be gained from these, especially at the local cellular level. Electrical field measurement does not work well to find small areas of damage in the body as well as magnetic field measurements can. Electrical field measurement on the outside of the body can't "see" as deep into the body without having to insert probes. Also, electrical measurements capture voltage but magnetic measurements say more about total energy present or current, which is more physiologically relevant.

Biomagnetic fields are not blocked by tissues along their paths, such as the skull, as opposed to bioelectric fields. Biomagnetometers do not require electrode placement and allow intracellular currents to be measured compared to extracellular voltage charges. Therefore, magnetic field measurement allows for measuring cell membrane charges without penetration of the cell membrane. Cell membrane charge is important to determine how healthy a cell is. It therefore becomes easier to detect electric currents flowing within a person by detecting the associated MFs than by recording surface electric charges at the skin. This allows for accurate, non-invasive assessment of function or pathology.

Magnetically shielded rooms

Magnetically-shielded rooms have made it possible for new devices called SQUIDS to actually measure and map the fields of the whole body and its organs. Magnetic shielding requires the use of new artificial metals, called “mu” metals, combined with other metals, to get as close as possible to zero external magnetic fields. SQUIDS are Super-conducting Quantum Interference Devices. They are based on the physics of “Josephson Junctions” in super-conducting materials. The SQUIDS allow measurement of extremely tiny electrical and magnetic fields in the body or any given tissue under study.

Laboratories are very magnetically and electrically “noisy” environments. Even remote natural environments are still “noisy” relative to the body’s fields. The sensitivity of the SQUID and the amount of shielding determine how small the fields are that can be measured.

The body’s natural magnetic fields

The strength of the body’s fields in relation to the strength of the Earth’s magnetic field is shown in the table below. As can be seen, using the Earth’s magnetic field as a comparison, the body’s natural magnetic fields are incredibly tiny.

Strengths of endogenous magnetic fields versus Earth’s field

Signal source	FemtoTesla	Gauss	Earth’s field stronger by
Skeletal Muscle	~50,000	0.0000005	1 million times
Heart	~500,000	0.000005	100,000 times
Physiologic “noise”	50,000-5,000,000	0.0000005 0.00000005	1 – 10 million times
Earth’s field	50,000,000,000	0.5	

As widely known elsewhere in science and engineering, externally applied electric and magnetic fields interact with and affect each other. The body’s own biomagnetic fields have both time-varied (frequency) and DC components. While externally applied DC fields need to be stronger than the surrounding geomagnetic field to exert additional impact on the body, time-varied magnetic fields (TMF) can be much weaker than the Earth’s background field. In fact, the lower limits of strength of weak TMFs to have biologic effects have not been defined. What is known is that TMFs much weaker than the Earth’s field have been shown to exert actions on the body (to the picoTesla level, and maybe even to the femtoTesla level). Much of the instrumentation used for EMF treatment produces fields that are in the milliTesla range (which is hundreds of Gauss). These EMFs are thousands to tens of thousands times stronger than the Earth’s magnetic field. That means, for TMFs, they are tens to hundreds of millions times stronger than the body’s own EMFs. Some processes in the body only need very tiny levels of energy to create benefits, while others need much higher levels of energy. See the section on Application Basics for discussion on layers of energy in the body and to get an idea of the time that it takes to heal tissue.

Diagnostic use of biomagnetic measurements

The finding through objective basic research of these endogenous fields not only allows us to know what their magnitudes are, but also has allowed the development of new non-invasive

means of measuring cellular function. The technical ability to obtain sensitive, natural biomagnetic measurements is already in use in medicine, for instance, with magnetoencephalography (MEG). MEGs are used for helping neurosurgeons localize areas of the brain with increased electrical activity causing epileptic seizures. Studies are being done to evaluate cardiac function and pathology (magnetocardiography). Other applications are being considered, including measuring tissue iron loads in lung and liver, in the case of iron overload conditions. Muscle and other nerve function measurement systems are also possible in the future.

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