

## THERMAL VS. NON-THERMAL BIOLOGICAL EFFECTS

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### **ABSTRACT BODY:**

#### **Short Summary**

This is a biological approach to defining whether a biological effect arises from a thermal or non-thermal mechanism. The distinction between these mechanisms is often blurred. Thermal effects are recognized when identical temperature elevation-duration exposures from different sources lead to the same biological effect.

#### **Abstract:**

Detectable changes frequently occur when biological structures are exposed to electromagnetic waves. These changes may take various forms: structural, functional, or behavioral. They may be reversible or non-reversible, acute or delayed, obvious or subtle. Some changes are harmful, some are beneficial, and some have little or no consequence. Most will have a threshold, some will not.

The mechanism for inducing a biological change may be thermal, non-thermal, or some combination of thermal and non-thermal.

To a biologist, a thermal effect is defined as follows: if the same biological effect results from exposure to two different heat sources, such as microwaves and lasers, where the temperature elevation-duration profiles are the same, we say the effect is thermal. If not, then the effect is non-thermal.

Experimentally, the distinction between thermal and non-thermal biological effects is often blurred. For example, it is not always possible to set up identical exposures with the same energy absorption and distribution from two different sources. Furthermore, differences in effects may be due to statistical variation in measurement rather than to the fundamental mechanism.

Thermal effects in an organism are usually associated with heating of the whole body or an affected region that is sufficient to raise the temperature by a physiologically significant amount. Because of well developed thermostatic mechanisms in man and other animals, heating initiates thermoregulatory mechanisms to minimize the temperature elevation. Such mechanisms include sweating, blood flow changes, and behavior changes. Diurnal temperature variation in man averages about 0.5 °C, and temperature elevations less than this are not considered harmful.

Non-thermal effects typically involve a frequency dependent mechanism such as resonance, or an exposure to a very short high-amplitude electromagnetic pulse. In either case, temperature elevation has little or no effect. However, in cases in which non-thermal effects occur, there is energy absorbed. This energy eventually degrades into heat, which will ultimately elevate the temperature. If the temperature rise is sufficient to cause a biological effect, the distinction between a thermal and non-thermal mechanism is further obfuscated.